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SUMMER SESSION ............................................. February
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Stanford, California

Published by the University
UNIVERSITY CALENDAR

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This section describes requirements for degrees which apply to all students at Stanford University. Special departmental or school requirements are described in the section on the school or department itself.

Candidates may be presented for graduation in January, April, June, and September, but all diplomas are awarded in June. No degree will be conferred upon any person who has not spent at least three quarters in resident study at the University. No honorary degrees are given.

UNDERGRADUATE DEGREES

GENERAL STUDIES PROGRAM

The aims of education at Stanford are two-fold—to provide a liberal education and to make available the best in specialized study. A liberal education is designed to produce a citizen worthy of a free society and a free university. Specialized study aims to equip a student to take his place in the profession or vocation of his choice. Both are essential to modern life.

The General Studies Program, the product of intensive study, is directed toward satisfying these aims. It is spread over the entire four years of undergraduate work, permitting flexibility in planning individual programs of study. A student may spend much of the first two years in fulfilling General Studies requirements, or he may begin specialization early and carry both his major and General Studies courses for four years.

There is much in the Program which is aimed at enriching the undergraduate's years at Stanford. On the academic side, students may be awarded up to 45 units of credit toward graduation for superior work completed in high school. Such advanced credit will be established on the basis of scores achieved on the College Board Advanced Placement Examination, subject to University approval, or on advanced placement tests administered after the student arrives on campus. Honors programs are offered in a number of departments, or cooperatively among several departments. These permit more individualized study and development for the capable student. Specialization under the direction of a particular department is also an essential part of the student's undergraduate experience. In addition, good English is expected in all University course work and is a consideration in grading. It is not an exercise limited only to English classes.

Although the student is not formally required to participate in extracurricular activities, the University recognizes the educational value of cultural, recreational, and community service activities, and it provides numerous opportunities for student participation in these areas. Here the goal is to encourage the individual to cultivate or to keep alive interests which will continue beyond the University years and make the increased leisure of modern life more productive. Attention is called to the value of sports and physical exercise, and to the courses offered by the Men's and Women's Physical Education departments. These courses are taught by specialists in their field and are designed to meet the needs and interests of the individual student. Attention is called, also, to the various opportunities offered by the Department of Music: band, orchestra, chorus, choir, and others. Beyond these lies a host of activities in dance, speech and drama, student government, the Stanford Daily, the yearbook, literary magazines, tutorial programs, etc., in which the student may participate if he desires. The student is reminded of the importance of maintaining some balance between purely academic pursuits and other kinds of valuable activity, and he is urged to inquire into, and to take advantage of, the variety of extracurricular activities available on the campus.

While flexibility is one of the major strengths of the General Studies Program, the following represents the general pattern of General Studies requirements. Both Bachelor of Arts and Bachelor of Science (Engineering, Physics, Chemistry, Earth Science, etc.) candidates are required to complete Basic and Area requirements, that is, subjects in "A" and "B" as follows:
A. Basic Requirements for All Students

1. **English 1, 2, 3.** Freshman English (Composition and Literature).

2. **History 1, 2, 3.** History of Western Civilization.

3. **Foreign Language or Mathematics.** Students may choose to complete either a foreign language or a mathematics series.
   a) **Foreign Language.** Acquisition of a reading ability equivalent to that reached in the following courses: Chinese 21, French 23, 82, German 22, 52, 82, Greek 23, Hebrew 23, Italian 23, 82, Japanese 21, Latin 23, Portuguese 23, Russian 52, Spanish 23, 53.
   b) **Mathematics.** Completion of the final course of any of the following sequences or the equivalent:
      1) Mathematics 10, 11, 21, 22, 23
      2) Mathematics 31, 32, 33, 34, 35
      3) Mathematics 41, 42, 43
      4) Mathematics 41, 52, 53

B. Area Requirements for All Students

Every student is exempt from the General Studies Area Requirements within that area — humanities, social sciences (including communication, history, and speech pathology and audiology) or natural sciences (including mathematics, applied science, and engineering)—in which he majors. This exemption does not affect the Basic Requirements in mathematics, foreign languages, English, and History of Western Civilization, as listed under “A” above. All students must therefore complete the following requirements in the two areas in which they are not majoring. The Humanities and Social Sciences area requirements are normally fulfilled by students who attend an overseas campus.

1. **Humanities.** A minimum total of 8 units selected from General Studies courses in at least two of the following three fields:
   a) The Fine Arts (including Music, Art, Speech and Drama)
   b) Philosophy, Religion
   c) Literature

2. **Social Sciences.** Two 5-unit General Studies courses selected from the following:
   a) Anthropology 1
   b) Communication 1
   c) Economics 1
   d) Geography 1
   e) Political Science 1
   f) Psychology 1
   g) Sociology 1

3. **Natural Sciences.** Students who have not taken biology in high school will take Biology 4, 5. Those who have had biology but not physical science in high school will take one of the following complete series:
   a) Physical Sciences 1, 2, 3 (9 units)
   b) Physics 21, 23, 29 (12 units)*
   c) Physics 51, 52, 53, 54, 55, 56 (15 units)*
   d) Chemistry 1, 2, 3 (13 units)
   e) Geology 1, 2 (10 units)

* Majors in the physical sciences and engineering normally enroll in the Physics 50-series; other students, including pre-meds, normally enroll in the 20-series.

Students who have taken both biology and a physical science in high school must take either the biology series or one of the complete physical science series above. The course series taken in fulfillment of this requirement must include laboratory.

With respect to all three areas listed above, students who start at Stanford are required to take at least one course in the humanities, at least one in the social sciences, and at least one laboratory sequence in the natural sciences at Stanford. Transfer students should consult the General Studies Program Bulletin for information concerning fulfillment of General Studies requirements.

C. Additional Requirements for Candidates for the A.B. Degree

1. **One of the following**
   a) Mathematics 1 and 2, Statistics 50, or an advanced mathematics course making use of calculus if mathematics was chosen under “A” above.
   b) Philosophy 3 (Logic).
   c) 4 units of additional reading in the foreign language which the student took
under "A." (This requirement may be fulfilled either in consultation with the student’s own major department or by taking French 54, Russian 54, Spanish 54, Portuguese 54, or by taking a language reading course numbered 100 or higher. Certain courses in Chinese and Japanese with lower numbers will be accepted.) This requirement may also be fulfilled by the language instruction at an Overseas Campus.

2. Additional courses in the Natural Sciences.
That number of units which, when added to the work completed under "B3," brings the total to 17 units. This additional work must be selected from the following courses in such a way as not to duplicate subject matter covered under "B3." Courses listed under "a" through "e" may be taken without laboratory in satisfaction of this requirement, but credit will be correspondingly reduced. Requirement "B3" must include laboratory.
   a) Biology 4, 5
   b) Chemistry 1, 2, 3
   c) Physical Sciences 1, 2, 3
   d) Physics 21, 23, 29; 51, 52, 53, 54, 55, 56, 57
   e) Geology 1, 2
   f) Mathematics 10, 11, 21, 22, 23; 31, 32, 33, 34, 35; 41, 42, 43; 52, 53
   g) Philosophy 3 (Logic)
   h) Statistics 50
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   l) Civil Engineering 170
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   n) General Studies 110 (Elementary Human Physiology)

3. Senior Colloquia. One 2-unit colloquium, as listed in the Time Schedule, under "Senior Colloquia." The following A.B. candidates are exempt from the Senior Colloquium requirement:
   a) Students taking their senior year of undergraduate study as their first year in the School of Law or School of Medicine.
   b) Students enrolled in Honors programs in Humanities or in Social Thought and Institutions.

U.S. HISTORY AND CONSTITUTION REQUIREMENT
California State law requires that baccalaureate degree programs include instruction in U.S. History and Constitution. For students who come to Stanford as freshmen, material contained in History 3 satisfies this requirement; transfers may meet this requirement through completion of any of several approved alternatives in Stanford’s Departments of Political Science and History or by completing the requirements at other collegiate institutions.

MAJOR REQUIREMENTS
The selection of a major may be made by a student at any time and must be made no later than the beginning of the junior year. The school or department selected for a major has the authority to prescribe not more than 60 units in the major subject (exclusive of elementary courses which may have been offered for entrance). The school or department shall also recommend such other courses as may be considered desirable, and shall exercise an advisory supervision over the student’s curriculum from quarter to quarter. It shall be considered a general principle of University policy, to be departed from only in exceptional cases, that at least 90 of the 180 units required for the degree be taken outside the major field of study.

In applied science the school may prescribe as much of the entire 180 units as it shall deem essential to the technical or professional requirements of the major subject.

Within these limitations the work is elective, and the student may freely choose any course which his previous studies have prepared him to undertake.

BACHELOR OF ARTS OR BACHELOR OF SCIENCE
The degree of Bachelor of Arts (A.B.) or the degree of Bachelor of Science (B.S.) is conferred upon candidates recommended by the Subcommittee on Graduation who, in addition to fulfilling the following requirements, have applied in advance for graduation:

1. The accumulation of an overall C average on all Stanford work.
2. The acquisition of twice as many grade
3. The completion of the curriculum requirements as prescribed by a major department. The recommendation of that department is necessary to graduation.

Candidates who fulfill these requirements in the Schools of Earth Sciences and Engineering, or the Departments of Chemistry, Mathematics, Physical Sciences, Physics, and Statistics in the School of Humanities and Sciences, or Nursing or Physiology in the School of Medicine receive the degree of Bachelor of Science; candidates who fulfill these requirements in other schools or departments receive the degree of Bachelor of Arts.

Forty-five units constitute a normal year's work. The degree is conferred whenever the requirements are met, provided the candidate has spent three quarters in resident study and completed at least 45 units (including the last 15) in this University. In special cases, students who have obtained at least 135 units in resident work, and who have completed all major requirements and all General Studies requirements, may be exempted from completing the last quarter's work in this University and be permitted to complete the required number of units elsewhere. In these cases the approval of the Subcommittee on Graduation is necessary.

If graduates of other universities desire to become candidates for the baccalaureate degree in a different field at Stanford University, they may apply for admission as undergraduates. If admitted, they will be given 135 quarter units of advanced standing and will be required to complete at least 45 units (three quarters) of university work and fulfill all major and General Studies requirements.

Second Bachelor's Degree

The holder of a Bachelor of Arts degree from Stanford may apply to the Subcommittee on Graduation for admission to candidacy for a Bachelor of Science degree, and the holder of a Bachelor of Science degree may apply in like manner for a Bachelor of Arts degree. Application must be filed prior to entry into the Graduate Division and the recommendation of the major school or department to be entered is required. A student approved for this program may re-register as an undergraduate and will be subject to the usual rules and regulations affecting undergraduates. Specific requirements may be obtained at the Registrar's Office.

As a recognition of high scholastic attainment the Bachelor's degree may be granted "With Distinction" or "With Great Distinction."

ADVANCED DEGREES

General University requirements for advanced degrees are stated in terms of time devoted to graduate study, or registration for graduate study, rather than in terms of units of credit. In case any of the work done at Stanford is on a part-time registration, its equivalence to full-time study is determined by tuition payments.

For each advanced degree there is a minimum requirement of one academic year (three quarters—at least 36 quarter units) of work as a graduate student at Stanford. The final units of credit toward any advanced degree must be earned at Stanford.

Each student should consult his major department and examine its section in this bulletin regarding specific departmental requirements for advanced degrees. Opportunities for advanced study of a single region or other special interests involving more than one department are described under Graduate Division Special Programs.

Candidacy for A.M., M.S., Engineer, and Ph.D. degrees must be approved by the University Committee on the Graduate Division. Candidacy is valid for five years from date of such approval and may be renewed by the submission and approval of a new application. All applications or petitions to the University Committee on the Graduate Division must be submitted to the major department for approval before being filed with the Graduate Study Office. Communications should be addressed to the Graduate Study Office, Old Union Building, Stanford University, Stanford, California 94305.

MASTER OF ARTS OR MASTER OF SCIENCE

Upon recommendation to the Academic Council by the faculty of the major department and the University Committee on the Graduate Division, the degree of Master of Arts (A.M.) or Master of Science (M.S.) is
conferred on candidates who have satisfactorily completed at least one academic year (three quarters) of work as a graduate student at this University, presented an acceptable thesis (unless this requirement is waived), and fulfilled such other requirements as may be prescribed by the school or department concerned. In no case will the degree be conferred unless the candidate has been registered at Stanford University for three full quarters, or the equivalent, as a graduate student. A longer period of residence will be necessary for students who are inadequately prepared or who devote less than the normal amount of time to their studies.

The University minimum unit requirement for the A.M. or M.S. is 36 quarter units earned at Stanford as a graduate. Most departments require more. At the discretion of a major department, this University minimum requirement of 36 graduate units at Stanford may be reduced to 30 on condition that at least 6 quarter units earned elsewhere as a graduate be validated by the department as the equivalent of specific Stanford courses. Such courses must be reported on the application for candidacy, with the name and number of each Stanford course, the number of Stanford units given for it, and the method of validation. In any case, the minimum residence requirement for the A.M. and M.S. shall remain unchanged—registration at Stanford as a graduate during at least three quarters and the payment of the equivalent of at least three full quarters' tuition at Stanford as a graduate.

Admission to candidacy is granted by the University Committee on the Graduate Division on the basis of an application, approved in writing by the school or department in which the candidate proposes to take the degree. This application should be filed with the Graduate Study Office not later than the fourth week of the quarter preceding the final quarter of candidacy. (The application should be submitted to the major department early enough to allow for departmental consideration before the University deadline. The required time varies with departments.) When granted, candidacy is valid for five years, after which it may be renewed by the approval of a new application by the major department and the University Committee.

If a thesis is a degree requirement, three bound copies, each bearing the approval of the instructor under whose supervision it was prepared, must be submitted to the Graduate Study Office on or before the last day of instruction in the final quarter of candidacy. If this date falls on Saturday, the deadline shall be the following Monday. These copies shall be the original and first two carbon copies, typed on paper of standard size and weight, with title and signature pages in the form prescribed by the University Committee on the Graduate Division. Upon acceptance, two copies are placed in the University Library, and the third copy is sent to the major department. Directions for the preparation and submission of theses are available in the Graduate Study Office, Old Union Building.

MASTER OF ARCHITECTURE

Upon recommendation to the Academic Council by the faculty of the Department of Art and Architecture and the University Committee on the Graduate Division, the degree of Master of Architecture (M.Archit.) is conferred on candidates who have satisfied the requirements laid down by the faculty of the Department of Art and Architecture and the University. (Full particulars concerning these requirements will be found elsewhere in this bulletin.)

MASTER OF BUSINESS ADMINISTRATION

Upon recommendation to the Academic Council by the faculty of the Graduate School of Business and the University Committee on the Graduate Division, the degree of Master of Business Administration (M.B.A.) is conferred on candidates who have satisfied the requirements laid down by the faculty of the Graduate School of Business and the University. (Full particulars concerning these requirements will be found in the Graduate School of Business Bulletin.)

ENGINEER

General Regulations—Upon recommendation to the Academic Council by the faculty of the major department and the University Committee on the Graduate Division, the degree of Engineer is conferred on candidates who have satisfactorily completed six quarters of approved work as a graduate (of which a minimum of three quarters — 36
quarter units—must be in residence at Stanford), presented an acceptable thesis, and fulfilled such other requirements as may be prescribed by the major school or department. A longer period of residence will be necessary for candidates who are inadequately prepared or who devote less than the normal amount of time to their studies.

Admission to Candidacy — Admission to candidacy for the degree of Engineer is granted by the University Committee on the Graduate Division on the basis of an application formally approved by the student's major department and filed with the Graduate Study Office not later than the fourth week of the quarter preceding the final quarter of candidacy. (The application should be submitted to the major department early enough to allow for departmental consideration before the University deadline. The required time varies with departments.) Candidacy, when granted by the University Committee, is valid for five years and may be renewed by the approval of a new application by the major department and the University Committee.

Thesis—Three bound copies of the thesis, bearing the approval of the instructor under whose supervision it was prepared, must be submitted to the Graduate Study Office on or before the last day of instruction in the final quarter of candidacy. If this date falls on Saturday, the deadline will be the following Monday. These copies are to be the original and first two carbon copies, typed on paper of standard size and weight, with title and signature pages in the form prescribed by the University Committee on the Graduate Division, and suitably bound. Upon acceptance, two copies are placed in the University Library, and the third copy is sent to the major department. Directions for the preparation and submission of theses are available in the Graduate Study Office, Old Union Building.

MASTER OF FINE ARTS

General Regulations—Upon recommendation to the Academic Council by the faculty of the major department and the University Committee on the Graduate Division, the degree of Master of Fine Arts (M.F.A.) is conferred on candidates who have satisfactorily completed six quarters of approved graduate work (of which a minimum of three quarters—36 quarter units—must be in residence at Stanford as a graduate) and fulfilled such other requirements as may be prescribed by the major school or department.

DOCTOR OF EDUCATION

Upon recommendation to the Academic Council by the faculty of the School of Education and the University Committee on the Graduate Division, the degree of Doctor of Education (Ed.D.) is conferred on candidates who have satisfied the requirements laid down by the faculty of the School of Education and the University. At the announced time in the quarter at the end of which the degree is to be conferred, the candidate must deposit with the School of Education three typewritten copies of the dissertation, four copies of an approved abstract of the dissertation (600 words or fewer in length), and two signed copies of a publication agreement. The candidate will be charged a $40 fee to cover cost of microfilming the dissertation, binding three copies of the dissertation (including one copy for the candidate), and publishing the abstract. This fee is payable at the Cashier's office on or before the last day of instruction in the final quarter of candidacy.

(Further information concerning these requirements will be found elsewhere in this bulletin and may be secured from the office of the Dean of the School of Education.)

DOCTOR OF MUSICAL ARTS

Upon recommendation to the Academic Council by the faculty of the Department of Music and the University Committee on the Graduate Division, the degree of Doctor of Musical Arts (D.M.A.) is conferred on candidates who have satisfied the requirements laid down by the faculty of the Department of Music and the University. This degree offers advanced professional training in composition, performance practice, conducting, or music education parallel to the musico-logical studies leading to the Ph.D. degree in music. A minimum of three years of graduate study (or two years following a Master's degree) is required of each candidate. A final project or dissertation appropriate to the area of concentration is also required.

Further information concerning the re-
DEGREES

BACHELOR OF LAWS

Upon recommendation to the Academic Council by the faculty of the School of Law and the University Committee on the Graduate Division, the degree of Bachelor of Laws (LL.B.) is conferred on candidates who have received the degree of Bachelor of Arts, or its equivalent, from this University or from some other institution of recognized collegiate rank, and who have satisfactorily completed courses in law aggregating the number of units required under the current Faculty Regulations of the School of Law after devoting not less than three academic years thereto, and who otherwise have satisfied the requirements of the University and of the School of Law.

MASTER OF LAWS

Admission to candidacy for the degree of Master of Laws (LL.M.) is granted only to students who are eligible for admission to the School of Law in regular standing and who have completed, with grades acceptable to this faculty, the work for the first degree in law at this University, or at some other university law school of recognized standing in which the work for the first degree in law covers a period of not less than six years of combined academic and law study, and who otherwise satisfy the requirements of the University and of the School of Law.

The degree of Master of Laws is conferred upon students so admitted to candidacy upon the completion, with distinction, of one academic year (26 term units) of work in this School in accordance with the rules of the University and of the School of Law. Upon his admission to candidacy, each student must present for the approval of the School of Law Committee on Graduate Study the program which he wishes to pursue for this degree.

DOCTOR OF THE SCIENCE OF LAW

Admission to candidacy for the degree of Doctor of the Science of Law (J.S.D.) is granted only to those who have received the degree of Master of Laws at this University, and who have completed the work required for such Master’s degree with marked excellence and have given clear proof of their ability to do legal research of high quality.

The degree of Doctor of the Science of Law is conferred upon applicants so admitted to candidacy who spend one full academic year in independent legal research and as a result thereof present a thesis which is, in the opinion of the faculty of the School of Law, a contribution to knowledge. Such work and thesis shall conform to the rules and regulations of the University and of the School of Law.

DOCTOR OF MEDICINE

Upon recommendation to the Academic Council by the faculty of the School of Medicine and the University Committee on the Graduate Division, the degree of Doctor of Medicine (M.D.) is conferred on candidates who have satisfactorily completed the required curriculum in medicine. (Full information concerning requirements for the M.D. degree will be found in the School of Medicine Bulletin.)

DOCTOR OF PHILOSOPHY

General Regulations

Upon recommendation to the Academic Council by the faculty of the major department and the University Committee on the Graduate Division, the degree of Doctor of Philosophy (Ph.D.) is conferred on candidates who have demonstrated substantial scholarship, high attainment in a particular field of knowledge, and ability to do independent investigation and present the results of such research.

A minimum of three years (nine quarters) of graduate registration satisfactorily completed is required of each candidate. The minimum requirements which must be completed as a graduate at Stanford are three full quarters (or the equivalent in part-time registrations as calculated on tuition payments) and 36 quarter units. These minimum requirements will apply only if the candidate has earned no other advanced degree at Stanford and has completed at least two years of acceptable work elsewhere as a graduate.

Admission to Candidacy

When a student has completed the major department’s required preliminary proced-
ures, and has completed the reading requirement in at least one foreign language, the major department may certify him to the University Committee on the Graduate Division for admission to candidacy. If the student's program includes a minor, certification by the minor department is also required. If the student offers no minor, his application must show at least three units of work taken (or to be taken) as a graduate under each of four or more Stanford faculty members. Application for admission to candidacy is made on Form G34, which must be filed with the Graduate Study Office not later than the fourth week of the final three quarters of candidacy. Candidacy, when approved by the University Committee, is valid for five years and may be renewed by the submission and approval of a new application.

Foreign Language Requirement

With the application for admission to candidacy, a certificate must be filed stating that the student possesses a reading knowledge of one or more languages in addition to English. The language or languages required will be selected in individual cases by the mutual assent of the student and the major school or department. The languages so selected will be those most likely to be useful in connection with the individual student's program of study for the degree and his predoctoral and postdoctoral research program. Any necessary certificate will be issued by an examiner designated by the major school or department.

University Oral Examination

When a candidate has been admitted to candidacy, and has shown special ability in his field of study and proved his capacity for independent investigation to the satisfaction of the schools or departments concerned, he may arrange through the Graduate Study Office for the University oral examination. This examination will not exceed three hours in length. It will not be held during the first two weeks in any quarter or after the last day of instruction in any quarter. The request for an oral examination must be submitted to the Graduate Study Office on Form G21 at least three weeks prior to the date proposed for the examination. The purpose of the examination is to test the candidate's command of his fields of study and to confirm his fitness for scholarly pursuits. The examining committee is to be composed of (1) the Dean of the Graduate Division or his delegate, presiding, (2) four or more faculty members appointed by the Dean of the Graduate Division from the major and minor departments, (3) any additional representatives selected by the major and minor departments and the Dean of the Graduate Division, and (4) any members of the Academic Council who may attend. On the favorable vote of three-fourths or more of the examining committee (including the presiding chairman), the candidate will be certified as having passed the examination.

Five members present and voting, including the chairman and representatives of both major and minor departments, will constitute a quorum.

Dissertation

Recommendation for the degree will be made only after the acceptance of a dissertation, which must be a contribution to knowledge and the result of independent work, expressed in satisfactory form. At an appropriate point in the preparation of the dissertation, the department head will take responsibility for appointing (on Form G81) a faculty reading committee consisting of the candidate's principal research adviser (who must be a member of Academic Council), a second member from within the major department, and a third member chosen from the major or another department. In cases where the dissertation topic makes advice from outside the department useful, the appointment of an appropriate outside reader should be made early, and he should be encouraged to follow and advise on the progress of the research. In any case, the Form G81 is due in the Graduate Study Office by the end of the next to the last quarter of candidacy. Each member of the reading committee will certify by signature on the final copies of the dissertation that he has read the dissertation, and that in his opinion it is of a scope and quality acceptable in fulfillment of this requirement for the degree. At least one member of the committee will read the dissertation in its final submitted form and so certify on Form G82.

The dissertation must be submitted to the
Graduate Study Office on or before the last day of instruction in the final quarter of candidacy if autumn, winter, or summer quarter; or by the end of the seventh week if the final quarter of candidacy is a Spring Quarter.

After its final acceptance, the dissertation will be microfilmed and bound at the direction of the Graduate Study Office. A negative microfilm copy of the dissertation will be kept on file by University Microfilms (in Ann Arbor, Michigan), from whom positive microfilm copies may be ordered. When bound, the original copy will be sent to the author, the first two carbon copies to the Stanford University Library, and the third carbon copy to the major department.

Directions regarding the form of the dissertation, title and signature pages, and the abstract may be obtained from the Graduate Study Office. The abstract (600 words or fewer in length) will be published in Dissertation Abstracts by University Microfilms. The candidate will be charged a $40 fee to cover the cost of microfilming the dissertation, binding four copies of the dissertation, and publishing the abstract. This fee is payable at the Cashier's office on or before the last day of instruction in the final quarter of candidacy.
COURSES of INSTRUCTION
1968–69

Note: Unless otherwise specified, courses numbered from 1 to 99 inclusive are primarily for first- and second-year undergraduates; from 100 to 199 inclusive, for third- and fourth-year undergraduates; from 200 to 499 inclusive, for graduate students.

Courses marked (#) may be used in satisfaction of General Studies requirements or options.

SUMMER SESSION

The Summer Session of 1969 will be eight weeks in length, except in certain schools which will offer ten-week courses.

This announcement includes, for the Summer Session of 1969, only those courses which can be tentatively scheduled at this time by each department. For the complete list of courses and faculty, request should be made for the special Summer Session Bulletin to be issued in February 1969.
GRADUATE SCHOOL of BUSINESS


Dean: ———
Associate Deans: James E. Howell, Samuel A. Pond


Lecturers: C. Sidney Cottle, Mark D. Larkin, Lamar Lee, Michael S. Montalbano, Samuel A. Pond, Karl M. Ruppenthal, Sterling D. Sessions

The Graduate School of Business, since its founding in 1925, has provided graduate education for careers in business management, research, and teaching. The two-year Master of Business Administration degree program is designed for the student who seeks preparation for a professional career in management. No specific undergraduate major or courses are required for admission, although prospective applicants are encouraged to include one year of college level mathematics in their undergraduate programs.

Those interested in college teaching and research are served by the Doctor of Philosophy program.

For detailed information on programs, curricula, and faculty write the Graduate School of Business for its current bulletin.

SCHOOL of EARTH SCIENCES

Dean: Richard H. Jahns
Associate Dean: Konrad B. Krauskopf
Assistant Dean: Ernest I. Rich

The School of Earth Sciences includes the Departments of Geology, Geophysics, Mineral Engineering, and Petroleum Engineering.

The aims of the School are threefold: (a) to train men for responsible positions in industry, government, education, and research in the fields of geology, paleontology, geochemistry, geophysics, mineral engineering, extractive metallurgy, and petroleum engineering; (b) to conduct original investigations including the development of new principles, techniques, and procedures for the discovery, technology of production, conservation, and utilization of the nation’s mineral resources; (c) to give general instruction in the earth sciences as part of a well-rounded education.

UNDERGRADUATE PROGRAM

Faculty Adviser—A student may enter the School of Earth Sciences when he selects one of the Earth Sciences fields for his major program. Upon entering the School, a student should report to the head of his department, who will designate a member of the faculty to act as his adviser. The adviser will aid the student in the selection of courses and will serve as consultant during his scholastic career. The adviser’s approval of the study plan must be obtained before registration is completed at the beginning of each quarter.

Requirements—Specific requirements for the Bachelor of Science degree are listed below for each department. As a general requirement for the School, a student’s mean grade in required courses in each of the fields of mathematics, chemistry, physics, and earth sciences must be C or better.
ROTC—Reserve Officers' Training Corps are maintained at Stanford by the Army, the Navy, and the Air Force (see Aerospace Studies, Military Science, and Naval Science in this bulletin). Students enrolled in the School of Earth Sciences who are also enrolled in an ROTC program will usually require more than four years (twelve quarters) in the University to obtain a baccalaureate degree.

These aerospace, military, and naval science courses require 36 units of credit in addition to the earth science course requirements, and the additional time required will vary from one to three quarters depending upon the circumstances in each case.

GRADUATE PROGRAM

The undergraduate curricula offered by the School of Earth Sciences are designed to give broad training, with emphasis on fundamental science. These curricula do not include sufficient specialization to prepare directly for professional work. The School offers graduate programs planned to prepare the student for responsible positions in industry, research, governmental work, and education. These programs lead to the advanced degrees of Master of Science, Engineer, and Doctor of Philosophy. Graduate degrees in Hydrology are also offered. See the section "Hydrology" in this bulletin.

Program in Earth Resources—To augment Stanford's school-wide program in earth resources, a new, interdisciplinary curriculum in Exploration has been introduced. See section "Mineral Engineering" in this bulletin.

Admission to the Graduate Program — A student who wishes to enroll for graduate work in the School must be qualified for graduate standing in the University and in addition must be accepted by the School of Earth Sciences. With the limited facilities available, it is not possible to accept all who apply for admission.

Faculty Adviser—Upon entering a graduate program the student should report to the head of his department, who will arrange with a member of the faculty to act as the student's adviser. The student, in consultation with the adviser, then arranges a course of study for the first quarter, and ultimately a complete plan of study for the degree sought.

Financial Aid—Scholarships, fellowships, and research grants are available to students in the School of Earth Sciences. Detailed information is available from the Dean's Office. Applications should be filed by January 15 for awards which become effective in autumn quarter for the following year.

Normally about twenty-two teaching assistantships are awarded to qualified students to assist in laboratory instruction.

SPECIAL PROGRAMS

MECHANICAL PROCESSES AND EARTH MATERIALS

Stanford offers a program of study in the application of mechanics to problems in mining, structural geology, geomorphology, engineering geology, and geophysics. Faculty members from all departments in the School collaborate in offering opportunities for advanced course work and research in the physical behavior of rocks and other earth materials. Stanford earth scientists are able freely to draw upon the knowledge of faculty in Stanford's Applied Mechanics and Materials Science departments, which are among the most outstanding in the country. Many faculty and students of the School of Earth Sciences at Stanford are applying principles of mechanics to the understanding of geologic processes. For example, several people are studying deformation of earth materials by modifying and amplifying concepts already developed to explain plasticity and fracturing of metals. Some are measuring seismic, gravity, magnetic, electrical and thermal properties of rocks as a means of exploring structures and earthquake mechanisms. Others are studying the mechanics of the formation of laccoliths and sills, growth of folds, inception and growth of faults, twinning of plagioclase feldspar, deep crustal faulting, formation of slaty cleavage, flow of slurries in channels, creep of soil, slope stability in fractured rock, and fracturing of granite. The combination of field, theoretical, and experimental work is emphasized in the solution of these problems.

Students in Earth Sciences are strongly urged to take courses in many other departments of the University.
Courses recommended for students interested in mechanics are:

Geol. 200. Mechanics of Earth Materials
Geol. 204. Computer Applications in the Earth Sciences
Geol. 209. Physics of Underground Fluids
Geol. 305. Theoretical Foundations of Geology
Min.E. 200. Introduction to Rock Mechanics
Geophys. 326. Mechanisms of Rock Deformation
Geophys. 327. Experimental Rock Mechanics
Geophys. 328. Theoretical Structural Geology
Mat. Sci. 50. Introductory Science of Materials
Mat. Sci. 238. Fracture of Solids
Applied Mech. 203. Theory of Elasticity
Applied Mech. 211. Elementary Theory of Plasticity

Opportunities exist to develop laboratories to meet the requirements of new research projects. For example, a high-pressure triaxial chamber and a 120-ton testing machine recently have been designed for experimental rock deformation, and a laboratory for the study of slurry flow has been developed in conjunction with the U.S. Geological Survey, Menlo Park.

PROGRAM IN ENVIRONMENTAL EARTH SCIENCE STUDIES

Environmental earth science studies are concerned with the effect of man's activities on geologic processes and, conversely, with the influence of geologic processes on the works of man.

The San Francisco Bay region is an area of rapid population influx. Here human activity has spread into areas that are replete with geologic hazards such as active fault zones, subsiding ground, and unstable slopes subject to landsliding and creep. With increasing population, problems of water distribution, waste disposal, and water and air pollution also have been intensified.

The program in environmental earth science studies is intended (a) to provide a focus for integrated studies involving faculty and students from a variety of departments and schools; (b) to educate undergraduate students in problems related to the natural environment, so that those who eventually attain positions of public influence may have a better basis for informed discussion and decision making; and (c) to educate students for professional service in environmental problems.

The following courses are especially recommended to students contemplating specialization in environmental studies:

Geol. 233. Principles of Geomorphology
Geol. 235. Photogrammetry and Photogeology
Geol. 361. Permafrost
Geol. 204. Engineering Geology
Geol. 205. Hydrogeology
Civ. Engr. 170. Man and His Environment
Civ. Engr. 190. Soil Mechanics and Foundations

GEOLOGY

Emeriti: Eliot Blackwelder, Siemon W. Muller (Professors)
Executive Head: Benjamin M. Page

Professors: Robert R. Compton, William R. Evitt, John W. Harbaugh, Arthur D. Howard, M. King Hubbert (Geology and Geophysics), Colin O. Hutton (Mineralogy), Richard H. Jahns, Myra Keen, Konrad B. Krauskopf (Geochemistry), Benjamin M. Page, Charles F. Park, Jr., O. Frank Tuttle.
Consulting: Harold W. Hoots

Associate Professors: William R. Dickinson, Norman J. Silberling

Assistant Professors: Arvid M. Johnson (Geology and Mineral Engineering), Paul Switzer (Statistics)


PROGRAMS OF STUDY

BACHELOR OF SCIENCE

The following requirements for the degree of Bachelor of Science in Geology and Geochemistry are in addition to the University requirements in general studies.

It should be noted that the Department of Geology has a specific requirement in foreign language. The general University requirement is completion of either Mathematics 23 or a course numbered 23 in a foreign language, but the Department of Geology requires completion of a language sequence whether or not Mathematics 23 is taken. Any modern language is accepted in fulfillment of this requirement, but German is recommended.
In addition to General Studies courses and foreign language, the following courses are required of all students:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Quarter</th>
<th>Given Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Chemistry 1, 2, 3. General Chemistry</td>
<td>AWS</td>
<td>13</td>
</tr>
<tr>
<td>Mathematics 10, 11. Analytical</td>
<td>Any</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Geology 1. Geoscience I (See Note 1)</td>
<td>Any</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geology 2. Geoscience II</td>
<td>W or S</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geology 25. Elementary Mineralogy and Crystallography</td>
<td>A</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geology 51. Elementary Petrology</td>
<td>W</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geology 105. Structural Geology</td>
<td>S</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geology 108, 109. Field Geology (See Note 2)</td>
<td>Summer</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Total. .............................................. 59

Note 1.—A student who has taken Geoscience III without having taken Geoscience I, or without Geoscience II, may omit either or both I and II if he obtains approval of the faculty.

Note 2.—A student who takes Geology 108 and 109 during the summer following his junior year will normally graduate at the end of winter quarter in his senior year.

Further course work depends on a student's special interests. Three alternative curricula are suggested below, all leading to the degree of Bachelor of Science in Geology. Substitution of other courses for some of the listed requirements is possible in exceptional cases. Such changes should be arranged in consultation with the adviser and must be approved by the faculty of the Department.

Curriculum in Physical Geology—For students planning careers in general geology, economic geology, petroleum geology, engineering geology, field geology.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Quarter</th>
<th>Given Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology 112. Elementary Paleontology</td>
<td>A</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geology 171. Introduction to Geochemistry</td>
<td>A</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>At least 5 additional units in geology (see Note 2)</td>
<td>Any</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geophysics 190. General Geophysics</td>
<td>A</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Physics 51, 52, 53, 54, 55, 56. Elementary Physics</td>
<td>WSA</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Mathematics 21, 22. Calculus</td>
<td>Any</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Mathematics 23, or Statistics 50 or 110</td>
<td>Any</td>
<td>3-5</td>
<td></td>
</tr>
</tbody>
</table>

Total. .................................................. 40-42

Note 2.—Geology 233, Geomorphology, is recommended as an elective.

Curriculum in Paleontology—For students interested primarily in paleontology, stratigraphy, relations of biologic activity to geologic processes.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Quarter</th>
<th>Given Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least 15 units from courses listed in the section on Paleontology and Stratigraphy. (Qualified students may take 200-level courses.)</td>
<td>Any</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Geology 157. Sedimentary Petrology</td>
<td>S</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Physics 21, 23, 29. Elementary Physics</td>
<td>WSA</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Statistics 50. Elementary Statistics</td>
<td>AS</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>At least 10 units from courses listed under the Department of Biological Sciences</td>
<td>Any</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Total. .............................................. 45

Curriculum in theoretical earth science—For students planning careers involving research in the quantitative aspects of the earth sciences.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Quarter</th>
<th>Given Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology 171, 271. Geochemistry</td>
<td>AW</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Geology 209. Physics of Underground Fluids</td>
<td>W</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geology 106. Physical Oceanography</td>
<td>S</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Geophysics 190. General Geophysics</td>
<td>A</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Mathematics 21, 22, 23, 24. Calculus</td>
<td>Any</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Physics 51, 52, 53, 54, 55, 56. Elementary Physics</td>
<td>WSA</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Total. .............................................. 45

Electives—A student entering Stanford with credits for two years of high school language and four years of mathematics will normally have 26-30 units of free electives, depending on which of the above curricula he chooses (based on an average load of 15 units per quarter). If his preparation is less adequate, the number of electives is correspondingly smaller. Electives should be chosen after consultation with the adviser. They may be courses offered by the Geology Department or by any other department in the University. The following geology courses are particularly recommended as electives, depending on a student's individual interests: Geology 234 and 235, Photogrammetry and Photogeology; Map Interpretation; Geology 220, Optical Mineralogy; Geology 160, Stratigraphy; Geology 182, Petroleum Geology and Subsurface Mapping; Geology 281, Ore Deposits; Geology 284, Engineering Geology; Geology 285, Hydro-
geology. (Courses numbered in the 200's are open to qualified undergraduates.)

Order of courses — The order in which courses are taken may be adapted somewhat to suit individual needs, but is restricted by the fact that some courses are prerequisites for others. It is strongly recommended that students intending to major in the Department of Geology take Chemistry 1, 2, 3 during their first year, and Geology 25 as soon as possible after Geology 1, since these courses are required as preparation for many of the more advanced courses. A student should work out his schedule of courses with his adviser well in advance, so that he can be sure to arrange the courses in proper sequence.

Grade requirements — In addition to the University requirement of an overall mean grade of C or better for graduation, the Department requires that the mean grade in required courses in each of the fields of mathematics, chemistry, physics, biology, and earth sciences must be C or better.

Special programs — Students whose interests lie in special fields such as mineralogy, economic geology, geomorphology, geochemistry, oceanoigraphy, or particular branches of paleontology should use some of their elective units to broaden their backgrounds in these fields. Special programs in these fields, involving possible substitutions for requirements listed above, may be arranged in consultation with the adviser and may be submitted to the faculty of the Department for approval.

Honors Program — The Geology Honors Program is designed to give a limited number of undergraduates with superior scholastic records, interest, and ability the opportunity to undertake independent study and research during their last year or two of undergraduate training. Admission to the program is by invitation of the faculty of the Department of Geology and is contingent upon (a) a minimum grade average of B in all University work, and (b) prior completion of Geology 1, 2, 25, 51, and 105. Entry is possible at any time after the end of the sophomore year. The Honors Program consists of the following:

1. The courses required of all geology majors: Chemistry 1, 2, 3; Mathematics 10, 11; Geology 1, 2, 25, 51, 105, 108, 109.

2. The courses in other science departments required for any one of the three regular curricula of the department.


Details of the program will be determined in consultation with the student's adviser, subject to the approval of the department faculty. Those completing the program satisfactorily will receive the degree of Bachelor of Science in Geology with Honors upon the recommendation of the faculty of the Department of Geology.

MASTER OF SCIENCE

Objectives — To round out the student's training for professional work in geology or geochemistry, through the completion of fundamental courses, both in the major field and in related sciences, and by obtaining a start on independent work and specialization.

Requirements for the Degree — The candidate must fulfill the following requirements:

1. Be registered in the graduate school for at least three quarters.

2. Complete 45 units, at least 6 of which must be independent work on a research problem. Units from School of Earth Sciences courses with grades of D will not be counted toward the required 45 units of work, and the average of all grades must be a B or better. No Geology courses numbered below 100, and not more than 10 units of Geology courses numbered below 200, will be counted toward the required 45 units of work.

3. Make up deficiencies in previous training. Previous training should be approximately equivalent to one of the three curricula leading to the B.S. degree in Geology at Stanford. Geology 220 and 221 (or equivalents) and one course in economic geology must be taken, if these courses or equivalents have not previously been completed.

4. Demonstrate in one of the following ways his knowledge of basic principles and research methods in his general field of study: (a) By writing a thesis, as may be recommended at the discretion of individual advisers. (b) By preparing a report, ordinarily a term paper written for the 6 units of research, to be submitted to at least two faculty members.
Courses taken for the Master of Science degree must include at least 4 units in each of four of the following fields:

- Petroleum engineering
- Materials science
- Mineral engineering
- Geophysics and structural geology
- Geomorphology and photogeology
- Mathematics and statistics
- Civil and industrial engineering
- Mechanical engineering and applied mechanics
- Electrical engineering
- Economic geology
- Exploration
- Paleontology and stratigraphy
- Mineralogy
- Petrography and petrology
- Physics
- Chemistry and geochemistry
- Biology
- Business
- Law

These courses must be junior, senior, or graduate courses (courses numbered 100 or higher). The courses must not include seminars or problems courses.

**Doctor of Philosophy**

**Objectives**—To develop the skills needed to conduct original geologic investigations, to interpret the results, and to present the data and conclusions in a clear and concise manner.

**Opportunities for Original Investigation**—Stanford University is situated in a region that invites geologic field research at all seasons of the year. The California Coast Ranges, Sierra Nevada, Cascade Mountains, Columbia Plateau, and the Basin Ranges are all within easy reach, and their complex geology offers many unsolved problems in all branches of the science. Laboratories are available for research in the various branches of geology, including paleontology and micropaleontology, mineralogy, petrology, geomorphology, photogeology, economic geology, ground water, geochemistry, rock mechanics, and geophysics.

**Requirements for the Degree**—A minimum of three years (nine quarters) of graduate study must be satisfactorily completed. At least one of these years, ordinarily the last, must be spent as a registered student at Stanford. The candidate must demonstrate by examination his ability to read a foreign language that is appropriate to his research. The choice of language must be made in consultation with the student's adviser and must be passed before taking the Departmental oral. His record must indicate outstanding scholarship, and deficiencies in previous training must be removed. Although he need not obtain an M.S. degree, the candidate will be expected to have, or to obtain, a training approximately equivalent to the Stanford M.S. program. He must pass the Departmental oral examination. He must fulfill the requirements of the minor department, if a minor is elected. He must prepare under faculty supervision a dissertation which is a contribution to knowledge and the result of independent work. (The dissertation must be reasonably concise, prepared in a form suitable for publication of a part or the whole.) He must pass the University oral examination, which is centered around the dissertation problem.

The Ph.D. dissertation must be submitted in its final form within five calendar years from the date of admission to candidacy by the University Committee on the Graduate Division. Candidates for the degree who fail to meet this deadline will be required to reapply for admission to candidacy and retake the Departmental and the University oral examinations. They will be given an additional year in which to submit their dissertations.

**Courses**

**General Geology**

**Note** — Courses in the 300 and 400 series ordinarily are not open to undergraduates. Courses in the summer quarter are offered for a ten-week period unless otherwise noted.

#1. Geoscience I—Study of the earth, with emphasis on its materials, its internal constitution, and the processes that affect it. Introduces geological and geophysical methods of investigating problems. Lectures, one 3-hour laboratory period per week, and field trip(s) required. A transportation fee will be charged for field trips. High school chemistry and physics or Physical Science 1 and 2 strongly recommended. (Students who have
studied geology in Physical Science 3 will 
receive only 3 units credit for Geology 1.)

5 units, Aut (Dickinson) MWF 8; lab, field 
trips by arrangement
Win (Page) MWF 9; lab, field trips 
by arrangement
Spr (———) MWF 8; lab, field trips 
by arrangement
Sum (8 weeks), (———) MTWThF 
9; lab, field trips by arrange-
ment

#2. Geoscience II—Continuation of Geo-
sience I, with emphasis on the history of 
the earth and life, the origin of major fea-
tures of the earth's crust, and the relation 
of earth science to humanity. Lectures, one 
3-hour laboratory per week, and field trips re-
quired. A transportation fee will be charged 
for field trips. Prerequisite: 1.

5 units, Win (Silberling) MWF 8; lab, 
field trips by arrangement
Spr (Staff) MWF 9; lab, field 
trips by arrangement

3. Current Topics of Geoscience—An intro-
ductive course in earth sciences chiefly for 
science and engineering students, and an /optio
nal continuation course for students 
who have taken Geology 1 or Geology 2 or 
both. A quantitative approach to selected 
geological and geophysical problems is em-
phasized. Lectures and laboratory, with dis-
cussion periods or field trips as required. A 
transportation fee will be charged for field 
trips. Calculus, high school chemistry, and 
physics recommended.

3 units, Spr (Jahns) MW 9; lab, field 
trips by arrangement

103. Geologic Problems—Supervised read-
ing, written reports thereon.

1 to 10 units, any quarter (Staff) by 
arrangement

105. Structural Geology—Nature and origin 
of faults, folds, and structures of metamor-
phic and plutonic rocks. Deformation of 
the earth's crust. Prerequisites: 1 and 2. Re-
commended: 51.

5 units, Spr (Page) MWF 9; one lab., field 
trips by arrangement

106. Physical Oceanography — Prerequi-
tsites : Mathematics 22 and Chemistry 3.
4 units, Spr (———) MTWThF 8

108. Field Geology I—First part of summer 
is spent mainly learning field techniques. 
These include observation of lithologic fea-
tures, measurement of stratigraphic and 
structural sections, application of traverse 
and plane table methods, and plotting of 
geologic data on topographic maps and aero-
rial photographs. Prerequisite: 105. (Open 
to women if two or more apply. Graduate 
students must obtain the permission of the 
instructor to enroll.)

6 units, Sum (Compton)

109. Field Geology II—Second part of sum-
mer is spent mapping geologic relationships, 
preparing geologic reports, and conducting 
related geologic investigations at one or 
more localities in the western states. Em-
phasis is placed on an integrated study of 
one field area, followed by a period of re-
port-writing in the office. Prerequisite: 108. 
(Open to women if two or more apply. Grad-
uate students must obtain the permission of 
the instructor to enroll.)

9 units, Sum (Compton)

150A. Honors Seminar in Geology—Direct-
ed reading and discussion of fundamental 
geologic knowledge and theory, recent geo-
logic research, and current geologic prob-
lems; oral and written reports. Registration 
by invitation only.

2 units, Aut (Staff) by arrangement

150B. Honors Seminar in Geology—Conti-
nuation of 150B.

2 units, Win (Staff) by arrangement

150C. Honors Seminar in Geology—Conti-
nuation of 150A, B.

2 units, Spr (Staff) by arrangement

155. Honors Research in Geology — Inde-
pendent field and laboratory investigations 
under faculty supervision; written report. 
Registration by invitation only.

1 to 6 units, any quarter (Staff) by 
arrangement

200. Mechanics of Earth Materials—Intro-
duction, for geologists, to the application of 
rheology, boundary conditions, and mechan-
ics to the solution of certain problems in 
structural geology, geomorphology and en-
gineering geology. Prerequisite: Calculus.

5 units, Aut (Johnson) lectures; field trip 
and one seminar by arrangement

202. Studies in Mechanics of Earth Ma-
terials — Continuation of 200. Individual
projects. Prerequisite: 200 or permission of instructor.

3 units Win (Johnson) by arrangement

204A. Computer Applications in Earth Sciences—Introduction to use of digital computers in the earth sciences, with emphasis on developing the student's ability to use computers in research. Students are expected to develop facility in computer programming if they lack previous experience. Stress is placed on each student developing a computing application that is unique to his research interests. Topics include programming principles, surface and space-fitting techniques, analytical classification methods, and stimulation of dynamic systems. Applications to petrology, structural geology, paleontology, geomorphology, petroleum exploration and mining are presented.

3 units, Aut (Harbaugh) MWF 10

204B. Computer Applications in Earth Sciences Seminar—Seminar which provides an opportunity for students who have been enrolled previously in C204A to present and discuss the results of their research applications.

1 or more units, Win (Harbaugh) by arrangement


5 units, Win (Hubbert) MTWThF 11

210. Geology of California — General survey of the physiography, structure, stratigraphy, and economic deposits of California. Two discussion periods and three hours of laboratory. Prerequisites: Geology 1, 2 and 51.

3 units, Spr (Muller) MWF 10; lab.

233. Principles of Geomorphology—A study of the origin and evolution of landscapes and the processes which create and modify them. Environmental aspects will be considered. Prerequisites: 1, 51, and 105.

4 units, Aut (Howard) MWF 9; lab.

234. Map Interpretation and the Scientific Method—Topographic maps provide basic data for application of the scientific method in interpretation of geologic structure and local and regional geomorphic development. Prerequisite: 233 (may be taken concurrently).

4 units, Win (Howard) MWF 10; lab.

F 1:15—4:05

235. Photogrammetry and Photogeology—Photogrammetric principles and practices applicable to geology; geologic interpretations from air photos. Registration limited. See instructor before enrolling.

5 units, Spr (Howard) MWF 10; lab.

W 1:15—4:05 and one lab. by arrangement

301. Problems in Various Fields of Geology and Geochemistry.

Each quarter (Staff) by arrangement

305. Seminar in Theoretical Foundations of Geology — Prerequisites: Calculus and college physics.

2 units, Win (Hubbert) by arrangement


3 units, Spr (Serata) by arrangement

320. Advanced Structural Geology—Significant topics of structure and orogenesis. Two lectures and one seminar per week, plus reading and term report. Prerequisite: 105 or equivalent.

3 units, Aut (Page) TTh 9; seminar W 4:00—5:30

337. Seminar in Geomorphology.

2 units, Win (Howard) by arrangement

361. Permafrost (Geocryology)—Engineering problems in permanently frozen ground. Open to graduate students; others by permission of instructor.

2 units, Spr (Muller) W 1:15—3:05
400. Research in Various Fields of Geology and Geochemistry.

Each quarter (Staff) by arrangement

MINERALOGY, PETROLOGY, AND GEOCHEMISTRY

25. Elementary Mineralogy and Crystallography—Rudiments of crystal structure, morphology and symmetry. Crystal classes and the stereographic projection. Properties of some of the more common rock-forming and ore-forming minerals. Introduction to the chemistry of silicates and mineral associations. Prerequisites: 1 and/or Chemistry 1 (either may be taken concurrently).

5 units, Aut (——) TTh 10; lab. TTh 1:15–4:05 and one lab. by arrangement


5 units, Win (Dickinson) TTh 9; lab. TTh 1:15–4:05 and one lab. by arrangement

171. Introduction to Geochemistry—Application of elementary chemical principles to geologic problems. Prerequisites: 1, Chemistry 3, and Geology 25; the last may be taken concurrently.

3 units, Aut (Krauskopf, Parks) MWF 9

220. Optical Mineralogy — (a) Elementary study of optical properties of crystals; emphasis on polarizing microscope as instrument of research. (b) Systematic study of important minerals, their determination by optical methods. Prerequisites: 25 and Physics 55, or equivalents.

5 units, Aut (Hutton) TTh 11; lab. TTh 1:15–4:05 and one lab. by arrangement

222. Igneous and Metamorphic Petrology — (Formerly 221 and 324) Interpretation of igneous and metamorphic rocks based largely on features observed with the petrographic microscope. Prerequisites: 51, 171 and 220.

5 units, Win (Compton) TTh 10; lab. TTh 1:15–4:05 and one lab. by arrangement

223. Sedimentary Petrology—(Formerly 157 and 207) Interpretation of sedimentary rocks based largely on features observed with the petrographic microscope. Prerequisites: 51, 171, and 220.

5 units, Spr (Dickinson) TTh 9; lab. TTh 1:15–4:05 and one lab. by arrangement

240. Electron Microprobe Analysis.

3 units, Spr (——) by arrangement

271. Geochemistry—Application of physical chemistry to geologic problems. Distribution of chemical elements in geologic environments. Prerequisites: 51 and 171, or 1 and Chemistry 171.

3 units, Win (Krauskopf) TTh 9; lab. TTh 1:15–4:05 or W 1:15–4:05

272. Spectrochemical Analysis — (Enroll in Mineral Engineering 272.) Fundamentals of spectrochemical analysis and its application to study of rocks and minerals. (Enrollment limited to 6.) Prerequisite: consent of instructor required.

5 units, Win (Staff) MW 10; lab. MW 1:15–4:05 and one lab. by arrangement


3 units, Spr (Staff) three 3-hour labs. by arrangement

274A. Introduction to Surfaces and Interfaces — (Enroll in Mineral Engineering 225A.) An introduction to the properties of surfaces and interfaces and their manifestations in a variety of contexts including Chemical, Civil, Mineral, and Petroleum Engineering; Biology, Geology, and Materials Science. A two-hour lecture and a one-hour discussion session weekly. Lectures offered by Prof. Eric Hutchinson, Department of Chemistry. No absolute prerequisites, but prior exposure to thermodynamics is recommended.

3 units, Win (Hutchinson, Staff) by arrangement

274B. Surfaces and Interfaces—(Enroll in Mineral Engineering 225B.) Advanced treatment of selected topics in Surface Chemistry with emphasis on inorganic colloidal systems and adsorption. Independent study, lectures, and discussions. Term paper. With 225A, this course replaces 225. Prerequisites: 225A or equivalent and Chemistry 173 or Materials Science 122, or equivalent.

3 units, Spr (Parks) 3 lecs. by arrangement, given alternate years, given 1968–69

275. Equilibria in Aqueous Systems— (Enroll in Mineral Engineering 227.) Techniques of predicting the probability and extent of
heterogeneous chemical reactions involving one aqueous phase. Prerequisites: Chemistry 173 and Materials Science 122 or Chemistry 173 and Geology 171.

3 units, Spr (Parks) 3 lecs. by arrangement, alternate years, given 1969–70

310. Phase Relations in One and Two Component Systems of Petrologic Interest—Geometry of binary phase diagrams in which pressure, temperature, and composition are the variables.

2 units, Aut (——) by arrangement

311. Phase Relations in Three and Four Component Systems of Petrologic Interest—Continuation of 310, with emphasis on condensed systems. Prerequisite: 310.

2 units, Spr (——) by arrangement

312. Laboratory Methods for Phase Equilibria Studies at High Pressures and Temperatures—Two 3-hour labs.; enrollment limited to 8 students. Prerequisite: 311.

2 units, Sum (——) by arrangement

323. Mineralogy of Sediments — (Formerly 223) (a) Laboratory methods for fractionating sediments. (b) Systematic study of mineral particles, with special reference to those of high density. Prerequisites: 221, and permission of instructor.

5 units, Win (Hutton) given 1969–70

325. Advanced Mineralogy — (Formerly 225) (a) Survey of methods for mineral diagnosis. (b) Systematic study of the more important rock-forming and ore minerals. Prerequisites: 221, Chemistry 111, 112, and permission of instructor.

7 units, Win (Hutton) given 1968–69

327. Seminar in Igneous Petrology.

2 units, Win (Jahns) by arrangement

371. Geochemistry of Ore Solutions—Prerequisites: 271 and 281.

2 units, Spr (Krauskopf) by arrangement, given 1968–69

471. Seminar in Geochemistry.

2 units, Spr (Krauskopf) by arrangement, given 1968–69

PALEONTOLOGY AND STRATIGRAPHY

111. Curatorial Methods in Paleontology—The arranging, cataloging, and studying of museum materials.

1 unit, Spr (Keen) by arrangement

112. Elementary Paleontology — Introduction to the study of fossils, with emphasis on principles; relevance to geology and other fields of knowledge. Prerequisite: 2 or permission of instructor.

5 units, Aut (Evitt) MWF 10; lab. W 1:15–4:05 and one lab. by arrangement

115. Introduction to Biological Oceanography—Readings and lectures on marine organisms, their ecology, relationships, morphology, and geographic distribution, and a survey of current methods and facilities for study. Prerequisites: One year Biology or one year Geology (or equivalent).

4 units, Aut (Keen) MTWTh 9

119. Vertebrates of the Past—A survey for nonspecialists. Distinctive characters, specializations for particular modes of life, evolutionary history, distribution in space and time of major vertebrate groups. No prerequisites.

3 units, Spr (Evitt) MWF 11


4 units, Spr (Silberling) MWF 11; field trips

213. Advanced Invertebrate Paleontology I—Morphology, taxonomy, and distribution of selected invertebrate phyla, with emphasis on Mollusca. Prerequisite: 112.

5 units, Win (Keen) MWF 11; lab. W 2:15–5:05 and lab. by arrangement

214. Advanced Invertebrate Paleontology II—Significant topics on morphology, taxonomy, and distribution of invertebrate fossils. Prerequisite: 112.

4 units, Aut (Silberling, Staff) lectures, seminar, and lab. by arrangement

218. Introduction to Micropaleontology — Principles and classification of various microscopic plants and animals.

5 units, Aut (——) MWF 11; lab. M 1:15–4:05 and one lab. by arrangement

316. Introduction to Palynology—Study of microfossils smaller than 200 microns.

5 units, Win (Evitt) by arrangement

317. Stratigraphic Palynology — Continuation of 316.

5 units, Spr (Evitt) by arrangement alternate years, given 1969–70
367. Seminar in Paleontology and Stratigraphy—Enrollment by approval of instructors.

2 units, each quarter (Staff)


ECONOMIC GEOLOGY

175. Field Trip—(Enroll in Mineral Engineering 175.) A ten-day field trip to various mining and metallurgical operations in Nevada, Utah, and California. Each student is required to prepare one chapter for the trip guidebook during the winter quarter. Given in alternate years with 176.

3 units, Spr vacation (Staff) by arrangement, alternate years, given 1969-70

176. Field Trip—(Enroll in Mineral Engineering 176.) Similar to 175 except limited to mining and metallurgical operations in California and Arizona.

3 units, Spr vacation (Staff) by arrangement, alternate years, given 1968-69


3 units, Spr (Harbaugh) by arrangement

215. Mineral Economics—(Enroll in Mineral Engineering 215.) Lectures, discussions on property acquisition, valuation, financing, marketing, geography, accounting, taxation, conservation, stabilization, government activities, international affairs, and labor relations pertaining to minerals, including petroleum, natural gas, and coal; surveys of individual minerals as commodities.

3 to 5 units, Spr (Just) by arrangement

219. Mine Exploration—(Enroll in Mineral Engineering 120.) Lectures, discussion, seminar. A survey of how mines are found, including prospector, geological and geophysical methods; organization, and economic aspects; optional seminar. Prerequisite: Geology 105.

3 to 5 units, Win (Staff) by arrangement


2 units, Spr (Harbaugh, Kruger) by arrangement

281. Ore Deposits—Principles of occurrence, processes of deposition, structure of ores. Prerequisites: 51 and 105.

5 units, Aut (Park) MTWTh 10; lab., field trips by arrangement


4 units, Win (Lyon) M 1:15-4:05; two labs. and one seminar by arrangement

284. Engineering Geology—Application of geologic factors to design and construction of engineering works. Emphasis on means for more effective interaction between geologists and engineers. Prerequisite: 1.

4 units, Aut (Jahn, Johnson) TTh 8; field trips and seminars by arrangement


5 units, Win (——) MWF 8; seminar M 2:15-4:05; lab. W or Th 1:15-4:05

286. Development of Ground-Water Resources—Numerical, graphical analysis of pumping tests; interpretation of well hydrographs; field techniques used in groundwater surveys. Prerequisite: 285.

3 units, Spr (——) TTh 11; lab. by arrangement

287. Minerals, Politics, and Economics—Mineral resources of the world; their political, economic effects.

3 units, Win (Park) MWF 9, given 1968-69

and three-dimensional space-fitting techniques to geological data, with stress on their use in petroleum and mineral exploration. Topics include facies mapping, subsurface structural mapping, paleogeologic mapping, fracture-set mapping, probability surfaces, and use of various types of two- and three-dimensional coordinate systems. Large digital computers are used in some of the exercises.

3 units, Win (Harbaugh, Staff) by arrangement

383. Genesis of the Metallic Ores — Advanced study of mineral, district collections; emphasis on genesis, localization control. Prerequisite: 283.

6 units, Spr (Park) MF 1:15–4:05; two labs. by arrangement

387. Seminar in Ore Deposits—Class is organized as a Board of Directors to which mineral propositions are presented.

2 units, Aut (Park) by arrangement

487. Seminar in Hydrogeology.

2 units, Aut (——) by arrangement

GEOPHYSICS

Executive Head: George A. Thompson

Professors: Allan V. Cox, George A. Thompson

Associate Professors: Robert L. Kovach, Ronald J. P. Lyon

Assistant Professors: Jon F. Claerbout, Chapman Young


OFFERINGS AND FACILITIES

Geophysics is the branch of earth science concerned with exploration of the earth and its history by physical measurements. The undergraduate and graduate programs are designed to provide (1) the background of fundamentals necessary to the study of geophysics and (2) course work in geophysics to coordinate and organize the required background with the principles of geophysics. The four-year undergraduate program leads to the degree of Bachelor of Science. The objectives of the graduate program are to prepare students for positions in the exploration industry, geophysical research programs, governmental work, and education. The Department of Geophysics is housed in the Henry Salvatori Laboratory of Geophysics. The Department has a number of special facilities among which are a seismic observatory, rock magnetism laboratory, time-sharing computer facilities, San Andreas magnetometer array, high pressure rock deformation laboratory, seismic model equipment, and a geophysics library. Graduate programs lead to the degree of Master of Science, and Doctor of Philosophy.

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

The following requirements for the degree of Bachelor of Science in Geophysics are in addition to the University requirements in general studies.

Curriculum

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Quarter</th>
<th>Given</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry 1, 2, 3 or 4, 5. General Chemistry</td>
<td>Any</td>
<td>18</td>
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<td></td>
</tr>
<tr>
<td>Math. 10, 11, 21, 22, 23 or 41, 42, 43 and 44. Analytical Geometry and Calculus</td>
<td>A or W</td>
<td>3</td>
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</tr>
<tr>
<td>Math. 130. Ordinary Differential Equations</td>
<td>W</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math. 131. Partial Differential Equations</td>
<td>WSA</td>
<td>3</td>
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<tr>
<td>Geophysics 190. Elementary Geophysics</td>
<td>WS</td>
<td>5</td>
<td></td>
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<tr>
<td>Physics 51, 52, 53, 54, 55, 56. Elementary Physics</td>
<td>AW</td>
<td>6</td>
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<tr>
<td>Physics 110, 111. Mechanics</td>
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<tr>
<td>Physics 120, 121. Electricity and Magnetism</td>
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<tr>
<td>German 3 or Russian 3.</td>
<td>AWS</td>
<td>5</td>
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<tr>
<td>Geology 1, 2 or 3. Geoscience</td>
<td>AWS 10 or 4</td>
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<tr>
<td>Geology 25. Mineralogy</td>
<td>A</td>
<td>4</td>
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<td>Geology 51. Elementary Petrology</td>
<td>W</td>
<td>5</td>
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<tr>
<td>Geology 105. Structural Geology</td>
<td>S</td>
<td>5</td>
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<tr>
<td>Geology 108, 109. Field Geology*</td>
<td>S</td>
<td>15</td>
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<tr>
<td>Geology 171. Geochemistry</td>
<td>A</td>
<td>3</td>
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<td></td>
</tr>
</tbody>
</table>

* A student who takes 108 and 109 during the summer following his junior year will normally graduate at the end of winter quarter in his senior year.

As electives in the Geophysics Curriculum the following courses are recommended: Geology 106, Physics 122, Mathematics 132, Electrical Engineering 261H, Geophysics 191.

MASTER OF SCIENCE

Objectives—To round out the student's training for professional work in geophysics through the completion of fundamental
courses, both in the major field and in related sciences, and by obtaining a start on independent work and specialization.

Requirements for the Degree—The candidate must fulfill the following requirements:

1. Be registered in the graduate school for at least three quarters.
2. Complete 45 units with at least a B average. At least 6 of these units must be independent work on a research problem.
3. Make up deficiencies in previous training. Not more than 10 units of such work may be counted as part of the minimum total of 45 units.
4. Demonstrate by examination his ability to read geologic literature in a foreign language. The examination must be passed no later than the date of filing for the Master of Science degree.

Doctor of Philosophy

Objectives—The degree of Doctor of Philosophy is conferred upon evidence of high attainment in geophysics, and ability to conduct an independent investigation and to present the results of such research.

Requirements for the Degree—A minimum of three years (nine quarters) of university graduate study must be satisfactorily completed. At least one of these years, ordinarily the last, must be spent as a registered student at Stanford. Ph.D. candidates in Geophysics are required to complete Physics 122; Physics 210, 211 and 212, or Applied Physics 213, 214, and 215; and advanced courses selected from the following topics: Applied Physics, Astrophysics, Atomic and Nuclear Physics, Communication Theory, Electromagnetic Theory, Engineering Mechanics, Geology, Geophysics (200 level or higher), Materials Science, Physics of Solids, Thermodynamics. The candidate must demonstrate by examination his ability to read German, French or Russian. His record must indicate outstanding scholarship, and deficiencies in previous training must be removed. He must pass the Departmental oral examination. He must fulfill the requirements of the minor department, if a minor is elected. He must pass the University oral examination, which is essentially a defense of the dissertation problem. He must prepare under faculty supervision a dissertation which is a contribution to knowledge and the result of independent work expressed in satisfactory form.

The Ph.D. dissertation must be submitted in its final form within five calendar years from the date of admission to candidacy by the University Committee on the Graduate Division. Candidates for the degree who fail to meet this deadline will be required to reapply for admission to candidacy and retake the Departmental and the University oral examinations. They will be given an additional one year in which to submit their dissertations.

Courses

190. General Geophysics — Elementary study of gravitational, magnetic, seismic, electrical, and thermal properties of the earth. Potential theory is introduced. Prerequisites: Geology 105, Mathematics 22, and Physics 55; any or all of these courses may be taken concurrently with 190.

3 units, Aut (Thompson) MWF 11

191. Geophysical Field Techniques—Geophysical field investigations in a region of geologic interest using seismic refraction, gravity, magnetic and electrical field techniques. Students engage in all phases of program, interpret the data, and prepare a final report. Prerequisite: Consent of the instructor.

4 units, Spr (Kovach, Thompson) by arrangement

203A. Stress Waves in Solids — (Enroll in Applied Mechanics 203A)
203B. Stress Waves in Solids — (Enroll in Applied Mechanics 203B)

250. Geomagnetism and Paleomagnetism—Spherical harmonic analysis of geomagnetic field; magnetic anomaly fields; basic background and techniques needed for research in paleomagnetism. Prerequisite: Physics 53.

3 units, Win (Cox) MWF 11

280. Geophysical Time Series Analysis — Methods for computer analysis of digitized time series and groups of time series, especially seismograms. Topics include: phase and group velocity; convolution and regressive filters for prediction; pulse shaping and inversion; correlation and spectral matrices; multichannel prediction and factorization; seismograms arising from layered earth models; synthesizing a layered earth model from
the seismograms. Prerequisite: consent of instructor.

3 units, Aut (Claerbout) by arrangement

281. Seismic Waves in Stratified Media —
Topics include stress-strain relations, energy relations, equations of motion, solutions in terms of rays, normal modes, and contour integrals, direct and iterative methods to determine the medium from seismograms, electromagnetism, hydrodynamics, and heat flow in a stratified medium. Prerequisites: Physics 61, 110 or 210.

3 units, Win (Claerbout) by arrangement

282. Introduction to the Upper Atmosphere —
Description of the constitution of the upper atmosphere and the ionosphere and an introduction to hydrodynamic and electromagnetic equations of motion. Prerequisite: consent of instructor.

1 unit, Spr (Claerbout) by arrangement

285. Advanced General Geophysics—A discussion of the available data of seismology, geodesy, heat flow and high pressure laboratory work in the understanding of the properties of planetary interiors. Prerequisite: Consent of the instructor.

3 units, Spr (Kovach) by arrangement

296B. Geologic Remote Sensing: Infrared and Radar—(Enroll in Mineral Engineering 296B.)

301. Problems in Geophysics.
Each quarter (Staff) by arrangement

309. Seminar in Rock Deformation—(Same as Geology 309, Mineral Engineering 309.) Weekly meeting for critical review of current research. May be repeated.

1 to 2 units, Aut, Win, Spr (Johnson, Thompson, Young) by arrangement

326. Mechanisms of Rock Deformation —
Relations between large scale structural deformation and the controlling atomic and microscopic phenomena. Applications to earthquake focal mechanisms. Criteria for ductile and brittle deformation of rocks. Prerequisites: Geology 105 and 200, or consent of the instructor.

3 units, Win (Young) MW 9; seminar by arrangement

327. Experimental Rock Deformation —
Study of recent techniques and concepts in experimental deformation. Laboratory work in the preparation, deformation, and analysis of single-crystal and polycrystal samples. Prerequisites: 328, 328, Geology 320.

2 units (Young) by arrangement

328. Theoretical Structural Geology —
Structural deformation studied as a physical process; geophysical, geological evidence bearing on origin of major earth structures. Prerequisites: 190 and Geology 105; recommended: 326, Geology 200 and 320.

3 units, Spr (Thompson) MW 9; seminar by arrangement

397. Seminar in Geophysics.
1 unit, any quarter (Staff) by arrangement

400. Research in Geophysics.
Each quarter (Staff) by arrangement

MINERAL ENGINEERING

Emeriti: Welton J. Crook, Evan Just (Professors)
Executive Head: Fredrick C. Kruger
Professors: John W. Harbaugh, Fredrick C. Kruger, Charles F. Park, Jr., Norman A. Parlee
Associate Professors: Robert W. Bartlett, Ronald J. P. Lyon, George A. Parks
Assistant Professor: Arvid M. Johnson
Research Associates (By Courtesy): Weston Bourret, Donnel F. Hewett

Members of the faculties of other divisions of the University giving courses or cooperating in the offerings of the Department of Mineral Engineering are William A. Tiller, S. O'Hara, O. Cutler Shepard, David A. Stevenson, Paul Switzer, R. H. Johns, Arthur D. Howard, George A. Thompson, and Chapman Young.

The Mineral Engineering curricula are designed for the threefold purpose of making graduates competent in the technology of mining, mineral processing, and chemical and extractive metallurgy, producing versatility in basic sciences, engineering, and business to cope with changes in technology, human affairs, and personal experience, thus qualifying them for promotion to executive status in the mineral industry. The Department emphasizes courses in exploration, development, and mining of mineral deposits, as well as in processing minerals for market, in extracting, refining and alloying of metals, and in mineral economics. Exceptions can be made, with Departmental permission, for students desiring more specialized study in narrower fields or those
interested in academic or scientific rather than industrial careers.

**UNDERGRADUATE PROGRAMS OF STUDY**

Undergraduate curricula are arranged to stress basic science, basic engineering and cultural education to provide the knowledge to meet new conditions in a rapidly changing world.

Mineral Processing and Chemical and Extractive Metallurgy curricula are combined under the latter name. Some specialization in the several branches of this option is possible by judicious choice of alternate courses and electives.

**COURSES TAKEN BY ALL UNDERGRADUATES**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>General Studies Requirements</strong></td>
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<tr>
<td></td>
<td>English 1, 2, 3. Freshman English</td>
<td>9</td>
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<tr>
<td></td>
<td>History 1, 2, 3. History of Western Civilization</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Math. 41, 42, 43. Analytical Geometry and Calculus</td>
<td>15</td>
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<tr>
<td></td>
<td>Group Activities (6)</td>
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<td></td>
<td>Humanities (including Speech 20)</td>
<td>8</td>
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<tr>
<td></td>
<td>Social Sciences (including Economics 1)</td>
<td>10</td>
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<td><strong>Total</strong></td>
<td>54</td>
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<table>
<thead>
<tr>
<th>Departmental Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 4 and 5. General Chemistry</td>
</tr>
<tr>
<td>Engr. 11 and 12. Engineering Mechanics</td>
</tr>
<tr>
<td>Engr. 15. Mechanics of Materials (See Note 1)</td>
</tr>
<tr>
<td>Engr. 21. Mechanics of Fluids (See Note 2)</td>
</tr>
<tr>
<td>Engr. 41 and 42. Circuits, Electronics, and Electromechanics</td>
</tr>
<tr>
<td>Geol. 1. Geoscience 1</td>
</tr>
<tr>
<td>Geol. 25. Elementary Mineralogy</td>
</tr>
<tr>
<td>Geol. 204A. Computer Applications in Earth Sciences</td>
</tr>
<tr>
<td>Min.E. 100. Industrial Report</td>
</tr>
<tr>
<td>Min.E.101. Elements of Mining</td>
</tr>
<tr>
<td>Min.E. 103. Principles of Mineral Processing</td>
</tr>
<tr>
<td>Min.E. 105. Extractive Process Metallurgy</td>
</tr>
<tr>
<td>Min.E. 175 or 176. Field Trip</td>
</tr>
<tr>
<td>Physics 51 to 56. Engineering Physics</td>
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<td><strong>Total</strong></td>
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</table>

**MINING OPTION**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>General Studies Requirements</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Econ. 5. Economics of Prices and Markets I</td>
<td>5</td>
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<tr>
<td></td>
<td>Engr. 161. Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>I.E. 133. Industrial Accounting</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Lang. 1, 2. Modern European Language</td>
<td>8</td>
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<td><strong>Total</strong></td>
<td>60-57</td>
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</tbody>
</table>

**CHEMICAL AND EXTRACTIVE METALLURGY OPTION**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 171, 173, 175, 176. Physical Chemistry</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Ch.E. 10. Introduction to Chemical Engineering</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Ch.E. 130B. Transport Phenomena</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Engr. 50. Introductory Science of Materials</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Math. 44. Advanced Calculus</td>
<td>3</td>
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<tr>
<td>Math. 130. Ordinary Differential Equations</td>
<td>3</td>
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<tr>
<td>Mat.Sci. 122. Solid State Thermodynamics</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Mat.Sci. 124. Phase Equilibria</td>
<td>3</td>
<td></td>
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<tr>
<td>Mat.Sci. 125. Structural Transformation in Materials, or Min.E. 225. Surfaces and Interfaces, or Min.E. 237. Equilibria and Kinetics in Aqueous Systems 3-4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Min.E. 207. Physical Chemistry of Metal Refining</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Min.E. 226. Electrometallurgy</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Min.E. 233. Rate Processes in Chemical Metallurgy</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Electives</td>
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<tr>
<td><strong>Total</strong></td>
<td>56-57</td>
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</table>

**MANAGEMENT OPTION**

This option is recommended for students interested in futures in mining industry management, to be coupled with a fifth year—Master's degree—emphasizing economic aspects of mining and metallurgy and courses in the Graduate School of Business.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Econ. 5. Economics of Prices and Markets I</td>
<td>5</td>
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<tr>
<td></td>
<td>Engr. 161. Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>I.E. 133. Industrial Accounting</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Lang. 1, 2. Modern European Language</td>
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<td><strong>Total</strong></td>
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</table>

and Group A or B below:

**A (Mining)**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Geol. 51. Elementary Petrology</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geol. 105. Structural Geology</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geol. 231. Ore Deposits</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Min.E. 114. Elementary Problems in Mining Engineering, or Min.E. 118. Mining Methods</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Min.E. 219. Mine Exploration</td>
<td>5</td>
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<tr>
<td>Electives</td>
<td>10</td>
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<tr>
<td><strong>Total</strong></td>
<td>57</td>
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</table>

**MINERAL ENGINEERING**

Min.E. 118. Mining Methods 2
Min.E. 219. Mine Exploration 5
Min.E. 200. Introduction to the Mechanics of Earth Materials 3
Electives 9

**Total** 57
B (Chemical and Extractive Metallurgy)
Chem. 171, 173. Physical Chemistry 6
Engr. 50. Introductory Science of Materials 3
High Temperature Laboratory, or Min.E. 109. Separation Flow-sheet Development (See Note 3)
Min.E. 216. Mineral Processing Seminar (Engineering), or Min.E. 228. Extractive Metallurgy Seminar (See Note 3)

Electives 9-10
Electives 12-13

Total. 55-57

Note 1.—Engineering 11, 12, and 15 can be replaced by Mathematics 130 and Physics 110 and 111.

Note 2—Chemical Engineering 130A may be substituted and is preferred in the Chemical and Extractive Metallurgy option.

Note 3.—Courses taken to satisfy this requirement must include at least one from the group Min.E. 106, 107, 109, and at least one from the group Min.E. 216 or Min.E. 228. Min.E. 207 may be used to complete the maximum unit requirement.

RECOMMENDED ELECTIVES

<table>
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<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
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<tbody>
<tr>
<td>Chem. 121.</td>
<td>Organic Chemistry</td>
<td>3</td>
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<tr>
<td>C.S. 136.</td>
<td>Use of Automatic Digital Computers</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 171 and 271.</td>
<td>Geochemistry</td>
<td>6</td>
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<tr>
<td>I.E. 152.</td>
<td>Introduction to Operations Research</td>
<td>3</td>
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<tr>
<td>Stat. 110.</td>
<td>Statistical Methods in Engineering</td>
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</table>

Mining Option

<table>
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<th>Subject</th>
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<tr>
<td>C.E. 240.</td>
<td>Construction Planning</td>
<td>2</td>
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<tr>
<td>Chem 171.</td>
<td>Physical Chemistry</td>
<td>3</td>
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<tr>
<td>Geophys. 190.</td>
<td>General Geophysics</td>
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</table>

Chemical and Extractive Metallurgy Option

<table>
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<th>Course No.</th>
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<tr>
<td>Engr. 181.</td>
<td>Engineering Economy</td>
<td>3</td>
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<tr>
<td>Geol. 283.</td>
<td>Microscopic Study of Ore Minerals</td>
<td>3</td>
</tr>
<tr>
<td>I.E. 133.</td>
<td>Industrial Accounting</td>
<td>3</td>
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<tr>
<td>Mat.Sci. 105.</td>
<td>Imperfections in Crystalline Solids</td>
<td>3</td>
</tr>
<tr>
<td>Min.E. 200.</td>
<td>Introduction to the Mechanics of Earth Materials</td>
<td>3</td>
</tr>
<tr>
<td>Phys. 57.</td>
<td>Atomic Physics</td>
<td>3</td>
</tr>
</tbody>
</table>

GRADUATE PROGRAMS OF STUDY

The Department of Mineral Engineering offers graduate programs to prepare students for responsible engineering, supervisory, research, and executive positions in the mining and metallurgical industries, or for governmental work or education. These programs lead to the advanced degrees of Master of Science, Engineer, and Doctor of Philosophy. As the requirements for adequate training in mineral engineering are unusually broad, the Department of Mineral Engineering recommends at least one year of graduate study.

Because the majority of mineral engineers seek industrial employment, these programs are designed to carry forward training in basic sciences, engineering, or business. Emphasis is often placed on business courses in order to overcome the deficiencies which handicap most engineers in qualifying for executive status. Candidates for the Master of Science and Engineer degrees are encouraged to take a portion of their credits in the Graduate School of Business.

Candidates for the degree of Doctor of Philosophy in Mineral Engineering are normally those preparing for careers in education or basic research. Department programs at this level are very flexible but place emphasis on advanced study in the basic sciences and on creative research.

Graduate students must maintain a B average in the School of Earth Sciences and equivalent status in other schools.

MASTER OF SCIENCE

Specific Requirements

1. Complete 45 units, at least 6 of which must be independent work on a research program properly reported; research work may include up to 24 units. Students must be registered in the graduate school for at least three quarters.

2. Overcome important deficiencies in previous training. Not more than 10 units of such work may be counted as part of the minimum total of 45 units.

Courses Required for the Master’s Degree

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
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<tbody>
<tr>
<td>Min.E. 215.</td>
<td>Mineral Economics</td>
<td>3-4</td>
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<tr>
<td>Min.E. 300.</td>
<td>Advanced Work</td>
<td>6</td>
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</table>

Mining Option

<table>
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<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>I.E. 133 or Business 210-11.</td>
<td>Industrial or Management Accounting</td>
<td>4-6</td>
</tr>
<tr>
<td>Min.E. 200.</td>
<td>Introduction to Rock Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>Min.E. 230.</td>
<td>Mining Seminar</td>
<td>3</td>
</tr>
<tr>
<td>Min.E. 231.</td>
<td>Mining Seminar</td>
<td>3</td>
</tr>
<tr>
<td>Min.E. 232.</td>
<td>Mining Seminar</td>
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<tr>
<td>Electives</td>
<td>17-20</td>
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</tr>
</tbody>
</table>
**Mineral Processing Option**

Min.E. 216. Mineral Processing Seminar (Engineering) 2
Min.E. 217. Mineral Processing Seminar (Research) 2
Min.E. 233, 234. Rate Processes in Chemical Metallurgy 6
Min.E. 225. Surfaces and Interfaces, or Min.E. 227. Equilibria and Kinetics in Aqueous Systems 3
Electives 16

**Chemical and Extractive Metallurgy Option**

Min.E. 226. Electrometallurgy 3
Min.E. 227. Equilibria in Aqueous Systems 3
Min.E. 228. Extractive Metallurgy Seminar 3
Min.E. 229. Principles of Steelmaking 3
Min.E. 234. Rate Processes in Chemical Metallurgy or Min.E. 224. Physical Chemistry of Metals Seminar 3
Chem. 267. Electrochemical Thermodynamics and Kinetics 2
Mat.Sci. Electives 6
Electives 18

**Management Option**

Bus. 200–01. Business Economics 6
Bus. 210–11. Management Accounting, or I.E. 133. Industrial Accounting 4–6
Bus. 371. Employment Relationships 3
Mineral Engineering Electives 8
Electives 7–9

**Exploration Options**

In addition to the required courses, Mineral Economics and Advanced Work, a student may select 35–36 units from the following lists:

**Mineral**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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<tbody>
<tr>
<td>Geol. 204A, B. Computer Applications</td>
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<tr>
<td>Geol. 205. Statistical Problems</td>
<td>3</td>
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<tr>
<td>Geol. 281. Ore Deposits</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geol. 283. Laboratory Study of Ore Minerals</td>
<td>4</td>
<td></td>
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<tr>
<td>Geol. 383. Genesis of Metallic Ores</td>
<td>6</td>
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<tr>
<td>Geophy. 190. General Geophysics</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Geophy. 191. Geophysical Field Techniques</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Min.E. 219. Mine Exploration</td>
<td>3–5</td>
<td></td>
</tr>
<tr>
<td>Min.E. 280. Quantitative Exploration Decision Making</td>
<td>2</td>
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</tr>
<tr>
<td>Min.E. 288. Mapping Techniques in Economic Geology</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Min.E. 296A, B, C. Geologic Remote Sensing</td>
<td>8–9</td>
<td></td>
</tr>
</tbody>
</table>

**Petroleum**

Geol. 182. Petroleum Geology and Subsurface Mapping 3
Geol. 204A, B. Computer Applications in Earth Sciences 4
Geol. 205. Statistical Problems 3
Geol. 209. Physics of Underground Fluids 5
Geophy. 190. General Geophysics 3
Geophy. 191. Geophysical Field Techniques 4
Pet.E. 150A, B, C. Formation Evaluation 8
Min.E. 280. Quantitative Exploration Decision Making 2
Min.E. 288. Mapping Techniques in Economic Geology 3
Min.E. 296A, B, C. Geologic Remote Sensing 8–9

**Engineer**

A minimum of two years (six quarters) of graduate study is required. At least one of these years, ordinarily the last, must be spent as a registered student at Stanford. The candidate must complete 90 units of course work, no more than 10 of which may be applied to overcoming deficiencies in undergraduate training. At least 30 units must be taken in advanced work, that is, work beyond the undergraduate requirements, in engineering and closely allied fields. The student must prepare a thesis meeting the approval of the supervising instructor and the University Committee on the Graduate Division.

**Courses Required for the Engineer Degree**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate School of Business Courses</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.S. 136. Use of Automatic Digital Computers</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>I.E. 252. Operations Research</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Min.E. 300. Advanced Work (Thesis)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Stat. 110. Statistical Methods in Engineering</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Electives</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

*In addition to requirements for Master's degree.*

**Doctor of Philosophy**

The degree of Doctor of Philosophy is awarded upon completion of the general University requirements.

The Department requires either (a) a reading knowledge of two foreign languages in addition to English, at least one useful in research. The other must be useful in the career of a mineral engineer, or (b) a speak-
Prior to applying for admission to candidacy the students must (1) demonstrate mastery of his option and related subjects by passing a written qualifying examination usually taken during the first year of residence, and (2) within one year after passing the written examination, demonstrate a high level of proficiency in his option by passing a Departmental oral examination, and should he elect as his option Mineral Processing or Chemical and Extractive Metallurgy, (3) develop and demonstrate his ability to plan and execute research problems by successful treatment of assigned projects while enrolled for a minimum of two units in course Min. E. 300. Candidates who take a Master of Science degree at Stanford may use their six-unit research requirements toward fulfillment of item (3).

**UNDERGRADUATE COURSES**

100. *Industrial Report in Mineral Engineering*—Student required to submit report covering at least two consecutive months of industrial experience in mining, mineral processing, or metallurgical plant work. Required for graduation in mineral engineering.

1 unit, Aut, Win, Spr (Staff) by arrangement

101. *Elements of Mining*—Introduction to mining. Prospectng, development, mine plant and equipment, mining methods, mine-engineering problems. Serves needs of engineering or geological student who seeks general knowledge of mining.

3 units, Aut (Kruger) by arrangement

103. *Principles of Mineral Processing*—Study of mineral separation techniques and auxiliary operations aimed at recognizing the basic principles involved and the means by which they may be applied in practice. Topics include comminution, sizing, solid-liquid separations and gravity, magnetic, electrostatic, and flotation techniques of solid-solid separation. Guided reading, occasional lectures, and periodic interviews. Prerequisites: Chemistry 5, Physics 55, and Mathematics 43.

4 units, Aut (Staff) by arrangement

105. *Extractive Process Metallurgy*—Introduction to metallurgical thermodynamics, and fundamentals of the processes used in the production and refining of metals. May be taken as an introduction to metallurgical thermodynamics by enrolling for 2 units. Prerequisite: Chemistry 5.

2 to 3 units, Win (Parlee) by arrangement

105A. *Introduction to Metallurgy*—Designed for non-metallurgy majors. Lectures, and reading assignments in all phases of metallurgy.

2 to 3 units, Win (Parlee) by arrangement

106. *Engineering Aspects of Mineral Processing*—Directed reading and laboratory projects culminating in written reports. At least two projects selected from the following topics: comparison and selection among alternative operations, optimization, scale-up, quality control and automation. Offered in conjunction with 206. May be repeated with credit. Offered only on request at least one quarter in advance. Prerequisites: 103 or equivalent required; Statistics 110 and Geology 204 recommended.

2 or more units, Win (Staff) by arrangement

107. *High Temperature Laboratory*—Lectures and laboratory projects relating to high temperature processes, atmosphere control, and vacuum technology; thermodynamic and kinetic measurements. Prerequisite: 105. (Chemistry 171 in special cases.)

2 units, Spr (Bartlett) TTh 1:15-4:05 alternate years, given 1969-70

109. *Separation Flowsheet Development*—Techniques of examination of ores and plant products. Practice in choice of treatment, integration of operations and diagnosis of problems. May be repeated with credit. Offered only on request at least one quarter in advance. Prerequisite: 103 or equivalent required. Materials Science 127 and Geology 220, or Geology 283 recommended.

2 or more units, Spr (Staff) by arrangement

114. *Elementary Problems in Mining Engineering*—Problems involved in mining practice, designed to supplement 101 as added work for those whose major interest is mining. Open to those concurrently registered in 101.

2 units, Aut (Kruger) by arrangement
118. Mining Methods—To follow 101. Discussion, seminar, using case histories to illustrate methods, equipment, and costs. Prerequisite: 101.
2 units, Win (Kruger) by arrangement, alternate years, given 1969–70

122. Solid State Thermodynamics—(Enroll in Materials Science 122.) Systematic development of basic laws, mathematical techniques, definitions, and derivation of thermodynamic relations. Solution thermodynamics. The reaction isotherm, law of mass action, and applications. Imperfection equilibria. Heterogeneous equilibria. Prerequisite: Chemistry 171 or Physics 170. Computer Science 5 recommended.
3 units, Aut (Stevenson) MWF 11

175. Field Trip—A ten-day field trip to various mining and metallurgical operations, including Ruth and McGill, Nevada; Bingham, Garfield, Tintic, Price and Moab, Utah; and Mt. Pass, California. Each student is required to prepare one chapter for the trip guidebook during winter quarter. This or 176 required of all candidates for the Bachelor of Science degree in Mineral Engineering. Given in alternate years with 176.
3 units, Spr vacation (Staff) by arrangement, alternate years, given 1969–70

176. Field Trip—Similar to 175 except to mining and metallurgical operations in California and Arizona, including New Idria, San Manuel, Ray, Hayden, Christmas, Pima, Magma, Mission, Iron King, Eagle Mountain, and Boron.
3 units, Spr vacation (Staff) by arrangement, alternate years, given 1968–69

180. Field or Laboratory Study and Report in Mining or Metallurgical Engineering.
1 to 2 units, Aut, Win, Spr (Staff) by arrangement

191. Geophysical Field Techniques—(Enroll in Geophy. 191.) Geophysical field investigations in a region of geologic interest using seismic refraction, gravity, magnetic and electrical field techniques. Students engage in all phases of program, interpret the data, and prepare a final report. Prerequisite: consent of instructor.
4 units, Spr (Kovach, Thompson) by arrangement

**Graduate Courses**

200. Introduction to Rock Mechanics—Application of rock mechanics and soil mechanics to the design of underground openings and of excavations. Prerequisite: Calculus, and Geol. 200 or Applied Mech. 202A.
3 units, Win (Johnson) by arrangement

201. Principles and Methods of Crystal Growth—(Enroll in Materials Science 201.) Broad look at the important phenomena involved in the growth and perfection of crystalline solids from melt, solution, vapor, electrodeposition, etc. Discussion of the merits of the various preparation methods.
3 units, Spr (O'Hara) MWF 9

202. Studies in the Mechanics of Earth Materials—Guided, individual or group study of some aspects of the mechanics of earth materials. Especially for students in Earth Sciences whose theses involve mechanics. Prerequisite: 200 or permission of instructor.
3 units, Spr (Johnson) by arrangement

203A. Advanced Mineral Processing: Separations—A sequel to 103. Advanced study of solid-solid separation methods. Prerequisite: 103 or equivalent, Geology 25, and Engineering 50. Enrollment in Engineering 50 may be concurrent.
4 units, Aut (Parks) MWF 11 and one discussion session by arrangement

203B. Advanced Mineral Processing: Auxiliary Operation—A sequel to 103. Advanced independent study of solid-fluid separations, comminution, and sizing. Periodic discussions. Prerequisites: 103 or equivalent and Engineering 50.
3 units, Win (Parks, Staff) by arrangement

204A. Computer Applications in Earth Sciences—(Enroll in Geology 204A.) Introduction to use of digital computers in the earth sciences, with emphasis on developing the student's ability to use computers in research. Students are expected to develop facility in computer programming if they lack previous experience. Stress is placed on each student developing a computing application that is unique to his research interests. Topics include programming principles, surface and space-fitting techniques, analytical classification methods, and simulation of dynamic systems. Applications to petrology, struc-
natural geology, paleontology, geomorphology, petroleum exploration and mining are presented.

3 units, Fall (Harbaugh) MWF 10

204B. Computer Applications in Earth Sciences Seminar—(Enroll in Geology 204B.) Seminar which provides an opportunity for students who have been enrolled previously in Geol. 204A to present and discuss the results of their research applications.

1 or more units, Win (Harbaugh) by arrangement

205. Statistical Problems in Earth Sciences—(Enroll in Geology 205.) Estimation of frequency distribution of minerals and of total ore tonnages, identification of minerals by remote sensing, design of field sampling procedures, evaluation of map accuracy, and other topics chosen from participants' interests.

3 units, Spr (Switzer) by arrangement

206. Advanced Solid Separations: Engineering—Advanced independent study of topics listed under 106. Offered in conjunction with 106 under the same conditions. Added prerequisites: 203 and 205.

2 units, Win (Staff) by arrangement

207. Physical Chemistry of Metal Purification—Refining processes and the physical chemistry underlying them. A systematic treatment, of unit processes based on types of impurity phases, deals effectively with the fundamentals of such widely different methods as the zone refining of semiconductors, the industrial refining of copper, steelmaking, and the vacuum refining of high temperature alloys. Prerequisite: 105, or Chemistry 171 or equivalent.

3 units, Aut (Parlee) by arrangement

209. Separation Flowsheet Development—Advanced treatment of material described under 109. Offered in conjunction with 109 under the same conditions. Prerequisites: Materials Science 127, and Geology 220, or Geology 283.

2 units, Spr (Staff) by arrangement

215. Mineral Economics—Lectures, discussions on property acquisition, valuation, financing, marketing, geography, accounting, taxation, conservation, stabilization, government activities, international affairs, and labor relations pertaining to minerals, including petroleum, natural gas, and coal; surveys of individual minerals as commodities.

3 to 5 units, Spr (Just) by arrangement

216. Mineral Processing Seminar (Engineering) —Lectures, guest speakers, and student seminars on Mineral Processing topics, emphasizing engineering and economic aspects. Open to undergraduates by permission. May be repeated with credit. Prerequisite: 103. In addition, Speech 20 recommended.

1 to 2 units, Spr (Parks) by arrangement

217. Mineral Processing Seminar (Research)—Weekly meetings for critical review of current literature and research. Occasional guest speakers. Open to undergraduates by permission. May be repeated with credit.

1 to 2 units, Win, Spr (Staff) by arrangement

219. Mine Exploration—Lectures, discussion. A survey of how mines are found, including prospector, geological and geophysical methods, organization and economic aspects; optional seminar. Prerequisite: Geology 105.

2 units, Sum (Staff) by arrangement

220. Drilling and Blasting—Lectures and discussions on theory and practice of blast-hole drilling and blasting.

2 units, Spr (Just) by arrangement


3 units, Spr (Stevenson) MWF 11

224. Physical Chemistry of Metals Seminar—Lectures, student seminars, guest speakers on topics in the physical chemistry of metals and in properties of liquid metals. Can be repeated with credit.

1 to 3 units, Sum (Parlee) by arrangement, alternate years, given 1969-70

225A. Introduction to Surfaces and Interfaces—An introduction to the properties of surfaces and interfaces and their manifestations in a variety of contexts including Chemical, Civil, Mineral, and Petroleum Engineering; Biology, Geology, and Materials
Science. One two-hour lecture and a one-hour discussion session weekly. Lectures offered by Prof. Eric Hutchinson, Department of Chemistry. No absolute prerequisites, but prior exposure to thermodynamics is recommended.

3 units, Win (Hutchinson, Staff) by arrangement

225B. Surfaces and Interfaces — Advanced treatment of selected topics in Surface Chemistry with emphasis on inorganic colloidal systems and adsorption. Independent study, lectures, and discussions. Term paper. With 225A, replaces 225. Prerequisites: 225A or equivalent and Chemistry 173 or Materials Science 122 or equivalent.

3 units, Spr (Parks), three lecs. by arrangement, alternate years, given 1968–69


3 units, Spr (Bartlett) by arrangement, alternate years, given 1968–69

227. Equilibria in Aqueous Systems — Techniques of predicting probability, extent and rate of heterogeneous chemical reactions involving one aqueous phase. Prerequisites: either Chemistry 173 and Materials Science 122 or Chemistry 173 and Geology 171.

3 units, Spr (Parks) three lecs. by arrangement, alternate years, given 1969–70

228. Extractive Metallurgy Seminar — Student seminars, discussions, and guest speakers on various aspects of chemical and extractive metallurgy.

2 to 3 units, Spr (Parlee) by arrangement

229. Principles of Steelmaking — Systematic development of the physical chemistry underlying ironmaking and steelmaking processes. Treatment generalized to promote understanding of the physical chemistry of other metals as well. Seminar treatment of important processes. Prerequisite: 105 or Chemistry 171 in special cases.

3 units, Win (Parlee) by arrangement, alternate years, given 1968–69


3 units, Aut (Kruger) by arrangement

231. Mining Seminar — Case histories, economics.

3 units, Win (Kruger) by arrangement

232. Mining Seminar — Valuation, law, organization.

3 units, Spr (Kruger) by arrangement

233. Rate Processes in Chemical Metallurgy I — Chemical kinetics and diffusion with emphasis on heterogeneous reactions and associated mass transport encountered in mineral engineering — leaching, roasting, aqueous and gaseous reduction, solvent extraction, slag/metal reactions, converter processes, and flotation. Prerequisite: 105 or Chem. 171.

3 units, Aut (Bartlett) MWF 10

234. Rate Processes in Chemical Metallurgy II — Continuation of 233 with transport of fluids and applications of kinetic and transport data in design of metallurgical unit operations.

3 units, Win (Bartlett) MWF 10


3 units, Win (Miller) S 9–12, alternate years, given 1969–70

272. Spectrochemical Analysis — Fundamentals of spectrochemical analysis and their application to study of rocks and minerals. Enrollment limited to 6. Prerequisite: consent of instructor.

5 units, Win (Staff) MW 10; lab. MW 1:15–4:05 and one lab. by arrangement

273. Advanced Spectrochemical Analysis — Enrollment limited to 6. Prerequisite: 272.

3 units, Spr (Staff) three 3-hour labs. by arrangement


2 units, Spr (Harbaugh, Kruger) by arrangement
SCHOOL OF EARTH SCIENCES

284. Engineering Geology—(Enroll in Geol. 284.) Application of geologic factors to design and construction of engineering works. Emphasis on means for more effective interaction between geologists and engineers. Prerequisite: 1.

4 units, Aut (Jahns, Johnson) TTh 8; field trips and seminars by arrangement

287. Minerals, Politics, and Economics—(Enroll in Geol. 287.) Mineral resources of the world; their political, economic effects.

3 units, Win (Park) MWF 9, given 1968-69

288. Mapping Techniques in Economic Geology—(Enroll in Geol. 288.) Theory and practice in applying mapping and three-dimensional space-fitting techniques to geological data, with stress on their use in petroleum and mineral exploration. Topics include facies mapping, subsurface structural mapping, paleogeologic mapping, fracture-set mapping, probability surfaces, and use of various types of two- and three-dimensional coordinate systems. Large digital computers are used in some of the exercises.

3 units, Win (Harbaugh, Staff) by arrangement

296A. Geologic Remote Sensing: Photographic Techniques—Application of aerial photography to mineral and mineral fuel exploration. Particular emphasis on geologic interpretation of aerial photos in the field; effect on the geologic interpretation of varying sun angles, flight altitudes, and film and filter combinations. Includes work with black and white, color and camouflage detection (IR) photographs and films.

3 units, Aut (Lyon, Howard, Rich) lec. T 1:15; lab. T 2:15-4:05 and Th 1:15-4:05

296B. Geologic Remote Sensing: Infrared and Radar—Examination of the physics of relationships between ultraviolet, visible, infrared, microwave, and electromagnetic signatures from rocks, soils, vegetation, and oceans. Analysis in the laboratory of spectral data and imagery with specific reference to exploration for mineral and mineral fuels, work with infrared instrumentation. Prerequisites: 296A or 235.

3 to 4 units, Win (Lyon) lec. TTh 1:15; lab. TTh 2:15-4:05 (Th lab. for 4th unit — field studies)

296C. Geologic Remote Sensing: Other Airborne Exploration Techniques.

2 units, Spr lec. (Lyon) and seminar by Staff and Invited Guests, by arrangement. (Term paper for grade.)

300. Advanced Work in Mining or Metallurgical Engineering — Individual work on a research problem in mining, mineral processing, or chemical and extractive metallurgy.

Each quarter (Staff) by arrangement

308. Rock Mechanics and the Design of Underground Structures—Development of continuum theory of rock behaviors, including viscoelasticity and viscoplasticity. Tensor description of rock behaviors based on constitutive equations. Definition of three-dimensional coefficients for rock. Application of theory to laboratory studies, to determination of underground stress fields, and to design of underground structures. Prerequisites: 200 or Geol. 200, or permission of instructor.

3 units, Spr (Serata) by arrangement

309. Seminar in Rock Deformation—(Same as Geology, Geophysics 309.) Weekly meetings for critical review of current research. May be repeated with credit.

1 to 2 units, Aut, Win, Spr (Johnson, Thompson, Young) by arrangement

326. Mechanism of Rock Deformation—Relations between large scale structural deformation and the controlling atomic and microscopic phenomena. Criteria for ductile and brittle deformation of rocks. Prerequisites: Geol. 105 and 200, or consent of the instructor.

3 units, Win (Young) MW 9; seminar by arrangement

327. Experimental Rock Deformation — Study of recent techniques and concepts in experimental deformation. Laboratory work in the preparation, deformation, and analysis of single-crystal and polycrystal samples. Prerequisites: 326, 328, Geol. 320.

2 units (Young) by arrangement

PETROLEUM ENGINEERING

Emeritus: Frederick G. Tickell (Professor)
Executive Head: Frank G. Miller
Professors: Sullivan S. Marsden, Jr., Frank G. Miller, Henry J. Ramey, Jr.
Visiting Lecturer: Thomas D. Mueller
Research Associate (By Courtesy): Marshall B. Standing
OFFERINGS

The study programs of the Department of Petroleum Engineering are designed to make graduates competent in the engineering technology of oil and gas production, prepare them for careers in professional engineering and research, and fit them for promotion in management leading to executive status. The undergraduate curriculum leads to the degree of Bachelor of Science. Owing to the scope of petroleum engineering, qualified students are encouraged to take graduate study. Graduate programs lead to the degree of Master of Science, Petroleum Engineer, Petroleum Engineer (Management Option), and Doctor of Philosophy.

LABORATORY FACILITIES

The Department occupies the Lloyd Noble Petroleum Engineering Building devoted exclusively to petroleum engineering. It contains five laboratories for instruction and research, a classroom, a seminar and library room, a drafting and computing room, staff offices, and office study space for graduate students.

PROGRAMS OF STUDY

UNDERGRADUATE

The four-year program provides a foundation for a career in petroleum engineering. Basic sciences and engineering are stressed. Breadth is provided through courses in the social sciences and humanities. The mean grade in required courses in each of the fields of mathematics, chemistry, physics, and earth science must be C or better.

COURSES TAKEN BY ALL UNDERGRADUATES

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 1, 2, 3.</td>
<td>General Chemistry, or Chem. 4, 5.</td>
<td>General Chemistry (Quantitative Treatment)</td>
</tr>
<tr>
<td>Chem. 171.</td>
<td>Physical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>Math. 10, 11, 21, 22, 23, 44.</td>
<td>Analytical Geometry and Calculus (Mathematics 40 series may be substituted for the 20 series)</td>
<td>18</td>
</tr>
<tr>
<td>English 1, 2, 3.</td>
<td>Freshman English</td>
<td>9</td>
</tr>
<tr>
<td>History 1, 2, 3.</td>
<td>History of Western Civilization</td>
<td>12</td>
</tr>
<tr>
<td>Physics 51, 53, 55.</td>
<td>Mechanics, Sound, Electricity, Light, and Heat</td>
<td>12</td>
</tr>
</tbody>
</table>

GRADUATE DEGREES

The petroleum industry is increasingly interested in engaging petroleum engineers having advanced training. A balanced Master's degree curriculum covering both professional engineering and research requires a minimum of one academic year beyond the baccalaureate. The demand for men with this background exceeds the supply. As a result, there are many attractive employment opportunities.

The degree of Engineer in Petroleum Engineering requires a comprehensive two-
year program of graduate study. This degree emphasizes professional practice rather than research.

The degree of Engineer in Petroleum Engineering (Management Option) requires two years of graduate study, combining engineering and business administration. This program is conducted in cooperation with the Graduate School of Business.

The degree of Doctor of Philosophy is awarded primarily on the basis of accomplishments in research. A minimum of three years of graduate work is required for the degree.

**Master of Science**

The objective is to prepare the student for professional work in petroleum engineering through the completion of fundamental courses, both in the major field and in related sciences, and by obtaining a start on independent work and specialization.

The candidate must fulfill the following requirements:

1. Be registered in the graduate school for at least three quarters.
2. Complete 45 units with at least a B average. At least 6 of these units must be independent work on a research problem. Units from courses with grades of D will not be counted toward the required 45 units of work, and the average of all grades must be a B or better.
3. Make up deficiencies in previous training. Not more than 10 units of such work may be counted as part of the minimum total of 45 units.
4. Demonstrate his knowledge of basic principles and research methods in his general field of study by preparing a report, ordinarily a term paper written for 6 units of research, to be submitted to at least two faculty members.

**Courses Required for the Master’s Degree**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pet.E. 270A.</td>
<td>Advanced Oil Reservoir Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 270B.</td>
<td>Applications of Oil Reservoir Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 270C.</td>
<td>Applications of Oil Reservoir Engineering</td>
<td>4</td>
</tr>
<tr>
<td>Pet.E. 272A.</td>
<td>Natural Gas Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 272B.</td>
<td>Natural Gas Engineering</td>
<td>2</td>
</tr>
<tr>
<td>Pet.E. 274.</td>
<td>Introduction to Research Methods</td>
<td>3</td>
</tr>
<tr>
<td>Electives*</td>
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<td>9</td>
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<tr>
<td>Total</td>
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<td>45</td>
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**Engineer (Management Option)**

The objective is to round out the student’s training in professional engineering and to provide him with a background in business administration.

A minimum of two years (six quarters) of graduate study is required. At least one of these years, ordinarily the last, must be spent as a registered student at Stanford. The candidate must complete 90 units of course work, no more than 10 of which may be applied to overcoming deficiencies in undergraduate training. At least 30 units must be taken in advanced work, that is, work beyond the undergraduate requirements, in engineering and closely allied fields. He must have a B average in courses given by the School of Earth Sciences. He must prepare a thesis meeting the approval of the supervising instructor and the University Committee on the Graduate Division.
the research. If the candidate has received unit credit for such research, this credit ordinarily would be transferable to the Engineer degree. No more than 10 of the required 90 units may be applied to overcoming deficiencies in undergraduate training. The candidate is required to take a minimum of 36 units in Industrial Engineering and the Graduate School of Business.

Additional units needed to make up the required 90 may be electives selected with the consent of the student's adviser. He must maintain a C average in Graduate School of Business courses. In all other courses he must maintain a B average. He must prepare a thesis specifically for the Engineer degree. It is to have the approval of the supervising instructor and the University Committee of the Graduate Division.

**Doctor of Philosophy**

The degree of Doctor of Philosophy is conferred upon evidence of high attainment in Petroleum Engineering, and ability to conduct an independent investigation and to present the results of such research.

A minimum of three years (nine quarters) of graduate study must be satisfactorily completed. At least one of these years, ordinarily the last, must be spent as a registered student at Stanford. The candidate must demonstrate by examination his ability to read one foreign language: Russian, German, French or Spanish. His record must indicate outstanding scholarship. He must pass the Departmental oral examination. He must fulfill the requirements of the minor department, if a minor is elected. He must pass the University oral examination, which is essentially a defense of the dissertation problem. He must prepare under faculty supervision a dissertation which is a contribution to knowledge and the result of independent work expressed in satisfactory form.

The Ph.D. dissertation must be submitted in its final form within five calendar years from the date of admission to candidacy by the University Committee on the Graduate Division. Candidates for the degree who fail to meet this deadline will be required to reapply for admission to candidacy and retake the Departmental and University oral examinations. They will be given one additional year in which to submit their dissertations.

**Courses**

**103. Survey of the Petroleum Industry**

Arranged to give the students a comprehensive view of organization and operation of petroleum industry. Exploration; drilling and off-shore drilling; development and production methods of oil fields; transportation and storage; refining and petrochemicals; marketing. Chemical properties of petroleum and its products. Prerequisite: Chemistry 3 (or consent of instructor).

3 units, Spr (Marsden) MWF 11

**150A. Formation Evaluation**

Lectures, problems. Methods for evaluating commercial significance of rock formations penetrated in exploratory drilling. Drilling muds, core analysis, mud logging, electric logging. Prerequisites: 103 and Physics 53.

3 units, Aut (Ramey) MWF 10

**150B. Formation Evaluation**

Lectures, problems. Continuation of 150A. Radioactivity, sonic and nuclear magnetism logging; formation evaluation programs.

3 units, Win (Marsden) T 9–11 and Th 10

**151A. Petroleum Reservoir Fluids**

Lectures, problems. Chemical, physical properties of reservoir fluids. Gas laws, behavior of liquids, phase equilibria, viscosities of hydrocarbons; properties of subsurface waters. Prerequisites: 103.

3 units, Aut (Miller) MWF 11

**151B. Fluid Behavior in Reservoir Rocks**


3 units, Win (Ramey) MWF 10

**151C. Drilling Fluids**

Lecture, laboratory. Colloidal behavior and rheology of drilling fluids.

4 units, Spr (Marsden) MW 1:15; lab. MW 2:15–5:05

**151D. Petroleum Reservoir Fluids Laboratory**

Physical properties of petroleum and its products, including distillation with fractionation, gravity, viscosity, surface tension. Prerequisites: 103, 151A or concurrently.

2 units, Aut (Marsden) M 2:15; lab. WF 2:15–5:05

**151E. Core Analysis Laboratory**

Porosity, permeability, capillary pressure, relative per-
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meability, formation resistivity factor, analog models. Prerequisite: 151B or concurrently.

3 units, Win (Marsden) T 1:15; lab. TTh 2:15-5:05

152. Development and Production Technology — Lectures, demonstrations, field trips. Oil field equipment for drilling, production. Prerequisite: 103.

3 units, Spr (Miller) T 9–11 and Th 9, alternate years, given 1969–70

160. Report on Oil Field Training — Student required to submit report covering at least two consecutive months of industrial experience related to petroleum engineering.

1 unit, any quarter (Staff) by arrangement

170. Elements of Petroleum Reservoir Engineering — Lectures, problems. Description and classification of natural underground oil and gas reservoirs. Engineering calculations of fluid contents of reservoirs and predicted recoveries. Prerequisite: 151B.

3 units, Spr (Miller) MWF 9


3 units, Aut (Ramey) MWF 11


Any quarter (Staff) by arrangement


3 units, Win (Miller) S 9–12, alternate years, given 1969–70


3 units, Aut (Miller) MWF 1:15


3 units, Win (Miller) MWF 11

270C. Applications of Oil Reservoir Engineering — Lectures, seminar. Advanced group study of reservoir engineering. Applications of electronic computing machinery to reservoir problems. Prerequisite: 270B.

4 units, Spr (Miller, Mueller) Th 10–12 and seminar by arrangement

272A. Advanced Natural Gas Engineering — Lectures, problems. Transient flow of gas in reservoirs, testing of gas wells, interference between wells, gas reservoir thermodynamics. Prerequisite: consent of instructor.

3 units, Win (Ramey) MWF 2:15

272B. Advanced Natural Gas Engineering — Lectures, problems. Gas reservoir material balances, water-drive gas reservoirs, production matching and forecasting, reserve estimation, gas storage reservoirs. Prerequisite: consent of instructor.

3 units, Spr (Ramey) MWF 10


Any quarter (Staff) by arrangement


3 units, Spr (Ramey) MWF 10


Any quarter (Marsden, Miller, Ramey) by arrangement
Emeriti: A. John Bartky, W. H. Cowley, Paul R. Hanna, Maud M. James, Lucien B. Kinney, Maud L. Knapp, Henry B. McDaniel, Quinn McNemar, Jesse B. Sears (Professors); Margaret Barr, Elwyn Bugge, Ernest P. Hunt (Associate Professors)

Dean: H. Thomas James
Associate Dean: Arthur P. Coladarci
Assistant Deans: Robert N. Funk, Richard C. Still


Associate Professors: Norman J. Boyan (on leave autumn, winter quarters), Edith M. Dowley, Elliot W. Eisner, Luell Guthrie, Marian S. Ruch, Wesley K. Ruff, Helen W. Schrader, G. Wesley Sowards, Robert B. Textor


Lecturers: Guy H. Browning, Harold A. Korn, James B. Lyon, William J. Platt, William H. Strand

The School of Education is responsible for the preparation of scholars investigating educational processes, and of teachers, supervisors, guidance workers, administrators, and other educational specialists. Three degrees with specialization in education are granted by the University: Master of Arts, Doctor of Education, and Doctor of Philosophy. The Master of Arts in Teaching degree is offered jointly with several academic departments. Various teaching and educational service credentials are issued by state departments of education upon certification of the School that properly accredited work has been completed by the student. The University recommends to the California State Board of Education that credentials be granted.

Acceptance of Work Done Elsewhere — Students transferring with advanced or graduate standing from other universities may have substantially equivalent training accepted in lieu of the courses required at this University in education and in the major and minor fields.

The University offers no correspondence or extension courses.

SUMMER SESSION

The full Summer Session in the School of Education is for eight weeks. In addition, several one-, two-, three-, and four-week workshops and institutes are offered which make it possible for students to earn credit in shorter periods of time. However, those who pursue a full program of study for eight weeks may earn a quarter of residence toward degree and credential programs. The number of units for which a student may register in the Summer Session may not exceed 16, unless part of the registration is for thesis or dissertation.

The Summer Session Bulletin, issued each year in February, will contain more definite information about Summer offerings.

PROGRAMS OF STUDY

Information about programs of study is reported below in relation to degrees and credentials. Many students entering the School of Education are candidates for both degrees and credentials. In that case, both
applicable sections should be consulted. Below are listed the degrees offered by the School of Education and the credentials with which they may be associated. (There is no necessary association between degrees and credentials. Requirements for degrees and credentials differ even when the candidate is preparing for both at the same time. Candidates may work for a degree only or for a credential only.)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Credential</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.M.</td>
<td>Standard Teaching Credential (Secondary)</td>
</tr>
<tr>
<td></td>
<td>Standard Designated Services Credential with a Specialization in Pupil Personnel Services</td>
</tr>
<tr>
<td></td>
<td>Standard Supervision Credential (requires two years of postgraduate education)</td>
</tr>
</tbody>
</table>

GRADUATE DEGREES

Students who wish to be candidates for the Ed.D. or Ph.D. degree are urged to write to the Chairman of the Committee on Advanced Graduate Degrees, School of Education, for full information. The sections below summarize the requirements for the degrees but do not describe the programs in detail. The details are supplied upon request by the Office of the Dean.

Basis of Acceptance as Candidates for Advanced Degrees in Education—Students who have been admitted to graduate standing at Stanford University should inquire, during their first quarter in residence, about advanced degree application procedures. Admission to graduate standing by the University does not in itself constitute admission to candidacy for advanced degrees in the School of Education.

The Graduate Record Examination (Aptitude Test) is required for all graduate admissions.

Students working toward graduate degrees should follow the suggestions outlined under each degree. Students applying for the Master's or Doctor's degree will present a preliminary program of study which represents the work to be completed in earning the degree. They will also consult their advisers with regard to organizing their graduate programs within the limits described in this bulletin.

Students who are candidates for the degree of Master of Arts or Doctor of Philosophy should consult also the University's general requirements described in the section "Degrees" in this bulletin.

Field of Concentration for Advanced Degrees—Candidates for advanced degrees in education should plan to specialize in the field of their professional interest, preparing for some line of professional activity and at the same time securing mastery of an organized body of knowledge. The choice should be made in light of the professional objectives of the student. The program of study for the various fields of concentration is somewhat flexible, allowing a student, in consultation with his adviser, to emphasize certain aspects of the work, depending on his special interests and his professional objectives. Each candidate will select a faculty adviser to assist him in planning his program of study and in projecting research plans for his dissertation. Other members of the faculty of the School of Education may also be consulted with regard to the particular field chosen by the student. Each program as finally approved will designate one area of special interest as a major field of concentration.

The fields of concentration for the Doctor of Education and Doctor of Philosophy degrees are listed below. Members of the faculty of the School of Education who are specialists in a particular area serve as advisers to students who have selected that field of concentration.

- General School Administration*
- Elementary School Education
- Secondary School Education
- Higher Education
- Junior College
- Guidance (Counseling Psychology)
- Philosophy and/or History of Education
- International Development Education (formerly Comparative Education)
- Social Foundations of Education
- Health Education
- General Curriculum
- Research Training Program
- Psychological Studies in Education
  - Educational Psychology
  - Child Development
  - Counseling Psychology
- Mathematical Studies in Educational Processes
- Studies in Curriculum and Instruction
- Studies in School Organization

* Elementary School and Secondary School Administration and Supervision are included in the concentrations of Elementary School and Secondary School Education, respectively.
Teacher Education, or Elementary Education, or Secondary Education, or Special Curriculum, with concentrations in any of the following:

- Art
- Health
- Journalism
- Language Arts or English
- Mathematics
- Foreign Languages
- Music
- Physical Education for Men
- Science
- Social Studies
- Speech

Candidates who select one of the fields of concentration listed above should identify their field as in the following examples:

- Art: Teacher Education
- Science: Secondary Education
- Mathematics: Elementary Education
- Journalism: Special Curriculum

Other possible fields of concentration may be arranged for candidates with the approval of both the student's adviser and the Committee on Advanced Graduate Degrees.

Application for formal admission into the doctoral programs is required by the end of the third quarter of graduate study at Stanford (see School of Education Manual on Advanced Graduate Degrees for procedures).

**MASTER OF ARTS**

The program for the degree of Master of Arts in Education provides for a common core of training for all candidates for the degree, and for specialization in the selected fields of concentration which follow:

- Elementary Education (with specializations such as Supervision, Administration, Curriculum, Teaching)
- Secondary Education (general or with specializations such as Physical Education for Men, Social Studies, etc.)
- College Student Personnel
- Counseling and Guidance
- Health Education

Other possible fields of concentration may be arranged for individual advanced graduate candidates when approved by both the student's adviser and the Master of Arts Committee of the School. Requirements for the core program are listed for each of the concentrations; information may be obtained from the Master of Arts secretary. Courses presented for core requirements must have been taken within five years of the date of the formal application. The remaining courses are to be determined by the candidate and the adviser. Graduate course work taken seven or more years before the date of formal application will be evaluated by the adviser and the Master of Arts Committee, and additional course work in the foundation fields will be required in certain cases.

General requirements for the completion of the degree of Master of Arts (A.M.) include:

1. A minimum of 45 units of graduate study is required. At least 36 units must be completed at Stanford. Two-thirds of the program must be in the School of Education. Application for formal admission into the doctoral programs is required by the end of the third quarter of graduate study at Stanford (see School of Education Manual on Advanced Graduate Degrees for procedures).

2. A student admitted to graduate standing in the School of Education is eligible to apply for candidacy to a Master of Arts degree program when he has completed at least 12 units of course work, graded on a letter basis, at Stanford. If, after the completion of these 12 units,
   a) he has a grade point average of at least 2.75 and the recommendation of his adviser, his application for candidacy will be approved;
   b) he has a grade point average between 2.50 and 2.75, the application will be reviewed jointly by the Committee on the Master of Arts Degree and the student's adviser to determine whether or not the application for candidacy will be approved;
   c) he has a grade point average below
2.50, his application for candidacy will not be approved.

A student admitted to candidacy must take at least 12 additional units of courses graded on a letter basis and must maintain at least a 2.75 grade point average in the program of courses approved by his adviser for the Master of Arts degree. A candidate who does not achieve the minimum grade point average at the completion of his approved program may petition the Committee on the Master of Arts Degree for the inclusion of no more than 15 additional units to raise his grade point average to the required minimum.

(Units receiving a "+" grade and units transferred from other institutions will count toward the unit requirements for the degree but will not be included in the computation of the grade point average.)

3. Preliminary application materials, listed below, are to be submitted to the Master of Arts secretary in the School of Education two quarters before the conferring of the degree:
   a) Transcripts of all academic work previously taken.
   b) A proposed program of courses for the degree, signed by the adviser.

4. Satisfaction of all requirements for the degree within five years after the formal application for the degree has been accepted.

5. Completion of student teaching, internship, or other appropriate practicum, or one year of teaching experience.

6. Recommendation from the adviser and the Master of Arts Committee that the degree be granted.

The degree of Master of Arts (A.M.) is conferred by the University, on recommendation of the University Committee on the Graduate Division.

Two types of programs are offered leading to the degree of Master of Arts in education:

1. **Research type.** A thesis is required. Recommended for future doctoral candidates, research workers, and college teachers of education.

2. **School Specialist type.** No thesis. Planned for elementary and secondary school teachers, administrators, guidance workers, etc.

Lists of current advisers, programs of study, and order of procedure should be obtained from the School of Education Credential Secretary during registration day in the first quarter of residence.

**MASTER OF ARTS IN TEACHING***

The degree of Master of Arts in Teaching is offered jointly by the following academic departments and the School of Education: Art, Biology, Chemistry, Classics, English, French and Italian, German, History, Mathematics, Physical Sciences, Physics, Political Science, Slavic, Sociology, Spanish and Portuguese, and Speech and Drama. In addition to these fields, it is possible for candidates to work out special programs in areas such as the social sciences, humanities, and linguistics. General requirements for the degree include these:

1. The applicant must have completed a Bachelor's degree with an acceptable grade point average to qualify him for graduate study. The department of the major teaching field determines the adequacy of this preparation. The School of Education determines the adequacy of the candidate's background in professional education. The candidate must be admitted to the program both by the department of the teaching major and the School of Education.

2. The candidate must have a teaching credential.

3. Three quarters of full-time residence (or equivalent) are a requirement for this degree. This may be satisfied by the candidate's attending a series of summer quarters.

4. A minimum of 45 quarter units of graduate study is required. At least 36 of these units must be completed at Stanford.

* The degree of Master of Arts in Teaching is ordinarily reserved for experienced teachers or for individuals who have previously completed a program of teacher preparation. Candidates seeking their initial preparation for teaching by way of a teaching internship may prepare for the degree of Master of Arts in Education as well as for a credential. See "Teaching Credential (Secondary)" for pertinent details.
5. A minimum of 25 units of the courses taken for the MAT must be in the teaching field in which the degree is to be given.

6. At least 12 units of the MAT requirements shall consist of graduate courses in the School of Education at Stanford. Certain courses cross-listed in two departments may be used to satisfy requirements in either the academic department or the School of Education, but the same courses may not be used to meet requirements in both departments. Requirements for the School of Education consist of courses in the following areas to supplement the candidate's preparation:
   a) Curriculum and methods in the candidate's teaching field.
   b) General curriculum in Secondary or Elementary Education.
   c) Recent work in Psychological or Social Foundations is required. If both have been completed elsewhere, other work in the foundation fields (Health, History, Philosophy, Comparative Education, etc.) must be selected in consultation with the adviser in the School of Education.

7. Requirements in the major teaching field are determined by the major department, and the program of professional courses by the School of Education. Both the preliminary and the final application forms for the degree must be signed by a representative of the academic department and of the School of Education.

8. The candidate must achieve at least a B average in approved Stanford courses in his teaching subject and in professional education or grades in these courses equivalent to those required for his academic department's Master of Arts degree.

9. Approved general background courses outside of the teaching field and professional education may be used to satisfy some of the unit requirements for the degree.

10. Specific course requirements in both the teaching field and professional education will be determined in part by the candidate's previous program of studies.

**Doctor of Education**

The degree of Doctor of Education (Ed.D.) is a professional degree conferred by the University on recommendation of the faculty of the School of Education and the University Committee on the Graduate Division.

**Residence** — Nine quarters of graduate study (a minimum of 135 units) beyond the baccalaureate degree are required for the doctorate, of which at least one full quarter (a minimum of 12 quarter units) must be outside the field of education. Evaluation of Stanford residence is based on tuition payments. Candidates for the degree normally will be required during the course of work to register at Stanford for a minimum of two academic years (six quarters). A minimum of two of these quarters must be in consecutive full-time residence. All requirements for the degree must be completed within five years of the establishment of Ed.D. candidacy. Graduate course work beyond the Master's degree taken seven or more years ago will not ordinarily be included in the doctoral program. Applicants 45 years of age and over are not admitted to the doctoral program in education.

**Organization of Program** — The candidate for the Ed.D. degree will organize his program in conference with an adviser in his field of concentration. The adviser will make recommendations to the Committee on Advanced Graduate Degrees in connection with application for candidacy, will aid in planning, approve the program of the individual, and function as adviser on research for dissertation. The adviser will be aided by other members of the faculty in the direction of the research program.

Complete information concerning the organization of this program may be secured from the Office of the Dean of the School of Education.

**Doctor of Philosophy**

The degree of Doctor of Philosophy (Ph.D.) is conferred by the University on recommendation of the University Committee on the Graduate Division. Students working toward this degree in the School of Education are ordinarily preparing for the direction of research work in public school systems or in specialized institutions, or are preparing to conduct research as faculty members of colleges or universities.

**Residence** — Nine quarters of graduate study (a minimum of 135 units) beyond the
baccalaureate degree are required for the doctorate, which must include a minor field of study if the candidate does not hold a Master’s degree outside the field of education. Evaluation of Stanford residence is based on tuition payments. Candidates for the degree normally will be required during the course of work to register at Stanford for a minimum of two academic years (six quarters). A minimum of two of these quarters must be in consecutive full-time residence. All requirements for the degree must be completed within five years from the date the applicant is admitted to Ph.D. candidacy by the University Committee on the Graduate Division. Graduate course work beyond the Master’s degree taken seven or more years ago will not ordinarily be included in the doctoral program. Applicants 45 years of age and over are not admitted to the doctoral program in education.

Organization of Program — Considerable flexibility is allowed in projecting a program for the Ph.D. degree. The candidate will be expected to organize his program of work for the degree in conference with an adviser in his field of concentration. All programs require the approval of the School of Education Committee on Advanced Graduate Degrees and the University Committee on the Graduate Division. Complete information may be secured from the Office of the Dean of the School of Education.

Ph.D. Minor in Education — Candidates for the Ph.D. degree in other departments or schools of the University who elect a minor in education will be expected to choose a field of concentration and to have fundamental grounding in certain foundation fields. They will be required to take a minimum of 30 units in graduate courses in education. In the organization of his program, the student who applies for a minor in the School of Education will consult with the Chairman of the Committee on Advanced Graduate Degrees in the School of Education.

CREDENTIALS FOR PUBLIC SCHOOL SERVICE

The University is authorized to recommend the granting of certain credentials for service in the public schools of California. The course work and teaching experience required for California credentials will in many instances meet the credential requirements of other states.

Persons desiring to work for California credentials are required, at the beginning of their training program, to present evidence of their qualifications to a committee on credentials. The function of the committee is to encourage those applicants who, in the judgment of the committee, are qualified to pursue credential programs. The Credential Secretary in the School of Education should be consulted as to the necessary procedure.

ADMINISTRATION AND SUPERVISION CREDENTIALS

The Stanford School of Education is authorized to recommend the supervision and administration credentials described below. Information about current advisers, programs of study, and application procedures should be obtained from the Credential Secretary in the School of Education, on or shortly after registration day in the first quarter of residence.

The Standard Supervision Credential authorizes the holder to serve as supervisor, consultant, coordinator or equivalent supervisory or intermediate administrative position. The Supervision Credential is designed to prepare the applicant to serve in an area in which his basic credential authorizes him to teach or serve: elementary principalship, secondary principalship, junior college principalship, elementary school supervision, secondary school supervision, junior college supervision, subject field supervision, supervision of special education, supervision concerning instructional aids, or any additional capacity when approved by the State Board of Education.

The Standard Administration Credential authorizes the holder to administer and supervise schools as a superintendent or in any intermediate level administrative position and, under approved circumstances, as principal or supervisor.

Standard Supervision Credential Requirements

1. Two years of acceptable postgraduate education including a Master’s degree or its equivalent. If the Master’s degree or the baccalaureate degree plus the equivalent
of Master's degree work is not in an academic subject matter area, the two years of postgraduate education shall include the equivalent of 18 quarter units of course work in academic subject areas.

2. The possession of a valid basic credential.

3. Five years of successful full-time classroom teaching experience in public elementary or secondary schools, or in private schools of equivalent status.

4. The two years of acceptable postgraduate education shall include one of the following:
   a) Completion of an approved supervisory internship program.
   b) Completion of a program of study, including a minimum of 18 quarter units of professional education, designated by the Committee on Credentials as appropriate to the area in which the applicant expects to serve. The program shall be approved by the adviser in the School of Education and filed with the Credential Secretary.

**Administration Credential Requirements**

1. Three years of acceptable postgraduate education with one of the following degrees:
   a) A Master's degree in an academic subject matter area.
   b) A baccalaureate degree plus the equivalent of a Master's degree in an academic subject matter area in an institution offering a doctoral degree but not a Master's degree in that area.
   c) A doctoral degree, including 36 quarter hours of work in academic subject matter areas.

2. The possession of a valid basic credential.

3. A minimum of five years of successful full-time classroom teaching experience in public elementary or secondary schools or in private schools of equivalent status.

4. The three years of acceptable postgraduate education shall include either:
   a) Completion of an approved administrative internship program.
   b) Completion of a program of study, including a minimum of 36 quarter units of professional education, designated by the Committee on Credentials as appropriate to the area in which the applicant expects to serve. The program shall be approved by the adviser in the School of Education and filed with the Credential Secretary.

**Teaching Credentials**

The Stanford School of Education is authorized to recommend the following teaching credentials:

**Standard Teaching Credential (Secondary),** which authorizes the holder to teach in all grades of any senior high school, four-year high school, junior high school, or the seventh and eighth grades of elementary schools in the major teaching area.

**Standard Teaching Credential (Junior College),** which authorizes the holder to teach in all grades of any junior college.

**General Requirements**

Candidates for teaching credentials must present evidence of meeting standards in the following:

1. A certificate of mental and physical fitness from the University Health Service.

2. Approval of candidate's competency in oral expression.

3. Fulfillment of the U.S. Constitution Requirement, either by passing an examination or by taking satisfactory course work. The following courses at Stanford will satisfy this requirement: Political Science 10, History 60, or History 151.

4. Approval by the appropriate committee, based on scholarship and other requisites for successful teaching.

The lists of requirements for teaching credentials are available from the School of Education Credential Secretary.

**Exemption from Student Teaching (Junior College)—**Part of the student teaching requirement may be waived for one year of successful teaching or student teaching elsewhere after the satisfactory completion of half of the student teaching requirement at Stanford. Such a waiver does not imply granting of credit. Course work must be substituted for exemptions in order to complete the required number of education units.

* Stanford does not offer training at this time for the credential in elementary education.
Programs of study and order of procedure should be obtained from the Credential Secretary in the School of Education on registration day in the first quarter of residence. A brief summary of these credentials follows.

**Teaching Credential (Secondary)—Secondary Teacher Education Program (Internship)**

Candidates preparing for the Standard Teaching Credential with a specialization in Secondary School Teaching can also complete requirements for a Master of Arts degree in Education. Consult Master of Arts secretary for information.

This program must be completed in sequence. Candidates may be admitted for any quarter to complete academic requirements or to take supplementary course work, but the formal secondary teaching program begins ONLY in summer quarter of each year. The program consists of four quarters of study at the University and half-time teaching responsibilities as an intern in secondary schools in the vicinity of Stanford from September until June.

1. Eligibility. Graduates in the humanities and sciences, from colleges and universities of recognized standing, with little or no work in professional education are eligible to apply if they have maintained at least a B— academic average in undergraduate and graduate courses. Because the number of internships is limited, persons meeting minimum requirements are not assured of admission to the program.

2. Closing date for filing applications. Completed applications (available from the Secondary Teacher Education Office, School of Education) should be filed no later than the fifteenth of March. However, candidates who wish to receive consideration for scholarship awards must have their applications filed by January 15.

3. The Graduate Record Examination (Aptitude Test and the Advanced Test in the candidate's major field) is required for admission. Candidates who intend to earn the credential through a teaching major in a modern foreign language are urged to submit their scores in the ETS-MLA test for advanced students and teachers at the time of their application. These scores may be substituted for the Advanced Test of the Graduate Record Examination.

4. Personal interviews. Three personal interview dates have been established for intern applicants. At the time a candidate submits his application, he should indicate which of these dates is most convenient. In unusual cases it is possible to petition to have the personal interview waived.

   a) Wednesday, December 18, 1968
   b) Saturday, January 25, 1969
   c) Saturday, March 1, 1969

5. Notice of admission. Candidates will be notified of preliminary admission to candidacy approximately three weeks after receipt of all application materials and subsequent to the personal interview.

6. School internship. School placement is a requisite of internship. Placement may be guaranteed for outstanding candidates at the time of admission. Cooperating high schools will consider for employment persons who have been admitted to preliminary candidacy. Employment interviews are arranged by the Intern Office. The intern normally spends a half day in school, including teaching two classes. In return, the intern receives about one third of the salary for a beginning teacher (approximately $2000). The intern spends the balance of his half day in school in supplementary activities, such as classroom observation.

7. Requirements. To complete the program in Secondary School Teaching, the candidate must satisfy the following requirements. Requirements marked (*) are normally completed prior to admission. Requirements marked (**) are normally substantially completed prior to admission, but provision has been made within the program for their completion. Other requirements are normally completed as a part of the program itself.

   a) A four-year college course with a Bachelor's degree with 68 quarter units (45 semester hours) in general studies, including work in at least four of the following six fields:

      1) Humanities, excluding foreign languages but including a year of English. (Competency in composition
must be demonstrated, either by completing a college course or passing an examination.) This field is required as one of the four.

2) Social sciences (anthropology, economics, geography, history, political science, psychology, sociology).

3) Natural sciences (biological sciences, physical sciences).

4) Mathematics (requiring as a prerequisite an understanding and knowledge of high school algebra and geometry).

5) Fine arts (history, theory, appreciation, criticism, and practice in art, drama, music).

6) A foreign language.

Only 9 quarter units (6 semester hours) of courses included in the general studies requirements listed above may be used as part of a teaching major or teaching minor.

**b) A teaching major consisting of a minimum of 36 quarter units (24 semester units) of upper division or graduate courses. This State minimum requirement is typically exceeded by Stanford’s requirements. Requirements for specific majors may be obtained from the Credential Secretary of the School of Education. Stanford offers the credential in the following major fields only: Art, Drama, English, Mathematics, a Modern Language, Music, Physical Education (Men), Physical Sciences, Biological Sciences, Social Studies, Speech.

c) Interns will be responsible for a program of courses totaling 48–54 quarter units over a four-quarter residence at Stanford, which includes approximately one third of the work in academic courses, one third of the work in professional courses in education, and one third in practical teaching experiences, including the micro-teaching clinic in the summer quarter and the internship during the academic year.

8. There are miscellaneous tests to be completed at designated times during the program.

Education course requirements for the Secondary Teacher Education Program:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Quarter Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>211A</td>
<td>Foundations of Education: Psychological</td>
<td>Summer 3</td>
</tr>
<tr>
<td>211B</td>
<td>Foundations of Education: Psychological</td>
<td>A 3</td>
</tr>
<tr>
<td>211C</td>
<td>Foundations of Education: Social</td>
<td>W 3</td>
</tr>
<tr>
<td>240A</td>
<td>Secondary Education</td>
<td>Summer 3</td>
</tr>
<tr>
<td>240B</td>
<td>Secondary Education</td>
<td>A 1</td>
</tr>
<tr>
<td>240C</td>
<td>Secondary Education</td>
<td>W 1</td>
</tr>
<tr>
<td>240D</td>
<td>Secondary Education</td>
<td>S 1</td>
</tr>
<tr>
<td>246A</td>
<td>Micro-Teaching Clinic</td>
<td>Summer 3</td>
</tr>
<tr>
<td>246B,C,D</td>
<td>Intern Teaching AWS*</td>
<td>11</td>
</tr>
</tbody>
</table>

260 Series:

- Curriculum and Instruction in Major Field
  - Summer 3
  - A 1
  - W 1
  - S*

* This course requirement may be waived at the discretion of the instructor.

**STANDARD TEACHING CREDENTIAL (JUNIOR COLLEGE)**

A student preparing for the Junior College credential will fulfill the following requirements:

1. Completion of professional course requirements, which include a course or courses in the psychological foundations of education, curriculum and instructional procedures and materials (students must start program at the beginning of either autumn or summer quarter), and practice teaching.

2. Completion of the Master’s degree in the teaching major.

3. Completion of a teaching major and a teaching minor satisfactory to the departments concerned. For details consult the Credential Secretary of the School of Education.

4. Completion of general education courses prescribed by the California Administrative and Education Codes.

5. Acceptance by the academic department and the School of Education.

**STANDARD DESIGNATED SERVICES CREDENTIAL WITH A SPECIALIZATION IN PUPIL PERSONNEL SERVICES**

Stanford University is authorized to recommend candidates for the Standard Designated Services Credential with a Specialization in Pupil Personnel Services, which is...
necessary for certification in counseling. Two programs for counseling are available, depending upon the candidate's present or anticipated teaching experience:

1. Candidates who desire to qualify as school counselors and who have had three full-time years of recognized teaching experience in public schools or private schools of equivalent status must obtain a Master's or higher degree in an academic area or in counseling and must satisfactorily complete the following graduate level courses or their equivalent:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ed. 230</td>
<td>Developmental Guidance: Basic Principles and Practices</td>
<td>2</td>
</tr>
<tr>
<td>Ed. 231</td>
<td>Developmental Guidance: Group Procedures</td>
<td>3</td>
</tr>
<tr>
<td>Ed. 232</td>
<td>Developmental Guidance: Research</td>
<td>2</td>
</tr>
<tr>
<td>Ed. 233</td>
<td>Decision Making: Basic Principles</td>
<td>3</td>
</tr>
<tr>
<td>Ed. 234</td>
<td>Decision Making: Measurement and Prediction of Outcomes</td>
<td>3</td>
</tr>
<tr>
<td>Ed. 235</td>
<td>Decision Making: Evaluation of Information Sources</td>
<td>1</td>
</tr>
<tr>
<td>Ed. 236</td>
<td>Behavior Modification: Introduction</td>
<td>2</td>
</tr>
<tr>
<td>Ed. 237</td>
<td>Behavior Modification: Research and Practice</td>
<td>2</td>
</tr>
<tr>
<td>Ed. 238</td>
<td>Practicum in Guidance</td>
<td>12</td>
</tr>
<tr>
<td>Psych. 60</td>
<td>Statistical Methods</td>
<td>5</td>
</tr>
<tr>
<td>Psych. 114</td>
<td>Exceptional Children</td>
<td>3</td>
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<td>Psych. 131</td>
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<td>Psych. 255</td>
<td>Principles of Personality Change II</td>
<td>3</td>
</tr>
<tr>
<td>Ed. 323</td>
<td>Public School Law</td>
<td>3</td>
</tr>
<tr>
<td>Ed. 239B</td>
<td>Observation of Study Skills and Developmental Reading in College, or</td>
<td>4</td>
</tr>
<tr>
<td>Ed. 398</td>
<td>Reading in Secondary Schools</td>
<td>3</td>
</tr>
</tbody>
</table>

2. Candidates who desire to qualify as school counselors and who have not had (or will not be able to obtain) three years of recognized full-time teaching experience may qualify for the credential by meeting the following minimum requirements:

a) All the requirements listed under "1."

b) A total of approximately 90 quarter units in graduate level course work to be planned with the adviser and to include preparation in the field of education and other disciplines.

c) An additional 240 clock hours of supervised field experience in pupil personnel services over a second full academic year while enrolled in Ed. 238, Practicum in Guidance, for an additional 12 units.

**Courses in Other Divisions of the University**

Teachers, administrators, and specialists in other areas of education are expected to have a substantial knowledge of a variety of academic fields outside the areas encompassed by professional education. Students are therefore urged to consider the courses offered in other divisions of the University in planning their programs.

**Courses in Education**

Junior-senior courses: 100–199; graduate courses: 200–299; courses for experienced teachers or advanced graduates: 300–399; seminars and directed study and research: 400–499.

The various courses are distributed as follows:

- Foundations of Education (Digits 00–19), e.g., 218, Health Foundations of Education
- Administration (Digits 20–29), e.g., 320A, B, C, Advanced Public School Administration
- Guidance and Personnel (Digits 30–39), e.g., 230A, Guidance in Elementary Schools
- General Curriculum and Methods (Digits 40–49), e.g., 246B, Internship in Teaching
- Statistics, Evaluation and Research (Digits 50–54), e.g., 251, Educational Testing and Evaluation
- Physical Education (Digits 55–59 and 70–79), e.g., 155, Elementary Analysis of Body Movement
- Special Curriculum and Instruction in Other Fields (Digits 60–69 and 80–99), e.g., 261A, B, C, D, Curriculum and Instruction in Secondary School Art

**Junior-Senior**

These courses are also open to graduate students.

111. Developmental Psychology — (Enroll in Psychology 111.)

113. Adolescent Development — (Enroll in Psychology 113.)

116. Development in Middle Childhood—Development of the child from six to twelve. Research readings, observations, develop-
ment of case study materials. Prerequisite: Psychology 111 or equivalent.

4 units, Win (____) MWF 9 and one 3-hour block by arrangement

184. Literature for Adolescents—Required of credential candidates with a teaching major or minor in English. An opportunity for juniors and seniors to read and discuss ten to fifteen books written for adolescents. Some attention will be given also to the teaching of literature. Open only to experienced teachers and students preparing to teach.

3 units, Spr (Grommon) Th 4:15-6:05 and by arrangement

GRADUATE

These courses are open to seniors with permission of adviser and instructor of course.

200. History of Education—Foundational course in educational history meeting advanced degree requirements. Survey; emphasis upon European backgrounds, educators, schools, covering period from "Golden Age" of Greece to twentieth century.

3 units, Aut (Staff) W 7-10 p.m.
4 units, Sum (____) MTWTh 1:15 and by arrangement

201. History of Education in the United States—Detailed study of American educational history in its cultural setting. Education 200 will provide a helpful background but is not a prerequisite.

4 units, Spr (Staff) MW 4:15-6:05
Sum (____) MTWTh 10

204. Introduction to Philosophy of Education—Educational policies and practices analyzed to locate philosophical assumptions and key concepts. Construction of coherent educational theories. No previous study of philosophy assumed.

4 units, Win (Thomas) MTWTh 10

206A. Comparative Education—An introductory course for non-majors in International Development Education.

3 units, Spr (____) TWTh 2:15

206B. Comparative Education—An introductory course in International Development Education.

4 units, Sum (____) MTWTh 2:15

210. Social Foundations of Education—For credential and Master of Arts degree candidates. Influence of social structure on schools, school systems; American cultural values and their influence on education; special problems of ethnic groups in American schools; school system as formal organization in mass society; case studies of teachers, administrators.

4 units, Aut (____) MW 1:15-3:05
Sum (____) MTWThF 8

The following courses in the Foundations of Education are taken by students admitted to the program for the secondary teaching internship. Students enrolled in other programs select foundation courses from Education 200, 204, 206A, 210, 215, 218.

211A. Foundations of Education: Psychological—Application of psychological principles to problems of learning and child and adolescent development. Major topics include learning, personality development, social interaction, and theories of instruction. Prerequisite: Psychology 1 or equivalent.

3 units, Sum (McDonald) MTWTh 1:15

211B. Foundations of Education: Psychological—Measurement and evaluation of student characteristics and achievement. The construction and interpretation of evaluation procedures are major activities in this course. Necessary statistical ideas are presented at an elementary level. Prerequisite: Education 211A.

3 units, Aut (McDonald) M 4:15-6:05 and W 4:15

211C. Foundations of Education: Social—Application of sociological and anthropological principles to problems of learning and development.

3 units, Win (Cohen) MW 4:15 and by arrangement

213. Foundations of Aesthetic Education—Analysis of historical and philosophical aspects of art education. Designed to introduce students to the changing functions of art in American education and to the examination of various conceptions of art as they relate to education.

4 units, Aut (Eisner) MW 4:15-6:05

215. Psychological Foundations of Education—(Same as Psychology 145.) Introductory course in application of psychological
principles to educational practices. Prerequisite: Psychology 1 or equivalent.

4 units, Aut (Gage) MTWTh 9  
Sum (Staff) MTWTh 9 and by arrangement

216A. Individual Differences in Cognitive Processes in Children—Differential cognitive variables of relevance to children's intellectual development are examined, together with their antecedent conditions. Research approaches and educational implications are explored. Prerequisites: Psychology 60 or equivalent and Psychology 111 or equivalent, or consent of instructor.

3 units, Win (Sieber) MWF 11

216B. Early Learning—The developmental sequence of processes which comprise or affect early learning is examined. Relevant theories, research paradigms and educational implications are discussed. Prerequisites: Psychology 60 or equivalent and Psychology 111 or equivalent, or consent of instructor.

3 units, Spr (Sieber) MWF 11

218. Health Foundations of Education — Relationship of health and education; nature of a practical school health program.

3 units, Win (Byrd) MWF 11

4 units, Sum (———) MTWThF 9

219. Artistic Development of the Child — Designed to introduce students to research in the behavioral sciences having relevance for understanding of the child's artistic development.

4 units, Win (Eisner) MW 4:15-6:05

220. Introduction to Public School Administration — School district organization for administration; emphasis upon development, function of school administration.

3 units, Win (Odell) Th 7-10 p.m.

4 units, Sum (Odell, Strand) MTWThF 9

221. Elementary School Administration and Supervision—Systematic study of the roles of the elementary school principal and supervisor. For teachers and candidates for administrative and supervisory credentials.

3 units, Aut (———) Th 7-10 p.m.

222. Secondary School Administration and Supervision — For teachers and candidates for administrative and supervisory credentials. Systematic treatment of full range of problems of administration of schools that include grades 7-12. Administration viewed from vantage point of the principal.

3 units, Aut (———) Th 7-10 p.m.

4 units, Sum (———) MTWThF 11

225. Field Practice in School Administration and Supervision — Field practice in school administration and supervision that will meet requirements for California Standard Administration and Standard Supervision Credentials. Consent of instructor required.

1 to 6 units, Aut, Win, Spr (Staff) by arrangement

228. Research in Higher Education — An analysis of recently completed or ongoing studies involving higher education. Substance of studies will change periodically.

3 units, Spr (Mayhew) M 3:15-6:05 and by arrangement, given 1969-70

229. Administration of School Health Program—Significant problems in school health facing school personnel.

3 units, Spr (Byrd) W 7-10 p.m.


2 units, Aut (Thoresen) W 3:15-5:05

230A. Guidance in Elementary Schools — Review of modern guidance practices. Particularly directed to needs of teachers, administrators, guidance workers.

3 units, Spr (Sears) MW 4:15-5:30, alternate years, given 1969-70

231. Developmental Guidance: Group Procedures—Principles and practices of counseling in groups to enhance student development and to solve problems. Limited direct experiences as group member and leader involved.

3 units, Win (Thoresen) TTh 2:15 and by arrangement

232. Developmental Guidance: Research—Evaluation of research studies on attempts to foster student development and to prevent problems. Supervised experience in research activity.

2 units, Spr (Krumboltz) T 3:15-5:05
233. Decision Making: Basic Principles and Theory — Methods of making decisions in guidance which maximize various criteria of success. Application of decision theory strategies to educational and vocational planning and to problems in emotional and social behavior.

3 units, Aut (Krumboltz) TTh 4:15-5:30


3 units, Win (Krumboltz) TTh 4:15-5:30


1 unit, Spr (Staff) M 2:15


2 units, Aut (Thoresen) T 2:15-4:05


2 units, Spr (Thoresen) Th 3:15-5:05

238A,B,C. Practicum in Guidance — Supervised experience in public school counseling and guidance activities. Students must arrange a minimum of 8 hours per week in the school setting plus a two-hour seminar. Sequence must begin in Autumn Quarter. Practicum coordinated with Ed. 230-237. Consent of instructor required.

4 units, Aut, Win, Spr (Krumboltz, Thoresen, Staff) M 3:15-5:05 and by arrangement

239A,B. Observation of Study Skills and Developmental Reading in College, and Directed Teaching of Study Skills and Developmental Reading — Two-quarter practicum, to be taken in sequence. Two-hour weekly seminar plus individual conferences with instructor supplement required observation (239A) and directed teaching (239B) of regular college class in developmental reading, study skills. Consent of instructor required.

4 units, Aut, Win, Spr (Browning) by arrangement

240A. Secondary Education: Instructional Problems — An orientation to the American Secondary School with a focus on the problems of teaching. Topics are specifically related to the instruction laboratory (246A) which is taken concurrently. Limited to Secondary Interns.

3 units, Sum (——) MTWTh 2:15

240B. Secondary Education: Student Problems — Consideration of typical student personnel problems confronting the beginning teacher. Specifically related to the internship experience (246B) which is taken concurrently. Prerequisite: 240A.

1 unit, Aut (——) W 5:15

240C. Secondary Education: Curriculum Problems — Consideration of problems and issues of curriculum design, including the relationship between instruction in various subject areas of the secondary school curriculum. Specifically related to the internship experience (246C) which is taken concurrently. Prerequisite: Education 240B.

1 unit, Win (Bush) W 5:15

240D. Secondary Education: Staff and Organizational Problems — Consideration of the administrative structure of the secondary school, including proposals for change. Problems of internal communication and staff relationships. Specifically related to the internship experience (246D) which is taken concurrently. Prerequisite: Education 240C.

1 unit, Spr (——) T 5:15 and by arrangement

246A. Instruction Laboratory: Micro-teaching Clinic — Training and practice in specific skills of teaching. Micro-teaching is a closely controlled teaching encounter. Candidates teach 5- or 10-minute lessons at first to one student and later to increased numbers of students. These lessons are subjected to a critique by supervisors and students. The clinic is closely associated with concurrent courses in the secondary education program: 211A, 240A, and the 260 series course in the
teaching major. Limited to Secondary Interns.

3 units, Sum (——) MTWThF 8-1 and 4:15

246B,C,D. Internship in Teaching — Field experience in local secondary schools. Taken during each quarter of internship. Includes a 1-hour weekly meeting with Stanford tutor supervisors. Prerequisite: 246A.

246B. 2 to 6 units, Aut (Staff) by arrangement
246C. 2 to 6 units, Win (Staff) by arrangement
246D. 2 to 6 units, Spr (Staff) by arrangement

249. College Curriculum and Instruction—Curriculum and methods of teaching in the undergraduate college.

3 units, Win (Mayhew) M 3:15-6:05, given 1969-70


3 units, Win (Olkin) MWF 11:00-12:30

250B. Statistical Analysis in Educational Research—Continuation of 250A. Analysis of variance and design of experiments, simple regression and correlation, other measures of association. Prerequisite: 250A.

3 units, Spr (Olkin) MWF 11:00-12:30

251. Educational Testing and Evaluation—Introduction to principles of evaluation; emphasis upon application to construction and use of tests in educational practice. Prerequisite: 215 or equivalent.

4 units, Sum (——) MTWTh 1:15 and by arrangement

252. Introduction to Test Theory — Concepts of reliability and validity; mathematical models underlying commonly used procedures for test analysis. Test scales and norms. Prerequisite: Psychology 60, Statistics 7, or equivalent.

3 to 4 units, Aut (Cronbach) MW 2:15-4:05, alternate years, given 1969-70

253. Attitude Theory and Measurement—Concepts of attitude and their relevance to empirical and theoretical concerns in education. Introduction to procedures for constructing attitude scales. Prerequisite: Psychology 60 or Statistics 107, or equivalent.

2 to 4 units, Aut (Coladarci) MW 2:15-4:05

255. Human Abilities — (Same as Psychology 155.) The nature, development, and measurement of intellectual abilities. Prerequisites: Psychology 1 and Psychology 60.

3 units, Spr (Cronbach, Snow) by arrangement

CURRICULUM AND INSTRUCTION IN SECONDARY SCHOOL MAJOR TEACHING FIELDS

As a part of the Standard Teaching Credential (Secondary) program, a candidate is required to complete the four-quarter sequence of Curriculum and Instruction courses in the field of his teaching major.

* This course requirement may be waived at the discretion of the instructor.


261A. 3 units, Sum (Eisner) MTWTh 3:15
261B. 1 unit, Aut (Eisner) T 4:15-6:05
261C. 1 unit, Win (Eisner) T 4:15-6:05
261D.* 1 unit, Spr (Eisner) T 4:15

262A,B,C,D. Curriculum and Instruction in Secondary School English — Evaluation of conflicting views of programs of language arts; study of research and recommendations for teaching of composition, critical thinking, semantics, grammar, usage, punctuation, spelling; study of recommendations for teaching of reading and of the various types of literature.

262A. 3 units, Sum (Eisner) MTWTh 3:15
262B. 1 unit, Aut (Grommon) T 4:15-6:05
262C. 1 unit, Win (Grommon) T 4:15-6:05
262D.* 1 unit, Spr (Grommon) T 4:15


263A. 3 units, Sum (Higgins) MTWTh 3:15
263B. 1 unit, Aut (Higgins) T 4:15-6:05
263C. 1 unit, Win (Higgins) T 4:15-6:05
263D.* 1 unit, Spr (Higgins) T 4:15

264A. 3 units, Sum (Politzer) MTWTh 3:15
264B. 1 unit, Aut (Politzer) T 4:15-6:05
264C. 1 unit, Win (Politzer) T 4:15-6:05
264D.* 1 unit, Spr (Politzer) T 4:15

265A. 3 units, Sum (Kuhn) MTWTh 3:15
265B. 1 unit, Aut (Kuhn) T 4:15-6:05
265C. 1 unit, Win (Barnes) Th 4:15-6:05
265D.* 1 unit, Spr (Kuhn) T 4:15

266A,B,C,D. Curriculum and Instruction in Secondary School Physical Education (Men) — Major emphasis on knowledge of the activities basic to school physical education and athletic programs. Also involves teaching techniques, curricular materials, and evaluation. Theoretical and practical training.
266A. 3 units, Sum (Nixon) MTWTh 3:15
266B. 1 unit, Aut (Nixon) T 4:15-6:05
266C. 1 unit, Win (Nixon) T 4:15-6:05
266D.* 1 unit, Spr (Nixon) T 4:15

267A,B,C,D. Curriculum and Instruction in Secondary School Science — Examination of possible objectives of secondary school science teaching and related methods; selection and organization of content and instructional materials; laboratory and demonstration techniques; evaluation, tests; curricular changes; ties with other subject areas.
267A. 3 units, Sum (——) MTWTh 3:15
267B. 1 unit, Aut (——) T 4:15-6:05
267C. 1 unit, Win (——) T 4:15-6:05
267D.* 1 unit, Spr (——) T 4:15

268A,B,C,D. Curriculum and Instruction in Secondary School Social Studies — Emphasis on the methodology of social studies instruction; review of curriculum trends; survey of teaching materials; opportunities to develop teaching and resource units.
268A. 3 units, Sum (Staff) MTWTh 3:15
268B. 1 unit, Aut (Staff) T 4:15-6:05
268C. 1 unit, Win (Staff) T 4:15-6:05
268D.* 1 unit, Spr (Staff) T 4:15 (For Minors)

269A. 3 units, Sum (——) MTWTh 3:15
269B. 1 unit, Aut (Schrader) T 4:15-6:05
269C. 1 unit, Win (Schrader) T 4:15-6:05
269D.* 1 unit, Spr (Schrader) T 4:15

281. Linguistics for Teachers of Modern Languages — Principles of phonology, morphology, and syntax applied to the learning and teaching of foreign languages.
4 units, Sum (Politzer) MTWThF 1:15

283. Spanish Linguistics — (Same as Spanish 190.)
3 units, Spr (Petersen) TTh 9 and one hour by arrangement

287. German Applied Linguistics — Phonology and Morphology. (Same as German 190.)
2 units, Win (Politzer) T 2:15-4:05

288. Methods of Teaching French — (Same as French Teacher Training course 288.)
3 units, Win (Politzer) M 4:15-6:05 and by arrangement

291. Methods of Teaching German — (Same as German 200.)
2 units, Spr (Lohnes) MWF 11

292. Methods of Teaching Spanish — (Same as Spanish 210A.)
2 units, Aut (Petersen) TTh 1:15
2 units, Sum (Petersen) MTWThF 11

295. Language Laboratory Techniques — (Same as Spanish 210B.)
2 units, Sum (Petersen) MTWThF 11, alternate years, given 1968-69

298. Practice Teaching in Foreign Languages in the Elementary School.
1 to 2 units, any quarter (Politzer) by arrangement

299. Children's Literature — General survey of children's literature for both pre-school and elementary school years.
3 units, Win (Iverson) W 7-10 p.m.
COURSES FOR EXPERIENCED TEACHERS OR ADVANCED GRADUATE STUDENTS

302. Philosophies of Education—The epistemology, axiology, and metaphysics of contemporary philosophies compared for their significance in guiding educational policy and research. Prerequisite: a course in Philosophy of Education or in general Philosophy.

4 units, Aut (Thomas) MTWTh 3:15
Spr (Thomas) MTWTh 2:15

305. Comparative Ideologies and Education—Construction of a democratic theory of education; consideration of conflicting views of American fascism, marxism, conservatism, and pragmatic liberalism.

4 units, Aut (Thomas) MTWTh 1:15
Spr (Thomas) MTWTh 10

306A. International Development Education I—Integrated introduction to advanced study of international development education, followed by examination of education's role in development from cultural, social-structural, and psychological perspectives. Required for all first-year SIDEC doctoral students. Consent of instructor required for others.

3 units, Aut (Textor) by arrangement

306B. International Development Education II—Major emphasis on the relationships between education and the political system, with special regard to problems of political socialization and recruitment in new states, followed by initial consideration of education's role in economic development. Required for all first-year SIDEC doctoral students. Consent of instructor required for others.

3 units, Win (Weiler) T 4:15-6:05
and by arrangement

306C. International Development Education III—Further consideration of education's role in economic development and of economic aspects of educational problems and plans. Concluding this course sequence will be an integrative approach to educational strategies for development. Required for all first-year SIDEC doctoral students. Consent of instructor required for others.

3 units, Spr (——) T 4:15-6:05
and by arrangement

306D. Seminar on International Development Education I—Problems and case studies, to illustrate applications of concepts and analytical techniques considered concurrently in 306A. Open only to SIDEC doctoral students.

3 units, Aut (Textor) Th 4:15-6:05
and by arrangement

306E. Seminar on International Development Education II—Problems and case studies, to illustrate applications of concepts and analytical techniques considered concurrently in 306B. Open only to SIDEC doctoral students.

3 units, Win (Weiler) Th 4:15-6:05
and by arrangement

306F. Seminar on International Development Education III—Problems and case studies, to illustrate applications of concepts and analytical techniques considered concurrently in 306C. Open only to SIDEC doctoral students.

3 units, Spr (——) Th 4:15-6:05
and by arrangement


2 to 4 units, Aut, Win (Weiler) by arrangement

306I. Tutorial on Education and Development in Asia—Interrelations of education with economic-political-social development in selected Asian countries. Consent of instructor required.

2 to 4 units, Aut, Win, Spr (Textor) by arrangement

306J. Tutorial on Education and Development in Latin America—Interrelations of education with economic-political-social development in selected Latin American countries. Consent of instructor required.

2 to 4 units, Spr (——) by arrangement

307. Social Psychology of Higher Education—Analysis of the behavior and development of college students and of the college as a social organization.

2 units, Spr (Sanford) T 4:15-6:05

310. Research Problems in the Sociology of Education—The aim of this course is to acquaint the doctoral student with the rapidly
expanding field of research on sociology of education. The student will be expected to develop the ability to evaluate and criticize as well as the ability to conceptualize basic and applied research in this area. Topics considered include the relationship of education to status systems, the school as a formal organization, informal social structure and the school, power and educational decision-making, and current problems in American education such as the maladjustment of the low status and minority group child to the school. Students who are not doctoral candidates in the School of Education must obtain consent of instructor.

4 units, Aut (Cohen) MTWTh 10

311. Socialization of Pre-Adults in Contemporary U.S. Society—Study of socialization of children into systems of society with special attention to the relationship between social structure and acquisition of behavior. Data and theories on socialization of children into systems (political, educational, religious, economic) will be discussed. Particular attention will be given to social class and ethnic differences in socialization processes and outcomes. Theories of socialization will be reviewed with respect to their implications for socialization of children of minority and other disadvantaged groups. Class will be arranged to accommodate lectures and small group discussion.

3 units, Spr (Hess) by arrangement

315. Cultural Transmission—(Same as Anthropology 256.) Education in cross-cultural perspective: transmission of values; transmission of covert culture, implicit cultural assumptions; adolescent education; case studies of teachers in American schools. For advanced graduate students in education, anthropology, other behavioral sciences.

3 units, Aut (Spindler) M 7–10 p.m.
4 units, Sum (——) MTWThF 9

316. Advanced Educational Psychology: Classroom Learning—An advanced course applying the concepts of learning and motivation to instructional practices in school subjects; analysis of research on variables related to the design of instructional systems. Concurrent enrollment in individual study is normally expected to review relevant research in a subject-matter curriculum area. Prerequisites: 317A and B, or equivalent.

4 units, Aut (McDonald) MWF 9 and by arrangement

317A,B. Advanced Psychological Foundations of Education—An advanced course in topics in educational psychology covering motivation, learning, measurement, individual differences, developmental psychology, the social conditions of learning, personality development and problems of personal and school adjustment. Normally taken by doctoral candidates not majoring in Psychological Studies. Prerequisites: Psychology 60, or equivalent, and Education 215 or its equivalent, or consent of instructor.

317A. 1 to 4 units, Win (Staff) MTWTh 3:15
317B. 1 to 4 units, Spr (Staff) MTWTh 3:15

318. Advanced Educational Psychology: Social Psychology and Educational Practice—An advanced course applying the concepts of social psychology to educational practice. Deals with role theory, consistency theory, interpersonal perception. For doctoral candidates majoring in Psychological Studies. Prerequisites: 317A and B or equivalent.

4 units, Win (Gage) M 7–10 p.m. and by arrangement

320A,B,C. Advanced Public School Administration—Designed primarily for advanced degree candidates in school administration. Prerequisite: Education 220 or equivalent, or consent of instructor.

320A. Role of Theory in Educational Administration.
3 units, Aut (Odell, Strand) W 7–10 p.m.

320B. Interpersonal Relationships in Staff Development and Personnel Management.
3 units, Win (Odell, Strand) W 7–10 p.m.

320C. Administrative Relationships in Education.
3 units, Spr (Odell, Strand) W 7–10 p.m.

321. Problems in Elementary School Administration and Supervision—Designed to provide students interested in school administration and supervision an opportunity to examine these functions in light of the changes taking place in the program and or-
ganization of the elementary school. Prerequisite: Education 221 or equivalent or permission of instructor.

3 units, Spr (Sowards) M 7–10 p.m.

323. Public School Law—Nature of legal responsibilities faced by public school administrators; resources available for solution of legal problems; review of social welfare legislation and laws relating to children. Specifically designed to meet requirements for California administrative and counseling credentials.

3 units, Spr (James, Staff) M 7–10 p.m.

324. School Staff Personnel Problems—For experienced teachers, administrators. Recruitment, selection, placement of teachers; orientation of new teachers; administrative responsibilities for in-service education; staff participation in salary scheduling and other aspects of economic welfare of teachers; administrator-teacher relations; codes of ethics; merit rating; certification, tenure.

3 units, Spr (——) Th 7–10 p.m.

4 units, Sum (——) TWTh 4:15–6:05

325A. School Facility Planning—An analysis of principles, methods, and problems in relating educational programs to school facilities, including an assessment of current planning practices at the elementary, secondary, college, and university level. Basic course in relating educational planning to school facilities.

3 units, Aut (MacConnell, Staff) S 9–12

325B. School Facility Planning: Educational Specifications—An analysis of conditions and problems involved in school planning for selected metropolitan cities, suburban communities and rural districts. Special emphasis on emerging concepts in education related to school facilities and the role of the educational facilities planner.

3 units, Win (MacConnell, Staff) S 9–12


3 units, Spr (MacConnell, Staff) S 9–12

326A. School Finance—Principles, problems involved in financing public schools generally; emphasis upon practice, problems, trends in California.

3 units, Aut (James, Staff) M 7–10 p.m.

326C. Public School Business Administration—Basic principles, methods, and problems in public school administration.

3 units, Win (Staff) M 7–10 p.m.


1 to 3 units, Aut, Win, Spr (Staff) by arrangement

334. Counseling Center Practicum—Experience in college counseling center operations, including testing and counseling. Placements made through Stanford Counseling and Testing Center. By permission. May be repeated for credit.

2 to 4 units, Aut, Win, Spr (Black, Lyon) by arrangement

338. Student Personnel Services in Higher Education—Critical examination of operation of student personnel services in American colleges and universities. Each student will be expected to spend four hours each week in one of the student personnel service offices. Autumn, winter, spring sequence required.

4 units, Aut (Korn) Th 11:00–1:05 and by arrangement

Win (Korn) Th 11:00–1:05 and by arrangement

340. Curriculum Theories and Curriculum Change—An examination of alternative conceptions of curriculum theory with special attention to competing value positions and to the techniques employed in curriculum development. Students will learn to formulate researchable problems in general curriculum. Consent of instructor required.

3 units, Win (Eisner) TTh 1:15–2:45


4 units, Win (Bush) MW 8–10

Sum (——) MTWThF 9

344. Elementary School Curriculum. Instruction, and Supervision—Theory, practices, trends, issues in curriculum development and instruction in the elementary school. For experienced elementary school...
personnel and advanced degree students from areas of concentration other than elementary education.

4 units, Aut (Shaftel) TTh 2:15-4:05
Sum (Sowards) MTWThF 2:15

344A. Seminar on the Elementary School—Comprehensive analysis of developments, with particular attention to alternatives, in curriculum, instruction, and organization for the elementary school in light of educational purposes to be achieved. Registration limited to students in the Elementary Education Specialist Program.

2 units, Aut, Win, Spr (Sowards, Staff) by arrangement

345. Sociodrama and Related Techniques—Designed to help classroom teachers explore the rationale and skills for role-playing, dramatic play, and related techniques as teaching tools for inter-personal relations, cross-cultural understanding, and decision-making in the social studies.

3 units, Win (Shaftel) Th 7-10 p.m.

347. An Overview of American Higher Education—Contemporary examples of institutions of higher education and an analysis of their functions and problems. Recommended for candidates for the junior college credentials and for others concentrating in higher education.

3 units, Aut (---) M 3:15-6:05
4 units, Sum (Mayhew) MTWThF 1:15, given 1969-70

349. Professional Education of Teachers—For doctoral candidates interested in studying programs and procedures for teacher education.

4 units, Spr (Bush) MW 1:15-3:05
Sum (---) MTWThF 1:15

350. Research Methodology—Introduction to nature of scientific thinking in education, various methodological approaches relevant to research problems. Consideration given to particular concerns relating to doctoral dissertations. Prerequisite: Education 317A and B or consent of instructor.

4 units, Spr (---) MW 3:15-5:05

351A. Advanced Statistical Analysis in Educational Research I—An advanced course in statistical methodology devoted to the analysis of multivariables. Topics include multivariate normal distribution, multiple regression, partial and multiple correlations; linear and nonlinear models, analysis of covariance. Prerequisites: Education 250B or equivalent and consent of instructor.

3 units, Aut (Elashoff) MWF 11

351B. Advanced Statistical Analysis in Educational Research II—Multivariate analysis and factor analysis, matrix theory, discriminant analysis, canonical correlation. Prerequisites: Education 351A or equivalent and consent of instructor.

3 units, Win (Elashoff) MWF 11

352. Individual Psychological Testing—Instruction and practice in the administration and interpretation of individual tests of intelligence and their use in connection with other diagnostic instruments.

Spr (---) by arrangement, alternate years, given 1968-69

353. Problems in Measurement—For prospective research workers. Survey of alternative mathematical models used in test construction and analysis covering such topics as profile analysis, measurement of gains, factor analysis, theory of personnel decisions. Prerequisites: Education 250B and 252, or equivalent.

3 to 4 units, Aut (Cronbach) MW 2:15-4:05, alternate years, given 1968-69

354. Curriculum Evaluation—Functions of evaluation, outcomes to be measured, design of evaluation programs, qualities desired in evaluation instruments. For persons concerned with curriculum research. Prerequisites: Education 251 and permission of instructor.

3 to 4 units, Win (Cronbach) MTWTh 10 alternate years, given 1968-69


3 units, Sum (Eisner) MTWThF 10

383. Recent Developments in Secondary School Foreign Languages—Basic assumptions, findings of scientific study of language as applied to language teaching methods. Use of audio-visual aids in language class. Programmed instruction in foreign languages.

3 units, Aut (Politzer) W 4:15-6:05 and by arrangement
387. Elementary School Language Arts — For experienced teachers, graduate students. Reviews research, curriculum issues, instructional procedures related to language arts in elementary schools.

3 units, Aut (Iverson) W 7–10 p.m.
4 units, Sum (——) MWTThF 11 and by arrangement

388. Foreign Languages in the Elementary School—Discussion of the rationale, curriculum, methods and materials of foreign language instruction in the elementary school; problems of articulation with the high school curriculum in foreign languages.

3 units, Spr (Politzer) W 4:15–6:05 and by arrangement

390. Recent Developments in Elementary School Mathematics — Purposes and program of mathematics in elementary schools; teaching materials, methods. For experienced teachers, supervisors, administrators only.

2 to 3 units, Win (Begle) by arrangement

391. Recent Developments in Secondary School Mathematics — Purposes and program of mathematics in secondary curriculum; teaching materials, methods. For experienced teachers only.

2 to 3 units, Win (Higgins) by arrangement

392. Tutorial on Problems in Mathematics Education—Discussion of special problems of current interest in mathematics education. Consent of instructor required.

2 to 4 units, Aut, Win, Spr (Begle) by arrangement


3 units, Win (Bridgham) M 7–10 p.m.

394. Recent Developments in Secondary School Science—Consideration of selected curricula — rationale, implications for instructional technique, appropriateness for different student populations; patterns of offerings in science; guidance of science students. Prerequisites: major or minor in science and teaching experience in science.

4 units, Spr (Bridgham) TTh 1:15–3:05


4 units, Sum (——) MWTTh 2:15 and by arrangement


4 units, Aut (Shaftel) MW 2:15–4:05

Sum (Shaftel) MTWTh 1:15 and by arrangement


3 units, Aut (Iverson) M 7–10 p.m.

399. Reading in Elementary Schools—For experienced teachers, graduate students. Reviews research, curriculum issues, instructional procedures related to program of reading in elementary schools.

3 units, Win (Iverson) M 7–10 p.m.

4 units, Sum (——) MWTThF 9

SEMINARS AND SPECIAL COURSES FOR ADVANCED GRADUATE STUDENTS


3 units, Win (Thomas) W 7–10 p.m.

406A. Research Seminar on Education and Development I—A review of methods and techniques appropriate to research in international development education, including approaches used in various disciplines. Discussion will focus on particular concerns relating to doctoral dissertations. Required for all first-year SIDEc doctoral students. Others by consent of instructor.

4 units, Spr (Textor) W 7–10 p.m. and by arrangement

406B. Research Seminar on Education and Development II—Second of a sequence (beginning with 406A) in which students will
work on individual or group research projects. Discussion will focus on the relevance of political development theories to the planning of education. Required for all second-year SIDEC doctoral students. Others by consent of instructor.

2 to 4 units, Aut (Weiler) by arrangement

406C. Research Seminar on Education and Development III—Third of a sequence in which students will work on individual or group research projects. Discussion will focus on techniques of manpower planning and on problems of occupational education and training. Required for all second-year SIDEC doctoral students. Others by consent of instructor.

2 to 4 units, Win (Platt) by arrangement

406D. Research Seminar on Education and Development IV — A synthesis of the 306 and 406 seminar series with primary consideration to the application of development theory to educational policy. Required for all second-year SIDEC doctoral students. Others by consent of instructor.

2 to 4 units, Spr (——) by arrangement

406E. Research Seminar on Education and Development V — Research on education and the rural-urban transformation in developing areas. Open to second-year SIDEC doctoral students. Others by consent of instructor.

2 to 4 units, Spr (Textor) by arrangement

406H. International Development Education Seminar—A continuing seminar reviewing current policies for educational development in Africa, Asia, and Latin America. Open only to SIDEC doctoral students and associates.

1 unit, Aut, Win, Spr, Sum (Staff) W 12

410. Seminar on Theories of Socialization—Consideration of conceptualizations of the socialization process as viewed by theorists and researchers from different disciplines (psychology, sociology, political science, anthropology) and the application of these theories to relevant data in the several fields. Implications that follow from a conception of formal education as socialization into contemporary society will also be discussed with particular reference to education of disadvantaged children. Consent of instructor required.

2 units, Win (Hess) by arrangement


Aut, Win, Spr (Hess, Sieber) by arrangement

412. Race and Education—An advanced seminar with the goals of (1) developing original conceptualizations from a sociological perspective and (2) defining applied research problems based on these conceptualizations. Current literature will be critically reviewed. Prerequisite: Education 310. Consent of instructor required.

3 units, Spr (Cohen) M 7–9 p.m. and by arrangement, given 1969–70

415. Seminar in Educational Psychology—Topical seminar for advanced students. Admission by permission of instructor.

2 to 4 units, Spr (McDonald) by arrangement

4 units, Sum (Coladarci) by arrangement


417A. 3 units, Win (Atkinson) W 7–10 p.m.

417B. 3 units, Spr (Atkinson) W 7–10 p.m.

419. Seminar in Research on Teaching—A critical examination of research on teacher behaviors and characteristics considered as either dependent or independent variables.

3 units, Spr (Gage) M 7–10 p.m. and by arrangement

420. Seminar for Administrative Interns — Designed for interns in general school administration and for selected assistants in the School Planning Laboratory. Analysis of problems and opportunities emerging from internship assignments.

2 units, Aut, Win, Spr (Staff) by arrangement

423A,B,C. Seminar in School Facility Planning—Designed for advanced candidates in school administration. The autumn quarter will be conducted as a seminar; the winter quarter will be devoted to master-planning the school plant; and the spring quarter to the development of educational specifications for the school plant. Prerequisite: Education 325 or equivalent, or consent of instructor.
423A. 3 units, Aut (MacConnell, Strand)  
   Th 3:15–6:05
423B. 3 units, Win (MacConnell, Strand)  
   Th 3:15–6:05
423C. 3 units, Spr (MacConnell, Strand)  
   Th 3:15–6:05

424A,B,C. Seminar in College Administration—Curricular, instructional, administrative, and philosophical developments in collegiate administration with a special emphasis on individual institutions.

424A. 3 units, Aut (——) by arrangement
424B. 3 units, Win (——) W 3:15–6:05
424C. 3 units, Spr (——) W 3:15–6:05

431. Guidance Seminar — Designed for all doctoral candidates in guidance. Analysis of professional problems in guidance and personnel work. May be repeated for credit.

1 unit, Aut (Krumboltz, Thoresen) Th 7:30–9:30 p.m., biweekly
Win, Spr, Sum (Krumboltz, Thoresen) Th 7:30–9:30 p.m., biweekly

440. Seminar in the School Curriculum — Designed for advanced graduate students preparing for leadership positions in either public schools or colleges of education. Prerequisites: recent post-A.M. work in the foundations of education and post-credential work in the elementary and/or secondary school curriculum.

4 units, Spr (Sowards) TTh 3:15–5:05
   Sum (Eisner) MTWThF 8

444. Seminar in Elementary School Education—Enrollment limited to doctoral candidates in elementary school education and to those in special curriculum fields who plan to work primarily with the elementary school. Major issues and problems of elementary school education analyzed; relevant research literature explored; research problems formulated.

Organizational emphasis—2 to 5 units,  
   Aut (Sowards) TTh 1:15–3:05 and by arrangement
Curriculum and Instruction emphasis—  
   Win (Shaftel) MW 1:15–3:05 and by arrangement

446. Seminar in Secondary Education for Doctoral Candidates — Enrollments limited to doctoral candidates in secondary education. Major issues, problems of secondary education, including staff development, personnel management; application of foundational fields of education thereto; formulation of research problems.

2 units, Aut (——) W 4:15–6:05  
   (Administration emphasis)
Spr (——) T 3:15–5:05 (Teacher Personnel emphasis)

4 units, Sum (Bush) W 7–10 p.m. and  
   by arrangement (Student Personnel emphasis)

   1 to 10 units, any quarter (Staff) by arrangement

   1 to 30 units, any quarter (Staff) by arrangement

470. Practicum.  
   By arrangement

480. Directed Reading.  
   By arrangement

   2 units, Spr (Politzer) M 4:15–6:05

483. Seminar in Mathematical Models of Learning and Instruction — Discussion of current work in mathematical models, with emphasis on theoretical concepts and problems of data analysis. For advanced students.

1 to 3 units, Aut, Win, Spr (Suppes, Atkinson) by arrangement

490. Directed Research.  
   By arrangement

492. Seminar in Mathematics Education—Discussion of recent research in mathematics curriculum and instruction. For advanced students. Consent of instructor required.

2 to 3 units, Aut, Win, Spr (Begle) by arrangement

494. Seminar in Science Education—Consideration of researchable problems in science education, relevant research, and research strategies which may be applicable. For advanced students.

3 units, Aut (Bridgham) Th 7–10 p.m.

496. Seminar in Social Studies Education—For advanced students. Discussion of recent research and trends in social studies curriculum and instruction.

3 units, Win (Staff) W 7–10 p.m.
PROFESSIONAL PHYSICAL EDUCATION COURSES AND DEGREES FOR MEN

DEGREES

Graduate men desiring to major in Physical Education may become candidates for the A.M., Ed.D., and Ph.D. degrees in Education, with concentration in Physical Education. See the section on Graduate Degrees.

TEACHING CREDENTIALS

Men desiring to teach Physical Education classes and coach athletic teams as their preferential assignment in secondary schools should enroll in the Physical Education secondary teaching intern program in order to qualify for the Standard Teaching Credential in Secondary Education in the State of California. Course work in this credential teaching field program in Physical Education may begin in the sophomore or junior year. It continues through the senior and first graduate year. Interested students should obtain their A.B. degrees in a department of the School of Humanities and Sciences, and take the required professional physical education courses concurrently. For the requirements of the intern credential program, see the section “Teaching Credential (Secondary),” in the Education introductory material.

INFORMATION

For details concerning any of the above Physical Education major programs see Professor John Nixon or Professor Wesley Ruff in the School of Education, or in the Department of Physical Education and Athletics for Men.

155. Elementary Analysis of Body Movement—Introduction to anatomical and mechanical aspects of human movement. Enrollment by permission of instructor.

2 units, Spr (Ruch) TTh 8

156. Foundations of Physical Education—Psychological, biological and sociological bases of physical education, emphasizing basic research from the above disciplines, the body of knowledge of physical education and the development of sound principles from the above sources.

4 units, Aut, Spr (Nixon) MWF 9 and by arrangement

159. Evaluation in Physical Education—Theory and principles of evaluation in physical education. Emphasis on test construction, the role of evaluation in physical education curriculum and instruction, and research.

3 units, Win (Nixon) MWF 9

171, 172. Curriculum and Instruction in Men's Physical Education—Open only to men physical education major teaching credential candidates who have been admitted formally into the Physical Education Credential Program. Not open to freshmen.

171A. Baseball.

2 units, Win (Young) TTh 9 and by arrangement

171B. Basketball.

2 units, Aut (Dallmar) Th 11 and by arrangement

171C. Football.

2 units, Spr (Ralston) TTh 10 and by arrangement, alternate years, given 1969–70

171D. Track and Field.

2 units, Win (Jordan) MW 10 and by arrangement

171E. Adapted Physical Education.

1 unit, Spr (Ruff) M 1:15, alternate years, given 1968–69

171F. Combatives.

2 units, Win (Lunny, Reed) MWF 3:15

171H. Athletic Training and Conditioning.

2 units, Aut, Win, Spr (Blanchard) by arrangement

172A. Aquatics.

2 units, Spr (Gaughran) TTh 11 and by arrangement

172B. Gymnastics.

2 units, Win (Gilmore) MWF 2:15 and by arrangement

172C. Golf.

2 units, Win (Finger) TTh 11 and by arrangement
172D. Tennis.  
2 units, Aut (Gilmore) by arrangement

172E. Volleyball, Soccer, Speedball.  
2 units, Spr (Ruff) MWF 2:15, alternate years, given 1968-69

176. Intramural Programs — Theory and principles of intramural sports organization and administration.  
2 units, Win (Staff) TTh 9

177. Physiology of Exercise—Physiological adaptations of the human organism to exercise stress. Prerequisite: Biology 4 or equivalent.  
3 units, Aut (Ruff) lec. T 9-11; lab. Th 9-11 and one hour by arrangement

179. Kinesiology—Application of anatomy, physiology, laws of mechanics to human motion. Prerequisite: Anatomy 114.  
4 units, Spr (Ruch) MWF 1:15-3:05

277. Human Physical Performance Research—Emphasizes relevant literature and laboratory research experience. Prerequisite: Education 177 or equivalent.  
3 units, Win (Ruff) lec. W 7-10 p.m.; lab. by arrangement

356. Seminar in Physical Education Research — Critique of selected recent literature and research.  
3 units, Aut (Nixon) MWF 10  
Sum (Nixon) MTWTh 11

357. Seminar in Physical Education Curriculum — Research in physical education curriculum and instruction.  
3 units, Spr (Nixon) M 7-10 p.m.

358. Special Assignments, Physical Education—An opportunity for the graduate student to undertake the study of a significant problem in physical education or to engage in applied or basic research under the direction of the instructor.  
1 to 5 units, any quarter (Nixon, Ruff) by arrangement

377. Research Seminar on Human Physical Performance — Recent research in physical education, sports medicine, physiology and related fields concerning man’s ability to adapt to various forms of environmental stress while engaging in sports, dance, and designed exercise. Prerequisites: Education 177 and 277, or equivalent.  
4 units, Spr (Ruff) TTh 1:15-3:05

459. Seminar in Physical Education Issues —Selected issues and problems in physical education.  
3 units, Win (Nixon) M 7-10 p.m.

HEALTH EDUCATION

Emeriti: George S. Luckett (Professor); Lois P. Todd (Assistant Professor)  
Executive Head: Oliver E. Byrd  
Professor: Oliver E. Byrd  
Acting Assistant Professor: Harry E. Bryan

The undergraduate courses in health education are based upon the philosophy that knowledge of the factors that influence health should be the possession of every cultured individual and that an understanding of the principles of healthful living requires training in the application of the scientific facts of the various fundamental sciences which are related to health.  
The graduate courses in health education are designed for the training of teachers and school administrators who desire special competence in the field of school health.

TEACHING CREDENTIALS

Students in the Department of Health Education may follow a major or minor sequence of study leading to teaching credentials for the State of California. Detailed requirements may be secured from the Credential Secretary, School of Education.

PROGRAMS OF STUDY

Through the School of Education, the Department of Health Education offers the A.M. and Ed.D. degrees with specialization in health education. Candidates not interested in the field of education may secure the A.M. degree through the Department of Health Education. Candidates for the Master of Arts degree must complete at least 36 units of graduate work in the Department of Health Education. The degree of Doctor of Education may be recommended for those candidates who satisfy the requirements of the School of Education and who devote approximately one-half of their course work on the graduate level to certain offerings from the Department of Health Education. Complete information on this degree may be secured from the office of the Dean of the School of Education.
UNDERGRADUATE COURSES

101. Medicine for the Layman—A nontechnical interpretation of current medical research and clinical experience as revealed in the medical literature. Medical abstracts are based upon articles selected, condensed, and reported by the instructor. Student inquiry and group discussions are based upon these samples of opinion, research, and experience of modern medicine.

3 units, Aut (Bryan) W 7–10 p.m.
   Win (Byrd) MWF 9
   Spr (Bryan) MWF 11

106. Personal Mental Health — Group discussions of the specific personal mental health problems of students enrolled in the class against the background of the problems which the present-day college atmosphere presents.

3 units, Aut (Bryan) MWF 10
   Win (Bryan) MWF 11

107. Safety — A consideration of accidents as they occur — on the highway, at home, in schools, in recreation, etc.—and the means of prevention. Emphasis is placed upon looking at the individual and his values and at the environment as factors in accident prevention.

3 units, Win (Bryan) by arrangement

121. Marriage and Family — A comprehensive look at marriage and the resulting family, both as a significant phenomenon of the culture and a probable, personal concern of students. Emphasis on those areas where knowledge and adjustment are most crucial for happy marriage: health aspects, courtship and mate selection, finances, sex, religion, and interpersonal relations with other family members. Spring quarter class open to juniors and seniors only.

3 units, Win, Spr (Bryan) MWF 10

195. Independent Study in Health Science — This undergraduate course is based upon an exploration of the current medical literature for identification of leading health problems. It also offers the student an opportunity to study independently on specific health problems of his own choosing. Registration is limited to five units.

2 to 5 units, Aut (Bryan) by arrangement
   Win (Byrd) by arrangement
   Spr, Sum (—) by arrangement

GRADUATE COURSES


3 units, Win (Bryan) by arrangement

291. Curriculum and Instruction in Health Science — Familiarization with the many current sources of facts and ideas relative to health, with special focus on periodicals; utilization of materials in developing teaching materials; consideration of various methods for using materials in teaching.

6 units, Spr (Byrd) by arrangement

305. Practicum in School Nursing — Participation in work of school nurse under supervision of school district and University Department.

4 to 12 units, Win, Spr (Byrd) by arrangement

400. Individual Study in Health Science — This course is based upon an exploration of the current medical literature at deeper levels than course 195. It offers the student an opportunity to study intensively on specific health problems or to achieve a broad overview of the most up-to-date medical literature.

3 to 16 units, Aut (Bryan) by arrangement
   Win (Byrd) by arrangement
   Spr, Sum (—) by arrangement

405. Topical Seminar in Health Science — Consideration of current issues and controversies in health education. Limited to advanced graduate students in health education, other graduate students with at least six courses in health, and advanced medical and nursing students.

4 units, Spr (Byrd) W 2:15–6:05
SCHOOL of ENGINEERING

Dean: Joseph M. Pettit
Associate Deans: Donald J. Grace, L. Farrell McGhie, William R. Rambo (Research), Laurrell L. Wise (Student Relations)
Assistant Dean: Alfred D. Kirkland
Secretary of the Faculty: Michel Boudart

The School of Engineering has ten academic departments or divisions (Aeronautics and Astronautics; Chemical Engineering; Civil Engineering; Electrical Engineering; Engineering-Economic Systems; Industrial Engineering; Materials Science; Mechanical Engineering; and Operations Research), with Applied Mechanics as an interdepartmental activity having degree programs. These departments are responsible for the various student curricula, with the exception of the School-wide programs in General Engineering and Engineering Science. In research, where the scope of faculty interest and competence embraces both engineering and the supporting sciences, there are not only numerous programs within the School, but there is also faculty and student participation in several inter-School activities, including the Microwave Laboratory, the Center for Materials Research, the Institute for Plasma Research, and the Radio Astronomy Institute.

The School offers undergraduate curricula leading to the degree of Bachelor of Science, and various graduate curricula (administered by the departments of the School) leading to the degrees of Master of Science, Engineer, and Doctor of Philosophy. Requirements for the degree of Bachelor of Science may normally be completed in twelve quarters. Instruction in engineering is offered in each of the four quarters of the academic year. The summer quarter offerings include the basic courses required of all engineering students, a few other undergraduate courses, and selected regular and special graduate courses.

Undergraduate Admission

Students admitted to the University are permitted to major in the School of Engineering if they elect to do so; there are no additional procedures, course requirements, or examinations for admission to the School.

Preparation Recommended for Freshmen

Students who enter as freshmen intending to major in engineering should take mathematics in high school to as high a level as is offered, including trigonometry. Placement tests are given by the Department of Mathematics during the registration period. Students who do not place high enough in the test will be required to take Mathematics 0, Algebra and Trigonometry, in addition to the normal graduation requirements in engineering. High school courses in physics and chemistry are strongly recommended but not required. Additional elective course work in English is also recommended.

Preparation Recommended for Transfer Students

Students who do the early part of their college work elsewhere and then transfer to Stanford to complete their engineering programs should follow an engineering or pre-engineering program at the first school, selecting insofar as possible courses applicable to the requirements of the School of Engineering, i.e., courses comparable to those included in the list of "Courses Normally Taken by All Engineering Students." Some transfer students may require more than four years to obtain the B.S. degree. However, Stanford affords great flexibility in planning and scheduling individual programs, which makes it possible for transfer students having wide variations in preparation to plan full programs for each quarter and to progress toward graduation without undue delay.

Transfer credit will be applied to School of Engineering requirements whenever the courses are equivalent or substantially similar. Substitution of transfer credits for courses that are required by the General Studies Program is administered by the University Committee on General Studies. The policy of the School of Engineering is to study each transfer student's preparation and make a reasonable evaluation of the courses taken prior to transfer. Inquiries may be addressed to the Dean of Engineering at Stanford.
The principal objective of the School of Engineering is to provide, in the setting of a comprehensive, residential university, a combination of a cultural education, through the General Studies Program (including the Overseas Program), and a broad technical preparation for careers in modern engineering. Central to the latter is a strong preparation in the basic sciences, followed by a "common core" of engineering subjects embracing concepts and techniques which are judged to be fundamental to engineering as a discipline, irrespective of field of specialization.

A special opportunity exists whereby engineering students may spend their junior year in residence at the Instituto Tecnológico y de Estudios Superiores de Monterrey in Mexico. The student pursues a regular program of engineering courses, so little if any delay results in graduation. Instruction is in Spanish, so adequate language preparation is needed—either one year of college Spanish or high school equivalent. The student achieves a genuine fluency in a second language, and an opportunity to live in a different cultural setting.

A similar opportunity exists in France, at the École Nationale Supérieure de Mécanique of Nantes, to which substantially the same remarks apply.

As to specialization, there is a modest opportunity to use elective units in a systematic way to provide an introduction to and a measure of competence in a chosen field. Or conversely, in the General Engineering and Engineering Science curricula, there is opportunity to increase the breadth of exposure to subjects within and outside the School of Engineering. Undergraduate options are described on the following pages under departmental listings, and for convenience are tabulated here alphabetically:

- Aeronautics and Astronautics
- Chemical Engineering
- Civil Engineering
- Construction and Highways
- Electrical Engineering (including Electronics)
- Engineering Design
- Engineering Science
- General Engineering
- Hydraulics and Fluid Mechanics
- Hydrology and Water Resources
- Industrial Engineering (including Operations Research)
- Materials Science (including Metallurgy)
- Mechanical Engineering
- Mechanics
- Nuclear Engineering
- Product Design
- Public Works Administration
- Resource Strategy
- Sanitary Engineering
- Structures
- Thermosciences

These options are not rigid; the needs of each student can be considered individually.

Entering freshmen or sophomore transfer students who have not yet chosen the engineering curriculum in which they plan to major will be listed automatically as enrolled in General Engineering. Unless the student plans to earn a B.S. degree in General Engineering, however, he must elect a specific engineering major by the end of his sophomore year.

The four years of the B.S. program in all of these fields divide into about one fourth general studies (humanities and social sciences), one fourth basic sciences (mathematics, physics, and chemistry), one fourth common engineering subjects, and one fourth specialization in one of the elective options. Courses in all these categories are distributed throughout the four years in order to provide a fully integrated program.

All undergraduate curricula, namely, Chemical, Civil, Electrical, General, Industrial, and Mechanical Engineering, Engineering Science, and Materials Science, are accredited by the national organization responsible for accrediting of engineering curricula: The Engineers' Council for Professional Development (E.C.P.D.). The curriculum in Aeronautics and Astronautics is also accredited, but at the Master's degree level; the undergraduate curriculum in this field is an option within Mechanical Engineering.

Courses common to all curricula appear in the first table. Supplementary lists for each of the curricula will be found in the tables following. A student who satisfactorily completes the courses normally taken by all students of engineering, together with one of these supplementary lists, will be recommended by the School of Engineering for the degree of Bachelor of Science. The total
number of required units is a minimum of 150–152, depending upon the curriculum selected.

The requirements listed under the heading “Courses Normally Taken by All Engineering Students” may be modified in unusual situations to satisfy specific objectives. To do so requires a petition to the Registration and Graduation Committee of the School of Engineering, except for certain substitutions which are specifically permitted (see “Supplementary Requirements” for each curriculum). Such petitions must be submitted before the start of the third quarter preceding graduation to receive full consideration by the Committee.

Substitutions or deletions from the “Supplementary Requirements” may be made with the approval of the student’s faculty adviser. Every student is urged to discuss with his adviser any change that would improve the curriculum for his personal needs.

### COURSES NORMALLY TAKEN BY ALL ENGINEERING STUDENTS

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General Education subjects</td>
<td></td>
</tr>
<tr>
<td>English (English 1, 2, 3, 129) (See Note 3)</td>
<td>12</td>
</tr>
<tr>
<td>History of Western Civilization (History 1, 2, 3)</td>
<td>12</td>
</tr>
<tr>
<td>General Studies Humanities (See Notes 1 and 3)</td>
<td>5</td>
</tr>
<tr>
<td>General Studies Social Sciences (See Notes 2 and 3)</td>
<td>10</td>
</tr>
<tr>
<td>Public Speaking (Speech 20; see Notes 1 and 3)</td>
<td>3</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>42</td>
</tr>
<tr>
<td>2. Basic Science and Mathematics subjects</td>
<td></td>
</tr>
<tr>
<td>Physics (Physics 51–58, incl.)</td>
<td>18</td>
</tr>
<tr>
<td>Chemistry (Chem. 4, 5)</td>
<td>8</td>
</tr>
<tr>
<td>Analytic Geometry and Calculus (Math. 41–44, inc.; see Note 4)</td>
<td></td>
</tr>
<tr>
<td>Statistics (See Note 5)</td>
<td>3 or 4</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>47 or 48</td>
</tr>
<tr>
<td>3. Engineering Science and General Engineering subjects</td>
<td></td>
</tr>
<tr>
<td>Engineering Mechanics (Engr. 11, 12)</td>
<td>6</td>
</tr>
<tr>
<td>Mechanics of Materials (Engr. 15 or 18)</td>
<td>3</td>
</tr>
<tr>
<td>Mechanics of Fluids (See Note 6)</td>
<td>3 or 4</td>
</tr>
<tr>
<td>Thermodynamics (See Note 7)</td>
<td>3 or 5</td>
</tr>
<tr>
<td>Electrical Science (Engr. 41, 41A, 42, 42A)</td>
<td>10</td>
</tr>
<tr>
<td>Science of Materials (Engr. 50)</td>
<td>3</td>
</tr>
<tr>
<td>Introduction to Engineering Design (Engr. 9)</td>
<td>4</td>
</tr>
<tr>
<td>Engineering Economy (Engr. 161, 60)</td>
<td>3</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>35–38</td>
</tr>
<tr>
<td><strong>Total all subjects</strong></td>
<td>124–128</td>
</tr>
</tbody>
</table>

**Note 1.**—The General Studies Humanities requirement is at least 8 units selected from the list of approved courses given in the General Studies Bulletin. Speech 20 is a requirement of the School of Engineering and also may be offered as partial fulfillment of the General Studies requirement.

**Note 2.**—The General Studies Social Sciences requirement is at least two 5-unit courses selected from the list of courses given in the section on the General Studies Program.

**Note 3.**—All students who attend an Overseas Campus in Europe automatically fulfill the General Studies requirements in Humanities and Social Sciences; in addition, the School of Engineering requirements of Speech 20 and English 129 are waived.

**Note 4.**—The 3-unit mathematics sequence (Math. 10, 11, 21, 22, 23, 44) is an alternative which necessitates postponing physics until the second year and hence may delay graduation in some curricula. Math. 24 may be substituted for Math. 44 if no additional mathematics courses are to be taken.


**Note 6.**—Engr. 41, Mechanics of Fluids, 4 units, or (for Chemical Engineering students only) Ch.E. 115A, 116A, Unit Operations: Fluid Flow, 4 units.

**Note 7.**—Engr. 31, Elementary Engineering Thermodynamics, 5 units, or Chem. 171, 173, Physical Chemistry, 6 units, or Physics 170, Thermodynamics, 3 units. (Consult adviser.) Note that Physics 170 has Math. 130 as a prerequisite. Chemical Engineering and Materials Science students should take Physical Chemistry.

### SCHEDULING OF COURSES

Sample programs are available in the office of the Dean of Engineering to assist students in the selection and scheduling of courses. Many engineering courses have prerequisites and other departmental requirements which make scheduling difficult, hence the following rules should be noted:

- Engr. 5 is available for freshmen and sophomores only
- Engr. 9 should be taken before end of sophomore year
- Engr. 11 should be taken before end of sophomore year
- Engr. 12, 15, 21, 31, 41, 41A, 42, 42A should be taken before end of junior year
- Engr. 60 should be taken freshman year, or Engr. 161 should be taken junior or senior year.

Electrical engineering students should take Engr. 41, 41A, 42, 42A before end of sophomore year.

### 1. SUPPLEMENTARY REQUIREMENTS, CHEMICAL ENGINEERING

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 121, 123</td>
<td>Organic Chemistry</td>
<td>7</td>
</tr>
<tr>
<td>Chem. 122</td>
<td>Organic Preparations</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 176</td>
<td>Physico-Chemical Measurements</td>
<td>3</td>
</tr>
<tr>
<td>Ch.E. 10</td>
<td>Introduction to Chemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Ch.E. 115B,C</td>
<td>Unit Operations</td>
<td>6</td>
</tr>
</tbody>
</table>
2. Supplementary Requirements, Civil Engineering

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engr. 5 or C.S. 50A. Use of Digital Computers</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 107. Mechanics of Fluids</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 118. Materials Engineering</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 138. Specifications and Contracts</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 150. Transportation Engineering</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 160. Water-Resources Engineering</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>C.E. 170. Man and His Environment</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 180. Elementary Structural Analysis</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>C.E. 197 or C.E. 198. Engineering Synthesis; or Senior Report plus three units of additional restricted electives</td>
<td>9 or more</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives (see below)</td>
<td>13 or more</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>52 or more</td>
<td></td>
</tr>
</tbody>
</table>

Restricted electives: At least 9 units must be selected from the following list of courses:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.E. 20. Surveying</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 114. Mechanics of Materials</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 116. Plain Concrete</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 181. Structural Design</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 182. Structural Design</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.E. 190. Soil Mechanics and Functions</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Unrestricted electives: Enough additional units (13 minimum) of electives are to be selected by the student with the approval of his adviser to satisfy the University requirement of 180 units for graduation. The selection should represent a coherent plan of courses to best meet the student’s career objectives. In general, undergraduate students are not encouraged to enroll in graduate courses. Undergraduate options include civil engineering materials, construction, high-ways, hydraulics and fluid mechanics, hydrology and water resources, public works administration, sanitary and environmental engineering, and structural engineering. Lists of suggested electives are available in the Civil Engineering Department office. Students planning to continue into graduate work should be certain that their undergraduate programs provide proper prerequisites.

3. Supplementary Requirements, Electrical Engineering

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.E. 101, 102, 103. Circuits, Elementary Network Theory</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>E.E. 111, 112, 113. Electronics</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>E.E. 121, 122. Laboratory</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>E.E. 141, 142. Electromagnetic Fundamentals, Waves</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>E.E. 163. Control Systems</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>E.E. 126, 145, 171. Laboratory, or E.E. 124 or 139 or 179</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C.S. 5 or 136 or 50A,B. Introduction to Programming, or Introduction to Computer Science</td>
<td>3 or more</td>
<td></td>
</tr>
</tbody>
</table>

Free Electives                                      | 15 or more |
Total                                               | 53 or more |

Each student in consultation with his adviser chooses his electives according to his own interests and objectives. He should consider not only the courses offered in Electrical Engineering, but also those of other departments and schools of the University. Students should seriously consider graduate study, in either electrical engineering or a related field; those particularly interested in technical development or research may well include some electrical engineering courses numbered above 200 in their undergraduate programs.

4. Supplementary Requirements, Engineering Science

The procedure for entering this curriculum is described later under the heading “Engineering Science.”

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math. 130, 131 (Diff. Equations), or 45, 46 (Adv. Calculus)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Engineering Science (see below)</td>
<td>21 or more</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Basic Science (see below)</td>
<td>9 or more</td>
<td></td>
</tr>
<tr>
<td>Unrestricted Electives (see below)</td>
<td>17 or more</td>
<td></td>
</tr>
</tbody>
</table>

Total                                               | 53 or more |
### Restricted Electives in Engineering Science

A total of 21 units selected from the following list of technical courses, including a minimum of 3 units in laboratory work chosen from the first six courses listed:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.E. 122.</td>
<td>Mechanical Engineering Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>E.E. 121, 122.</td>
<td>Electrical Engineering Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>E.E. 171.</td>
<td>Control Systems Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>Mat.Sci. 107.</td>
<td>High Temperature Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>Engr. 175.</td>
<td>Radioactivity Measurements Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>Engr. 176.</td>
<td>Radiochemistry Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>A.M. 205.</td>
<td>Experimental Stress Analysis</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 107.</td>
<td>Mechanics of Fluids</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 114.</td>
<td>Mechanics of Materials</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 118.</td>
<td>Materials Engineering</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 171.</td>
<td>Environmental Radioactivity</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 179.</td>
<td>Nuclear Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 180.</td>
<td>Elementary Structural Analysis</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 280.</td>
<td>Theory of Structures</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 281a,b.</td>
<td>Matrix Analysis of Structures</td>
<td>6</td>
</tr>
<tr>
<td>Math. 106, 107.</td>
<td>Functions of a Complex Variable</td>
<td>6</td>
</tr>
<tr>
<td>Math. 113, 114.</td>
<td>Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>C.S. 137, 138.</td>
<td>Numerical Analysis</td>
<td>6</td>
</tr>
<tr>
<td>Stat. 27.</td>
<td>Introduction to Probability Theory</td>
<td>3</td>
</tr>
<tr>
<td>Stat. 110.</td>
<td>Statistical Methods in Engineering</td>
<td>4</td>
</tr>
<tr>
<td>Physics 61.</td>
<td>Optics and Wave Motion</td>
<td>3</td>
</tr>
<tr>
<td>Physics 140.</td>
<td>Elementary Nuclear Physics</td>
<td>3</td>
</tr>
<tr>
<td>Physics 210, 211, 212.</td>
<td>Introductory Theoretical Physics</td>
<td>9</td>
</tr>
<tr>
<td>Physics 130, 131, 132.</td>
<td>Atomic and Nuclear Structure</td>
<td>9</td>
</tr>
<tr>
<td>Physics 170.</td>
<td>Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>Physics 171.</td>
<td>Kinetic Theory and Introduction to Statistical Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>Physics 172.</td>
<td>Physics of Solids</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 141.</td>
<td>Nuclear Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 142.</td>
<td>Radiochemistry Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 171, 175.</td>
<td>Quantum Mechanics</td>
<td>9</td>
</tr>
</tbody>
</table>

### Restricted Electives in Basic Science

A total of 9 units selected from the following list of courses, except that no course may be used to satisfy more than one requirement:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math. 45, 46.</td>
<td>Advanced Calculus</td>
<td>6</td>
</tr>
<tr>
<td>Math. 130, 131, 132.</td>
<td>Differential Equations</td>
<td>9</td>
</tr>
<tr>
<td>Math. 45, 46.</td>
<td>Advanced Calculus</td>
<td>6</td>
</tr>
<tr>
<td>Math. 130, 131, 132.</td>
<td>Differential Equations</td>
<td>9</td>
</tr>
<tr>
<td>Math. 106, 107.</td>
<td>Functions of a Complex Variable</td>
<td>6</td>
</tr>
<tr>
<td>Math. 113, 114.</td>
<td>Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>C.S. 137, 138.</td>
<td>Numerical Analysis</td>
<td>6</td>
</tr>
<tr>
<td>Stat. 27.</td>
<td>Introduction to Probability Theory</td>
<td>3</td>
</tr>
<tr>
<td>Stat. 110.</td>
<td>Statistical Methods in Engineering</td>
<td>4</td>
</tr>
<tr>
<td>Physics 61.</td>
<td>Optics and Wave Motion</td>
<td>3</td>
</tr>
<tr>
<td>Physics 140.</td>
<td>Elementary Nuclear Physics</td>
<td>3</td>
</tr>
<tr>
<td>Physics 210, 211, 212.</td>
<td>Introductory Theoretical Physics</td>
<td>9</td>
</tr>
<tr>
<td>Physics 130, 131, 132.</td>
<td>Atomic and Nuclear Structure</td>
<td>9</td>
</tr>
<tr>
<td>Physics 170.</td>
<td>Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>Physics 171.</td>
<td>Kinetic Theory and Introduction to Statistical Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>Physics 172.</td>
<td>Physics of Solids</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 141.</td>
<td>Nuclear Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 142.</td>
<td>Radiochemistry Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 171, 175.</td>
<td>Quantum Mechanics</td>
<td>9</td>
</tr>
</tbody>
</table>

### Unrestricted Electives

— These elective units may be used for further studies in basic science, engineering science, more specialized engineering subjects, or General Studies.

### Special Note

— Students majoring in Engineering Science may substitute Physics 110 and 111 for Engineering 11 and 12 in the list of "Courses Normally Taken by All Engineering Students."

### 5. Supplementary Requirements, General Engineering

The program for the Bachelor of Science degree in General Engineering, without designation of a field of specialization, is intended to prepare students for appropriate, definite career objectives involving engineering. It is well suited for those who desire a general engineering education as preparation for a management or a military career, or who wish to incorporate more general studies before specializing in an engineering field later. It is also for students who desire a background involving unusual combinations in engineering that do not fit into the other professional curricula, e.g., Product Design or Resource Strategy (see General Engineering section on page 135).

The curriculum requires completion of the "Courses Normally Taken by All Engineering Students," as well as sufficient additional units to bring the total to at least 180. The same standards of academic performance are required as for other curricula; there are no special sections or courses for students in General Engineering.
Courses

Elective engineering courses (must be part of a coherent plan of courses meeting the student’s career objectives) 25 or more

Other elective courses from science, mathematics, engineering, business, languages, humanities, and social sciences (must be part of a coherent plan of courses meeting the student’s career objectives) 15 or more

Unrestricted electives (may include a maximum of 9 units of ROTC courses, or 4 units of musical performance courses, or 4 units of physical education courses) 15 or more

6. SUPPLEMENTARY REQUIREMENTS, INDUSTRIAL ENGINEERING

Course No. Subject Units
M.E. 4. Materials and Processes 3
Engr. 5 or C.S. 50A. Introduction to Programming, or Introduction to Computer Science 3
I.E. 100. Industrial Organization and Management 4
I.E. 108. Work Design and Measurement 3
I.E. 120. Quality Control by Statistical Methods 3
I.E. 133. Industrial Accounting 4
I.E. 141. Utilization of Computers 3
I.E. 161. Design of Production Systems 3
I.E. 162. Systems Planning and Control 3
I.E. 199. Senior Seminar 3
Psych. 122. Industrial Psychology 3
Econ. 145. Economics of Labor 5
Stat. 110. Statistical Methods or Stat. 27. Introduction to Probability Theory* 3 or 4

Restricted Electives 11

Total ........................................ 59-60

* Whichever course is not taken in satisfaction of the requirements for all engineering students.

The restricted electives must be selected to provide a coordinated program to give study in depth in one area, and must be approved by the adviser. Suggested sets of electives which meet these requirements are available in the Department Office.

7. SUPPLEMENTARY REQUIREMENTS, MATERIALS SCIENCE

Course No. Subject Units
Engr. 5 or C.S. 50A. Introduction to Programming, or Introduction to Computer Science 3
Chem. 171, 173. Physical Chemistry 6
Math. 45. Advanced Calculus 3
Math. 130, 131. Differential Equations 6
Mat. Sci. 104. Crystallography 2
Mat. Sci. 105. Imperfections in Crystalline Solids 3
Mat. Sci. 121. Mass Transport 3
Mat. Sci. 122. Solid State Thermodynamics 3
Mat. Sci. 124. Phase Equilibria 4
Mat. Sci. 125. Structural Transformations in Materials 4
Mat. Sci. 127. X-Ray Diffraction and Spectroscopy 3
Mat. Sci. 128. Materials Engineering 3
Mat. Sci. 130. Mechanical Behavior of Solids 4
Mat. Sci. 152. Electrical, Optical, and Magnetic Properties of Materials 4
Electives 6

Total ........................................ 57

Materials Science cuts across several traditional fields of science and engineering. Electives are provided to allow students to develop secondary emphasis in one or more of the traditional fields. Materials Science students who desire a particularly strong background in mathematics and physics in preparation for graduate study leading to a career in research and teaching should include the following elective courses:

Course No. Subject Units
Physics 110, 111. Intermediate Mechanics 6
Physics 120, 121, 122. Intermediate Electricity and Magnetism 9

To allow time for these courses, the requirements in Applied Mechanics, Mechanics of Fluids, and Engineering 41, 41A, 42, 42A, and 161 may be omitted from the list of “Courses Normally Taken by All Students of Engineering.” A Materials Science adviser must approve each student’s selection of electives.

8. SUPPLEMENTARY REQUIREMENTS, MECHANICAL ENGINEERING

Course No. Subject Units
Engr. 5. Introduction to Programming; or C.S. 50A. Introduction to Computer Science 3
Engr. 104. Dynamic Response 3
M.E. 4. Materials and Processes 3
M.E. 50. Mechanisms 3
M.E. 114A. Mechanical Engineering Design 3
M.E. 122. Mechanical Engineering Laboratory (or A.A. 131, Experimentation in Aeronautics and Astronautics) 3
M.E. 132. Engineering Thermodynamics 3
M.E. 136. Mechanics of Compressible Fluids 4
C.E. 114. Mechanics of Materials 3
Math. 130. Ordinary Differential Equations 3
Free Electives, to make up a total of 180 units 20 to 22

Total ........................................ 52-53

In the above program, depending upon the total number of units taken for graduation, the student has from twenty to forty
units of free electives. These are entirely at his disposal and may be used for various purposes.

The objectives of undergraduate students in Mechanical Engineering vary greatly. Some are using Mechanical Engineering as an undergraduate background for advanced work in fields outside of Engineering, such as the Graduate School of Business. There are a few who plan to work as engineers directly following receipt of the Bachelor’s Degree, primarily in the manufacturing and non-scientifically oriented industries. A large group have a strong technical interest and plan to obtain Master’s Degrees in Mechanical Engineering, or other areas of Engineering, and then practice engineering in industries with a scientific base. Finally, there are those with strong scientific interests and ability who intend to pursue the Ph.D. Degree in Mechanical Engineering, or some other branch of Engineering, as a basis for teaching, research, or advanced development. Quite independent of these objectives, the student may choose to use his electives either to develop a broader general education with courses in the humanities and social sciences, including the Stanford overseas campuses, or to develop considerably more depth in science and engineering, or for some combination of both.

For those students interested in developing a stronger professional program than is provided by the minimum requirements listed above, advisers will have available lists of suggested courses. Such students are particularly cautioned against putting off too many of the departmental requirements until the senior year leaving no room for more advanced courses which generally build upon the basic courses in the program.

Students intending to seriously practice mechanical engineering should consider the Master’s Degree as the normal professional degree, and should plan their program with the expectation of spending a fifth year obtaining the Master’s Degree. In this regard, the student is referred to those sections in this bulletin in which the graduate programs are described. The Department of Mechanical Engineering will accept the above listed program, regardless of the use of the electives, as adequate preparation for graduate school, assuming, of course, the student meets the minimum scholastic standards for graduate school. However, students anticipating doing graduate work in other departments or universities should consult with their advisers so that deficiencies will not be encountered. In particular, students anticipating graduate work in the Department of Aeronautics and Astronautics should request to be assigned to an adviser from the Department of Aeronautics and Astronautics so as to develop an undergraduate program compatible with the graduate program in that Department.

Reserve Officers’ Training Corps

Reserve Officers’ Training Corps are maintained at Stanford by the Army, the Navy, and the Air Force (see Aerospace Studies, Military Science, and Naval Science in this bulletin). The individual requirements of each of the Aerospace Studies, Military Science, and Naval Science programs are so varied in the nature of specialized work that the appropriate sections of this bulletin should be consulted in preparing an engineering program including ROTC. All services offer a two-year program and the Army and Navy have four-year programs. The additional units of specialized work under a four-year program, together with those of accredited engineering programs, will normally require from one to three extra quarters of study depending upon individual circumstances. ROTC students staying for more than one extra quarter may often arrange their programs to include an overseas campus and one or even two sequences of graduate courses in their major while working for their baccalaureate degrees. Residence credit toward an advanced degree, however, cannot be obtained until the baccalaureate degree program has been completed.

Comprehensive Five-Year Programs

For students who desire a broader training than any included in one of the regular four-year programs of the School of Engineering, comprehensive five-year programs leading to the degree of Bachelor of Science in Engineering are offered. These programs are worked out in cooperation with the students concerned, and can usually include one or two sequences of graduate courses in the student’s field of major interest.

Second Bachelor’s Degree

Students receiving the Bachelor of Science degree in Engineering who wish to broaden their undergraduate education by
additional work in other fields, such as in the humanities and social sciences, may also qualify for a Bachelor of Arts degree (see the description of “Second Bachelor’s Degrees” at the front of this bulletin). By careful planning it is possible to receive the second degree after three additional quarters of study, although more than one additional academic year may be required.

DUAL DEGREE PROGRAMS

Stanford University cooperates with certain liberal arts colleges (presently Central College at Fayette, Missouri, Claremont Men’s College, the College of Idaho, Hastings College, Knox College, Pacific Lutheran College, George Pepperdine College, The University of Redlands, Whittier College, and Willamette University) in providing a program that leads to concurrent award of the A.B. degree by the college and the B.S. degree by Stanford. These programs comprise three years of study at the college, with some emphasis on mathematics and science, followed by two years of study of engineering at Stanford. Inquiries may be addressed to the Dean of Engineering at Stanford, or to the above listed colleges. See description of Four-Two program under “Master of Science.”

GRADUATE ADMISSION

Application for admission with graduate standing in the School should be made to the Director of Admissions of the University; applications are reviewed by the appropriate department of the School before admission is authorized. Inquiries may be addressed to the Dean of Engineering or to the Executive Head of the department. While most graduate students have undergraduate preparation in an engineering curriculum, it is feasible to enter from chemistry, physics, or mathematics (see, for example, the Four-Two program described under “Master of Science”).

GRADUATE REGISTRATION

New graduate students should consult the faculty member who acts as adviser in the student’s field (or departmental secretary) on registration day of his first quarter for advice in planning his program and for instruction on departmental procedures.

GRADUATE PROGRAMS OF STUDY

Departments and divisions of the School offer graduate curricula, as follows:

AERONAUTICS AND ASTRONAUTICS

Aerodynamics
Aeroelasticity
Aerospace Systems Design
Aircraft, Missile, and Spacecraft Structures
Astrodynamics
Dynamics and Vibrations
Elastic and Inelastic Solids
Experimental Methods
Guidance and Control
Life Sciences-Biomechanical Engineering
Physical Gas Dynamics
Plasma Dynamics and Magnetohydrodynamics
Propulsion
Solid Mechanics and Wave Propagation
Structures and Materials

APPLIED MECHANICS

Continuum Mechanics
Elasticity, Plasticity, Viscoelasticity
Shells and Plates
Experimental Stress Analysis
Instabilities, Elastic, Plastic, Dynamic
Stress Waves in Solids
Rigid Body Dynamics, Space Dynamics
Vibrations, Linear and Nonlinear
Fluid Mechanics, Boundary Layers, Heat Transfer
Dynamic Optimization and Control
Mathematical System Theory
Stochastic System Analysis

BIOENGINEERING

(See Master of Science and Doctor of Philosophy programs.)

CHEMICAL ENGINEERING

Applied Reaction Kinetics
Chemical Catalysis
Interfacial Stability
Heat, Mass, and Momentum Transfer in Laminar or Turbulent Flow Systems
Non-Newtonian Fluid Mechanics
Optimization Theory
Process Dynamics and Control
Thermodynamics
Transport Properties of Fluids
Turbulence Theory

CIVIL ENGINEERING
Construction Engineering
Engineering-Economic Planning
Transportation
Water Resources
Hydraulic Engineering
Fluid Mechanics
Hydrology
Materials
Nuclear Hydrology and Water Engineering
Sanitary Engineering
Soil Mechanics and Foundations
Structural Engineering

ELECTRICAL ENGINEERING
Bioelectronics
Computers and Control
Electromagnetic Theory and Microwaves
Electronic Circuits and Devices
Network Theory
Plasmas
Quantum Theory
Radioscience
Solid State Materials and Properties
Systems Theory

ENGINEERING SCIENCE
Bioengineering
Nuclear Engineering

ENGINEERING-ECONOMIC SYSTEMS
Intersystem Relationships
Decision Analysis
System Analysis
Automation
Simulation
Long Range Planning

HYDROLOGY
(See separate section in this bulletin.)

INDUSTRIAL ENGINEERING
Computer Utilization
Economic Systems Planning
Management Systems Design
Systems Analysis and Synthesis

MATERIALS SCIENCE
Physical Metallurgy
Physical Ceramics
Photoelectronic Properties of Solids
Defects in Crystalline Solids and Their Effects on Electronics, Magnetic and Mechanical Properties
Magnetic Behavior of Solids
Mechanical Behavior of Solids and Structures
Thermodynamics of Solids
Reaction Kinetics in Solids
Phase Transformation in Solids
Crystal Growth
X-Ray and Electron Diffraction and Spectroscopy Applied to the Study of Solids

MECHANICAL ENGINEERING
Thermodynamics
Heat Transfer
Fluid Mechanics
Engineering Design
Product Design
Nuclear Engineering

OPERATIONS RESEARCH
Mathematical Programming
Probabilistic Models

SPACE SCIENCE
(See separate section in this bulletin.)
For further details see the department sections following.
Related aspects of particular areas of graduate study are commonly covered in the offerings of several departments and divisions. Graduate students are encouraged, with the approval of their departmental advisers, to select courses in departments other than their own to achieve a broader appreciation of their field of study. For example, most departments in the School offer courses concerned with properties of materials, and a student interested in an aspect of materials engineering can often gain appreciable benefit from the related courses given by departments other than his own.

MASTER OF SCIENCE
The degree of Master of Science (M.S.) is conferred on graduate students in engineering according to the University regulations stated elsewhere. A minimum of 45 units is usually required in M.S. programs in the School of Engineering. However, the presentation of a thesis is not a School requirement in Engineering.

Four-Two program — Superior students
who hold baccalaureate degrees in physical science with adequate physics and mathematics may complete the requirements for an M.S. in engineering at Stanford (in most of the curricula above) in two academic years (six quarters). Programs will be worked out in consultation with an adviser from the department in which the student wishes to study. Further information may be obtained from the department in which the student is interested.

Engineering Science—The degree of Master of Science is available to those who wish to follow a program of study emphasizing the scientific background of some aspect of engineering (e.g., Bioengineering, Nuclear Engineering) and which does not conform to a normal graduate program in a department. Such programs usually combine work in several engineering departments, or contain an unusual amount of mathematics, physics, chemistry, statistics, etc. Application for admission to Engineering Science should be made to the Dean of Engineering. Only students with superior academic records will be accepted for this type of program.

Engineer

The degree of Engineer is awarded at the completion of a comprehensive two-year program of graduate study. It is intended for those who desire more graduate training than can be obtained in a Master of Science program but who do not wish to undertake a Ph.D. program. The program of study must satisfy the student’s department and usually includes 90 units of which at least 60 must be devoted to advanced or graduate study in the major subject or intimately allied subjects. The presentation of a thesis is required. The University regulations for the Engineer degree are stated in the section “Degrees” in this bulletin, and further information will be found in the department sections following.

Doctor of Philosophy

Programs leading to the degree of Doctor of Philosophy are offered in each of the departments and divisions of the School. Special Ph.D. programs which may be interdepartmental in nature (e.g., Bioengineering, Nuclear Engineering) can be arranged. See “Graduate Division Special Programs” section in this bulletin. University regulations are given in the section “Degrees” in this bulletin, and further information will be found in the department sections following. Inquiries concerning programs in Bioengineering should be addressed to the Dean of the School of Engineering or the Dean of the School of Medicine.

Fellowships and Assistantships

Each department and division of the School of Engineering awards a number of fellowships, research assistantships, and teaching assistantships each year. Information and application blanks may be obtained from the head of the appropriate department or division.

Engineering

Associate Professors: Frederick W. Crawford, William D. Nix, Alan S. Tetelman, William Weaver, Jr.
Assistant Professors: Craig R. Barrett, Bruce B. Lusignan
Lecturer: Karl H. Vesper

The “Engineering” courses deal with subject areas within the basic sciences of engineering which are, in their essential nature, broader than the confines of any particular branch of engineering. Included in this category are the engineering courses which appear in the list of “Courses Normally Taken by All Engineering Students.”

Courses

1. The Engineer in Modern Society—Lectures, demonstrations, experiments, case studies, and field trips planned to show what engineering is and what engineers do. Creativity, design, and decision making. Open to any student.

2 units, Aut (R. J. Smith) TTh 11 and T 1:15–3:05

5. Introduction to Programming—(Enroll in Computer Science 5.) This course is an introduction to a specific procedure-oriented
language for describing computational processes. There will be practice in solving elementary problems on Stanford's automatic digital computers. The course is limited to freshman and sophomore students. Prerequisites: Mathematics 0 or equivalent.

3 units, Aut (Oakford) MWF 11
Win (Oakford) TTh 2:15-3:30
Spr (——) MWF 11

9. Introduction to Engineering Design—Exercises in engineering design stressing problem definition, conception of alternative solutions, criteria for evaluation. Presentation of solution in forms suitable for understanding and execution by others. Emphasis on spatial thinking and graphic communication. Orthographic projection and elements of descriptive geometry. Illustration of the engineering design process through practical examples.

4 units, Aut (Fuchs, Staff) lec. MW 1:15-2:05; lab. MW 2:15-4:05 or TTh 2:15-4:05
Win (Fuchs, Staff) lec. and lab MW 1:15-4:05


2 units, Aut (Weaver, Staff) TTh 9
Win (Weaver, Staff) TTh 9
Spr (Weaver, Staff) TTh 9

12. Engineering Mechanics (Dynamics) — Principles of dynamics of particles and rigid bodies, application to typical mechanical problems. Should be taken before the end of the junior year. Prerequisites: 11 and Mathematics 43.

4 units, Aut (Weaver, Staff) TThF 11
Win (Weaver, Staff) TThF 11
Spr (Weaver, Staff) TThF 11
Sum (Weaver, Staff)

15. Mechanics of Materials — Analysis of stresses and deformations in linear elastic materials: simple tension, compression, shear, torsion, and flexure; introduction to combined stresses and instability. Prerequisites: 11 and Mathematics 43.

3 units, Aut (Gere, Staff) MWF 10
Win (Gere, Staff) MWF 10
or 11
Spr (Gere, Staff) MWF 10
Sum (Gere, Staff) MTThF 10

21. Mechanics of Fluids — Statics and dynamics of incompressible fluids; viscosity, fluid friction, laminar and turbulent flow in pipes. Laboratory exercises. Should be taken before the end of the junior year. Enrollment limited to 64 students per quarter. Prerequisite: 12.

4 units, Aut (Vennard, Staff) MWF 9;
Win (Vennard, Staff) MWF 9;
lab. M or T, 1-4 or 3-6
Spr (Vennard, Staff) MWF 9 or 10;
lab. M or T 1-4 or 3-6
Sum (Vennard, Staff) MTThF 8;
lab. F 2-5

31. Elementary Engineering Thermodynamics—Introduction to the basic principles of continuum thermodynamics from elementary considerations of the microscopic nature of matter. Determination by thermodynamics of the relations between properties of matter. Application of thermodynamic principles in analysis of engineering systems. Laboratory demonstrations and discussions one afternoon per week. Prerequisites: Mathematics 44, and Engr. 21 (or concurrent Engr. 21), Physics 57 is desirable.

5 units, Aut, Win (Reynolds, Staff)
MTWF 8; lab. one afternoon
1:15-4:05 by arrangement
Spr (Reynolds, Staff) MTWF 11;
lab. one afternoon 1:15-4:05 by arrangement
Sum (Reynolds, Staff) MTWThF 9; lab. one afternoon by arrangement


41. 4 units, Aut (Staff) MWF 9;
2-hour problem session
Win (Staff) MWF 10;
2-hour problem session
Spr (Staff) MWF 9;
2-hour problem session
42. 4 units, Aut (Staff) MWF 10;  
   2-hour problem session  
Win (Staff) MWF 9;  
   2-hour problem session  
Spr (Staff) MWF 10;  
   2-hour problem session  
Sum (Staff)  
   MTWTh 9, and one hour  
by arrangement

41A. Laboratory I—To accompany 41.  
1 unit, Aut, Win, Spr (Lusignan) one  
3-hour lab. by arrangement

42A. Laboratory II—To accompany 42.  
1 unit, Aut, Win, Spr, Sum (Lusignan) one  
3-hour lab. by arrangement

50. Introductory Science of Materials—Introduction to the physical basis of the mechanical, electrical, and magnetic behavior of solids. Electron theory, imperfections in solids. Relations between structural features and properties. Prerequisite: Mathematics 23 or 43.  
3 units, Aut (Barrett, Nix, Tetelman)  
   MWF 9  
Win (Barrett, Nix, Tetelman)  
   MWF 11  
Spr (Barrett, Nix, Tetelman)  
   MWF 10  
Sum (-----) MTWTh 11

60. Engineering Economy — A special course offered to a limited number of freshman engineering students. Will satisfy School of Engineering requirements for Engr. 161.  
3 units, Aut (Ireson, Staff) MWF 10

101. Engineering Casewriting — Emphasizes (1) close examination of current engineering procedures in a company and (2) writing to exacting standards. Students visit local firms (contacts arranged by instructor) and describe engineering problem situations by writing cases for use as exercises in other courses. Enrollment limited.  
3 units, Win (Vesper) by arrangement

3 units, Aut (Cannon) MWF 11  
   Win (Waldron) MWF 11

161. Engineering Economy—Economic decision making for engineering alternatives. Use of compound interest and depreciation calculations to compare the relative economy of both technical investments and plant operating procedures before and after Federal income taxes. Simple decision making in the face of uncertainty as to possible damage or economic obsolescence. Open to those who have 90 units of credit and to others by permission.  
3 units, Aut (-----) MWF 8 and 10  
   Win (-----) MWF 9 and 11  
Spr (-----) MWF 9 and 11  
Sum (-----) TWThF 8

3 units, Win (Staff) MWF 9

172. Nuclear Chemistry—Properties of nuclei and radioisotopes; nuclear reactions; fission, fusion, reactors and accelerators; radiation detection and measurement; radiation safety; radiation chemistry, radio-tracers, radioactivation analysis, and their applications. Prerequisites: Chemistry 3 or 5, Mathematics 23, or Physics 57.  
3 units, Win (P. Kruger) TTh 11

175. Nuclear Measurements Laboratory — Principles and techniques of radiation detection and measurement: ionization chambers, proportional, Geiger-Muller and scintillation detectors, solid state detectors; statistical analysis of counting; beta and gamma spectrum analysis; radiation safety. Prerequisite: concurrent 171, or 172, or consent of instructor.  
3 units, Aut, Win (Staff) lab. one afternoon  
by arrangement

176. Radiochemistry Laboratory—Nuclear reactions, radiochemical separations, radioactivity genetics, radioisotope production,
neutron activation analysis and flux measurements; nuclear fission, radiotracers in physical chemistry and engineering. Prerequisites: 172 or 175 or consent of instructor.

3 units, Spr (Staff) Th 1:15 and one lab. by arrangement

181A,B,C. Seminar in Resource Strategy—The application of modern science and technology to the problems of newly developing nations. Analysis of technological needs, evaluation of resources, design of an optimum plan of development. Prerequisite: junior standing and consent of instructor.

2 units, each quarter (Smith) by arrangement

199. Special Studies in Engineering—Special studies, laboratory work, or reading under the direction of a faculty member. By permission only.

1 or more units, any quarter (Staff) by arrangement

207. Introduction to Astrophysics I: Solar-Terrestrial Relations—Origin and characteristics of the solar wind. Magnetosphere and bow wave; radiation belts; aurorae. Phenomena caused by solar flares: interplanetary shock waves; geomagnetic storms; Forbush effect. Prerequisite: Physics 220, or E.E. 243B, or A.A. 285A, or equivalent.

3 units, given 1969–70


3 units, given 1969–70


3 units, given 1969–70

210. Space Science and Astrophysics Seminar—Discussion of research problems and current literature in space science and astrophysics with contributions by faculty, students and outside specialists.

1 unit, Aut, Win, Spr (Staff) by arrangement

211. The Laboratory Plasma—Methods of forming laboratory plasmas and measurement of their properties. Collision processes, velocity distributions, the Boltzmann transfer equation, concepts of temperature and pressure, nonequilibrium velocity distributions. Macroscopic averages of the Boltzmann equation. D.C. and r.f. breakdown and avalanche phenomena, the effect of a magnetic field, the positive column at low pressure and medium pressure, ambipolar diffusion, the plasma sheath, wave propagation in infinite and in bounded plasmas. Prerequisite: E.E. 243 or equivalent.

3 units, Aut (F. Crawford) alternate years, given 1968–69

212. Experimental Plasma Physics I—Lecture course which, together with 212A is intended to introduce the student to selected basic plasma phenomena with emphasis on the production and characteristics of d.c. and r.f. discharges, and plasma diagnostics using d.c., r.f. and optical methods. Prerequisite: 211 or E.E. 354 or M.E. 251 or A.A. 285A, or permission of instructor.

2 units, Win (Staff)

212A. Experimental Plasma Physics Laboratory I—Experimental work to accompany 212. Concurrent registration in 212 required.

2 units, Win (Staff) by arrangement

213. Experimental Plasma Physics II—Continuation of 212. Prerequisites: 212 and 212A.

2 units, Spr (Staff)

213A. Experimental Plasma Physics Laboratory II—Continuation of 212A. Prerequisites: 212 and 212A. Concurrent registration in 213 required.

2 units, Spr (Staff) by arrangement

214. Plasma Physics Seminar—Discussion of research problems and current literature in plasma physics is offered by faculty, students, and outside specialists.

1 unit, Aut, Win, Spr (Staff)

235A,B. Space Systems Engineering—40-50 students, mostly from engineering, but also from business, political science, law, and education, form a team to prepare a pre-
liminary design study of a space system. In previous years, a Mars Exploration System, an International Weather System, and a Communications and Educational Satellite System for Underdeveloped Countries have been designed. About 20 invited speakers from government and industry give the class the necessary background information. At the end of the second quarter, the class gives a verbal briefing to government and industry representatives and publishes a final report on the system.

235A. 3 units, Win (Lusignan) TTh 1:15-3:05 and two hours by arrangement
235B. 3 units, Spr (Lusignan) TTh 1:15-3:05 and two hours by arrangement

296A. 1 unit, Win (Skilling) Th 3:15-5:05
296B. 1 unit, Spr (Skilling) Th 3:15-5:05

296A, B. Seminar on Engineering Teaching—Weekly presentations and discussions for guidance of those who intend to make a profession of engineering teaching. Open to all. Graduate students from all engineering departments are especially invited. Seminars in the winter quarter will relate particularly to teaching, and in the spring quarter particularly to the other responsibilities of the teacher such as administration, curricula, publication of books and papers, research, and professional duties. 296A need not precede 296B. A student completing this seminar may elect to receive either a letter grade or a +.

296A. 1 unit, Win (Skilling) Th 3:15-5:05
296B. 1 unit, Spr (Skilling) Th 3:15-5:05

299. Special Studies in Engineering—Special studies, laboratory work, or reading under the direction of a faculty member. By permission only.

1 or more units, any quarter (Staff)
by arrangement

AERONAUTICS and ASTRONAUTICS

Emeriti: Irmgard Flügge-Lotz, Alfred S. Niles, Elliott G. Reid (Professors)
Executive Head: Nicholas J. Hoff
Associate Executive Heads: Daniel Bershad-er, Jean Mayers
Professors: Holt Ashley, Daniel Bershad-er, John V. Breakwell, Robert H. Cannon, Jr.,

Chi-Chang Chao, Nicholas J. Hoff, Krishnamurty Karamcheti, Erastus H. Lee, Jean Mayers, Howard S. Seifert, Milton D. Van Dyke, Walter G. Vincenti

Associate Professors: Max Anliker, I-Dee Chang, Charles R. Steele
Assistant Professors: Donald Baganoff, Benjamin O. Lange.


Offerings and Facilities

This Department prepares the student for a professional career in aeronautics and astronautics by offering a comprehensive program of graduate teaching and research. Particular emphasis is given to structural, aerodynamic, guidance and control, and propulsion problems of aircraft, missiles and spacecraft. The teaching program provides courses leading to the degrees of Master of Science, Engineer, and Doctor of Philosophy. The Department of Aeronautics and Astronautics offers two curricula for the Master of Science and Doctor of Philosophy—one oriented toward the sciences, the other emphasizing engineering. Specific programs are available in the following areas:

Aerodynamics
Aeroelasticity
Aerospace Systems Design
Aircraft, Missile and Spacecraft Structures
Astrodynamics
Biomechanics
Dynamics and Vibrations
Elastic and Inelastic Solids
Experimental Methods
Guidance and Control
Physical Gas Dynamics
Plasma Dynamics and Magneto-aerodynamics
Propulsion
Solid Mechanics and Wave Propagation
Structures and Materials

Requirements for all degrees include courses on basic topics in aeronautics and astronautics, as well as in mathematics, physics and applied mechanics.
The current research activities cover a number of advanced fields, with special emphasis on:

- Thermal Effects in Structures—Structural Problems of Reentry
- Creep Effects in Structures
- Stability and Postbuckling Behavior of Thin Shells
- Maximum Strength Analysis of Structures
- Static and Dynamic Behavior of Sandwich and Composite Structures
- Continuum Mechanics—Viscoelasticity
- Dynamic Response—Wave Propagation
- Unsteady Aerodynamic Theory
- Aerospace Vehicle Dynamics—Aeroelastic Phenomena
- Viscous Flow—Boundary-Layer Theory
- Hypersonics—Mathematical Methods of Fluid Mechanics
- High Temperature Gas Dynamics—Nonequilibrium Flow
- Plasma Dynamics and Magnetoaerodynamics
- Attitude Control and Instrumentation for Space Vehicles
- Astrodynamics—Orbit Perturbations
- Contactor Control—Optimal Control
- Biomechanics—Hemodynamics

**FACILITIES FOR INSTRUCTION AND RESEARCH**

The work of the Department is centered in the Daniel Guggenheim Aeronautical Laboratory and the William Frederick Durand Laboratory.

The Guggenheim Laboratory houses classrooms, aerodynamic laboratory and offices. In the laboratory are a 7.5-foot subsonic wind tunnel (with six-component balance, propeller dynamometer, pressure recording and scaling equipment, etc.) which, with special equipment, is being used, at present, for instructional experiments. A zirconium-oxide pebble-heater blow-down tunnel is available for investigations of a structural nature in a hypersonic airflow at total temperatures up to 3,000 degrees Fahrenheit.

The Durand Laboratory houses a library, research laboratories for structures and gas dynamics, a machine shop, and faculty offices. The library contains a collection of text and reference books, reports of the principal aeronautical research organizations, and files of scientific journals and technical periodicals. The structures laboratory is set up with particular emphasis on equipment suitable for the study of structural behavior at high temperatures. Quartz-lamp heaters are used to produce rapid changes of temperature both in space and time. Ovens capable of maintaining temperatures of 1,000 degrees Fahrenheit are also used to investigate the effects of creep on stress distribution and structural stability. The gas dynamics laboratory includes a 15-inch arc-discharge wind tunnel for the investigation of hypersonic flows at Mach numbers up to 20 and total temperatures up to 14,000 degrees Fahrenheit. The aerophysics laboratory houses a high-pressure shock tube for the purpose of quantitative study of shock-heated plasmas. It is located in a nearby building which contains all the laboratories of the Interdepartmental Institute for Plasma Research. Measurement of dense plasmas is accomplished by high-speed rotating mirror optical interferometry. A student fluid dynamics laboratory includes a supersonic jet; a small low-turbulence air flow apparatus; hot wire equipment and apparatus for studying hydrodynamic sound production; a shock tube; optical equipment, including schlieren and interferometer apparatus; ballistic free-flight equipment; line reversal flame temperature measurement equipment; and associated control and recording devices.

In addition, there are three small laboratories adjacent to the Guggenheim Laboratory, two of which are being used for experimental work in the field of gas dynamics (experimental determination of the velocity distribution in gases with the aid of lasers) and one for guidance-and-control instrumentation. A plastic-structures research laboratory, located in close proximity to the campus, was recently completed.

A new building for aerospace engineering and sciences is nearing completion and is to be occupied during 1968–69. The building will house the most advanced in research and teaching facilities and will concentrate in one complex the Department of Aeronautics and Astronautics as well as the activities of other engineering departments allied in space exploration and aerospace technology.

The Stanford Computation Center has installed an IBM System 360/Model 67 timesharing system with many remote terminals conveniently located. This service will be
readily available for Departmental pro-
grams.

The Department also sponsors a student branch of the American Institute of Aeronautics and Astronautics which holds periodic meetings and conducts visits to nearby research, military, and industrial facilities.

**ADMISSION AND REGISTRATION**

To be eligible for registration in the Department a student must have received the Bachelor's degree in engineering, physical science, mathematics, or an acceptable equivalent. Students with an aeronautical engineering background should be able to qualify for the Master's degree in three quarters of work at Stanford. Students with a Bachelor's degree in physical science, mathematics, or other areas of engineering may find it necessary to take certain prerequisite courses, which may lengthen the time required to obtain the Master's degree.

**PROGRAMS OF STUDY**

**MASTER OF SCIENCE**

The University's basic requirements for the Master's degree are outlined in the section "Degrees" in this bulletin. The following are Departmental requirements.

**Engineering Curriculum** — To secure the recommendation of the Department for the Master's degree with a specialization in aero- and astronautical engineering, a candidate must complete a minimum of 24 units of basic course work in aerodynamics, propulsion, aircraft and missile structures, dynamics, control, and experimentation. In addition, 6 units of mathematics are required, plus a minimum of 12 units of advanced courses in any aerospace engineering area of specialization interest to the candidate, and 3 units of approved electives, making in all 45 units of course work. A detailed list of the requirements can be obtained upon request to the Department. No thesis is required. A minimum grade point average of 2.75 is expected.

**Science Curriculum** — To secure the recommendation of the Department for the Master's degree with a specialization in aero- and astronautical sciences, a candidate must complete 24 units of basic course work to be selected from the same areas as listed for the

**ENGINEER**

The University's basic requirements for the Engineer degree are outlined in the section "Degrees" in this bulletin. The following are Departmental requirements. In addition to satisfying the Department's requirements for the Master's degree, the candidate must complete: (1) 24 units of approved electives, of which 9 units shall be in mathematics and the remainder usually selected from one of the following fields: (a) Aerodynamics, (b) Aircraft, Missile and Spacecraft Structures, (c) Astronautics, (d) Guidance and Control, (e) Physical Gas Dynamics, (f) Plasma Dynamics and Magnetoo-aerodynamics, (g) Experimental Methods, (h) Propulsion; (2) 15 units of Engineer's Thesis; and (3) 6 units of free electives. A list of courses currently accepted as approved electives can be obtained upon request to the Department. Candidates for the degree of Engineer will be expected to have a minimum grade point average of 3.00 for work in courses beyond those required for the Master's degree.

**DOCTOR OF PHILOSOPHY**

The University's basic requirements for the Ph.D. degree are outlined in the section "Degrees" in this bulletin. The following are Departmental requirements.

Qualification for candidacy for the Doctor's degree is contingent on the passing of an examination given by the Department. This examination is given twice a year (autumn and spring) and should be taken as soon as possible in the second graduate year. A general list of subject matter for which the candidate is held responsible in the examination is available from the Department. Research on the doctoral dissertation may not be started formally prior to passing the examination. The candidate's study program must fulfill the requirements for the Master's degree or their substantial equivalent. Beyond the Master's degree, a total of 90 ad-
ditional units of work is required, including a minimum of 45 units of courses.

Engineering Curriculum — The 45 units beyond the Master's degree are chosen by the candidate and his adviser from a list of courses which can be obtained upon request to the Department and must include 12 units of advanced mathematics.

Science Curriculum — The 45 units beyond the Master's degree are chosen by the candidate and his adviser from a list of courses which can be obtained upon request to the Department and must include 15 units of advanced mathematics.

FELLOWSHIPS AND RESEARCH ASSISTANTSHIPS

Both fellowships and research assistantships are available to qualified graduate students. Fellowships sponsored by the National Science Foundation, National Aeronautics and Space Administration, Ford Foundation, Douglas Aircraft Company, Stanford University, and Affiliates of Stanford University in Aeronautics and Astronautics carry grants up to $4,000 for the nine-month academic year. NSF and NASA training grants have been allocated for students who plan to become doctoral candidates in the aerospace sciences. Students who already have a Master of Science degree or equivalent may qualify for half-time research assistantships. The minimum stipend for half-time research assistants, on the basis of 20 hours of work per week, is $250 per month, plus tuition for 9 units per quarter. Research assistants are normally given the opportunity of full-time summer employment at the rate of $500 per month. They may use their work as the basis for a thesis and for University credit toward an advanced degree.

Further information and application forms may be obtained upon request to the Department.

UNDERGRADUATE PROGRAM IN AERONAUTICS AND ASTRONAUTICS

A study program in aeronautics and astronautics leading to the Bachelor of Science degree is available in the form of 23 units of Aeronautics and Astronautics courses taken as free electives in the Mechanical Engineering Department.

COURSES

100. Introduction to Aeronautics and Astronautics — Explanation of principles of flight and propulsion. Concise discussion of aerodynamic performance, trajectories outside the atmosphere, and the problems of reentry. Remarks on the history of aeronautics and astronautics.

3 units, Aut (McIntosh) TTh 11:00–12:15


3 units, Aut (Cannon) MWF 11
Win (Manning) MWF 11

129. Colloquium on Life Science Problems in Space Exploration — Basic physiological principles with special emphasis on the cardiovascular, respiratory, metabolic and endocrine systems and their responses to space-related environmental stresses. Aspects of life-support protective systems and habitability of spacecraft. Human behavior under flight conditions. Recent advances in space biology will be included. A letter grade option exists for undergraduates who so elect at enrollment; a grade of + indicates satisfactory work for all others.

2 units, Win (Ogden, Billingham, Feller, Huertas, Klein, Young) W 2:15–4:05

131. Experimentation in Aeronautics and Astronautics — Introductory treatment of principles of experimentation; importance of experiment in aeronautics and astronautics; theory of measurements, scaling problems, dynamic response, and evaluation and reporting of results; laboratory experiments
selected from the various fields of aeronautics and astronautics.

3 to 4 units, Win (Bershader, Baganoff)
lec. Th 1:15–2:05; lab. Th 2:15–5:05
or T 1:15–4:05

188. Experimental Plasma Physics I—(Enroll in Engineering 212.) Lecture course which, together with 188A, is intended to introduce the student to selected basic plasma phenomena, with emphasis on the production and characteristics of direct current and radio frequency discharges, and plasma diagnostics using direct current, radio frequency, and optical methods. Prerequisite: 285A or E.E. 452 or M.E. 251, or permission of instructor.

2 units, Win (Staff)

188A. Experimental Plasma Physics Laboratory I — (Enroll in Engineering 212A.) Experimental work to accompany 188. Concurrent registration in 188 required.

2 units, Win (Staff) by arrangement

192. Vector Analysis and Cartesian Tensors with Applications—Vector algebra. Differentiation and integration of scalar and vector fields. Gradient, divergence and curl. Theorems of Gauss, Stokes, and Green. Cartesian index notation. Cartesian tensors: algebra and calculus. Dyadics. Selected applications. (All students taking graduate courses in Aeronautics and Astronautics are expected to be familiar with the basic subject matter covered in this course.) Prerequisite: Mathematics 44.

3 units, Aut (Karamcheti) MWF 8

200A. Engineering Analysis of Flight Vehicles—Examination of the dynamic, aerodynamic and structural considerations which govern the configuration of flight vehicles, including atmospheric cruisers, boosters and entry gliders. Examples of analytical methods will be taken from current development projects, and the roles of testing, digital computation and analogue simulation will be explained. Vehicle equations of motion. Definition and study of questions of performance, dynamic performance, static stability, dynamic stability, and control. Behavior of lift, drag and thrust. Special performance problems. Static stability and trim. Prerequisite: A.A. 100 (may be taken concurrently) or equivalent.

3 units, Aut (Ashley) MWF 9


3 units, Win (Ashley) MWF 9

200C. Engineering Analysis of Flight Vehicles—Continuation of 200B: Further consideration of currently interesting examples of flight vehicle analysis, with emphasis on derivation of the associated theory, and on the role of digital computation. Cases treated might include, but not be limited to, the following: subsonic cruising performance, supersonic transport drag and noise reduction; booster trajectory optimization, interceptor dynamics, lifting reentry, variable geometry, and problems of flight at very low speed. Prerequisite: 200B.

3 units, Spr (Ashley) MWF 9


3 units, Spr (Ashley) MWF 9


3 units, Win (———) MWF 1:15

207. Mechanics of Viscous Flow — (Enroll in A.M. 244.) Navier-Stokes equations. Very slow motion. Boundary layer equations for incompressible laminar flow. Energy equation for thermal boundary layers; compressible laminar boundary layer flow. Stability of boundary layer flows; introduction to tur-
bulent flow. Prerequisites: 206A and either 210A or M.E. 238A, or permission of the instructor.

3 units, Spr (———) MWF 11


3 units, Aut (Chang) MWF 10

210A. Fundamentals of Compressible Flow—Fundamentals of the flow of a perfect gas from the standpoint of the aerospace engineer; basic thermodynamics; steady and unsteady one-dimensional flow; shock waves; simple expansion waves.

3 units, Aut (Vincenti) MWF 10

210B. Fundamentals of Compressible Flow—Continuation of 210A: Equations and some general results for steady and unsteady three-dimensional flows; exact solutions; irrotational homentropic motion; equations of the linearized theory; thin airfoil in steady subsonic and supersonic motion. Prerequisites: 210A (or M.E. 136 or M.E. 138A) and 192.

3 units, Win (Karamcheti) MWF 1:15

210C. Fundamentals of Compressible Flow—Continuation of 210B: Slender body of revolution in steady subsonic and supersonic motion; introduction to higher approximations; similarity rules; hodograph method; method of characteristics. Prerequisite: 210B.

3 units, Spr (Karamcheti) MWF 1:15

211A. Physical Gas Dynamics—The fundamentals of high-speed, high-temperature flow of a gas from the molecular point of view: molecular concepts and simple kinetic theory; equilibrium properties of gases and gas mixtures as obtained from kinetic theory, chemical thermodynamics, and statistical mechanics.

3 units, Win (Mitchner) MWF 2:15

211B. Physical Gas Dynamics—High-speed, high-temperature flow of gas mixtures in local thermodynamic and chemical equilibrium; physical and chemical basis of rate equations; flows with vibrational and chemical nonequilibrium. Prerequisites: 211A and 210B, or equivalent background.

3 units, Spr (Vincenti) MWF 2:15

211C. Physical Gas Dynamics—Kinetic theory of gases in translational nonequilibrium: concepts from statistical mechanics; Boltzmann equation; molecular encounters and related concepts; conservation equations; H-theorem; Maxwell distribution; Chapman-Enskog method; viscosity and thermal conductivity for different molecular force models; selected applications. Prerequisites: 192 and acquaintance with basic equations of viscous flow, or consent of instructor.

3 units, Aut (Karamcheti) MWF 1:15

212. Gaskinetics—Gas dynamics based on kinetic theory: review of the theory for monatomic gas mixtures; introduction to the theory of polyatomic and reacting gases; boundary conditions at a solid-gas interface; outline of techniques for solving gasdynamic problems from the point of view of the Boltzmann equation, moment equations and model equations; discussion of selected specific problems such as Couette flow, boundary layer, free molecule drag and heat transfer, shock structure, and sound propagation; experimental methods. Emphasis is given to applications. Prerequisites: 211C and 207 (207 may be taken concurrently).

3 units, Spr (Karamcheti) MWF 9

214. Numerical Methods in Fluid Mechanics—Methods for numerical solution of gasdynamic equations in Eulerian and Lagrangian form. Applications include method of characteristics, method of integral relations, and other methods used to solve initial value problems for gases in equilibrium and non-equilibrium flow. Accuracy, stability, and programming complexity are considered.

2 units, Win (Lomax) TTh 9

215. Radiative Gas Dynamics—Interaction of radiative transfer and fluid motion: fundamentals of radiative transfer of energy in gases; conservation equations of radiative gas dynamics; types of approximations; solution of simple flow problems. Prerequisite: 211A or consent of instructor.

3 units, Win (Vincenti) MWF 2:15
216. Hypersonic Flow Theory — Aerodynamics at supersonic speeds so great that nonlinearities are essential: improvements on linearized theory; Newtonian, shock-layer, and other methods for blunt bodies; blast-wave theory and self-similar solutions; viscous interaction; numerical methods. Prerequisite: Completion of or concurrent registration in 210C. 3 units, Spr (Van Dyke) MWF 8, alternate years, given 1968-69

217. Aerodynamic Heating — Selected topics pertaining to hypervelocity flight: fully viscous and diabatic shocklayers; mass addition; mass and energy transport—Stefan-Maxwell relations for multicomponent gas mixtures; importance of thermal, pressure, and (electrically) forced diffusion—order of magnitude arguments, electrostatic approximation; charge separation—applicability of the Navier-Stokes equations to non-neutral gas, the linear flux argument; radiative transfer—nongrey gases, the vacuum ultraviolet, atomic lines, line broadening; flow field solutions—the stagnation region, flow about various body shapes; convective and radiative heating, coupling effects. 2 units, Win (Van Dyke) TTh 8

218. Symmetry and Similitude in Fluid Mechanics — Cylindrical and conical flow fields; separation of variables; local solutions; homogeneous and self-similar solutions; group properties; phase-plane methods; behavior at infinity; applications to problems of ideal, viscous, and compressible flow. Prerequisites: 207 or 210C, Mathematics 106, and Mathematics 132; or consent of instructor. 3 units, Win (Van Dyke) MWF 9

219. Perturbation Methods in Fluid Mechanics — Examples of perturbation solutions; asymptotic expansions; series and iteration schemes; singular perturbation problems; the method of matched asymptotic expansions; Lighthill’s and other techniques; application to flow problems; improvement of series. Prerequisites: 207 or 210C, Mathematics 106, and Mathematics 132; or consent of instructor. 3 units, Aut (Van Dyke) MWF 9

220. Physical Measurements in Fluid Dynamics — Lecture-laboratory course on experimental aerodynamics emphasizing compressible flow; measurement of flow variables and comparison with theoretical predictions for steady and non-steady gas motions; selected experiments dealing with application of pitot techniques, schlieren, interferometry, and hot-wire anemometry to jet flows; introductory shock-tube experiments; ballistic free-flight measurements; line reversal measurement of flame temperature. Prerequisite: 210A or equivalent. 3 units, Spr (Bershader) lec. T 2:15-3:05; lab. Th 2:15-4:05

221. Introductory Reentry Aerophysics — Description of the high temperature airflow environment surrounding hypervelocity vehicles. Application of equilibrium thermodynamics and thermostatistics to the analysis of dissociating and ionizing shock waves. Introduction to boundary layer flows, leading to a formulation of the hypersonic stagnation-point heat transfer problem. Concepts of gaskinetic collision phenomena as the basis for determination of transport properties. Fundamentals of thermal radiation in gases, with discussion of the absorption coefficient for air, and simple examples of radiative transport. 3 units, Aut (Bershader) T 2:15-3:05 and Th 2:15-4:05

225. Stochastic Processes in Aeronautics — Applications of probability theory to problems in aeronautics: analysis of a linear system subject to a random forcing function; correlation function; power spectrum; difference and differential equations for probability densities; Fokker-Planck equation with application to diffusion; Ehrenfest model and approach to thermodynamic equilibrium; random walk model for vibrational relaxation. 3 units, Aut (Baganoff) MWF 2:15

226. Astronomy for Physical Scientists — Introduction to stellar, galactic, and extragalactic astronomy: stars, galactic structure, the interstellar medium, galaxies. Stellar evolution: star formation, energy generation, the H-R Diagram. Origin and general properties of the planetary system. Techniques and technical problems. 2 units, Spr (Herbig) S 10-12

227A. Introduction to Space Physics I — Introduction to selected topics of geophysics and astrophysics with emphasis on conditions in the solar and terrestrial atmospheres and in interplanetary space. Solar-terrestrial
relations, sun spots, flares, solar wind, geomagnetic storms, ionospheric disturbances. 

Prerequisite: Physics 55.

2 units, Aut (Spreiter) MW 2:15

227B. Introduction to Space Physics II — Fundamentals of the motion of charged particles in electric and magnetic fields, geomagnetics and plasma physics with application to theories of Van Allen belts, solar phenomena, interplanetary plasma streams and shock waves, geomagnetic storms and wave propagation in the upper atmosphere and interplanetary space. Prerequisite: 227B or equivalent.

2 units, Win (Spreiter) MW 1:15

229A. Physiology for Engineers and Physical Scientists — Bioenergetics, circulation, renal function, gaseous exchanges. Neuro-muscular system, central nervous system, special senses and endocrine system. Emphasis will be placed on a quantitative approach and aspects of current interest in biomedical engineering. Prerequisite: Graduate standing or permission of instructor.

5 units, Win (Sapirstein) MWF 4:30-6:00

229B. Cardiovascular Dynamics and Respiration — Generation and transmission of pulse waves and sounds in cardiovascular systems. Pulsatile flow in arteries. Dispersion, stability and reflection phenomena in blood vessels. Regional blood flow, flow measurements, radiologic, isotropic and other techniques. Discussion of problems and experiments pertaining to manned space flight. Prerequisite: 229A or permission of instructors.

3 units, Spr (Anliker, Chang, Ogden, Sapirstein) MWF 5

230. VTOL Aircraft—Various VTOL configurations are examined and evaluated as regards their appropriate mission application. Dynamic and aerodynamic characteristics of the classical rotor, as the optimum hovering device, are considered. Combinations of rotor-wing and direct thrust-wing configurations are analyzed for high speed VTOL aircraft.

2 units, Spr (Carlson) S 10–12

235A,B. Space Systems Engineering—(Enroll in Engineering 235A,B.) 40–50 students, mostly from engineering, but also from business, political science, law, and education, form a team to prepare a preliminary design study of a space system. In previous years, a Mars Exploration System, an International Weather System, and a Communications and Educational Satellite System for Under-developed Countries have been designed. About 20 invited speakers from government and industry give the class the necessary background information. At the end of the second quarter, the class gives a verbal briefing to government and industry representatives and publishes a final report on the system.

235A. 3 units, Win (Lusignan) TTh 1:15–3:05 and two hours by arrangement

235B. 3 units, Spr (Lusignan) TTh 1:15–3:05 and two hours by arrangement


3 units, Win (__) MWF 9


239A. 3 units, Aut (Kalman) TTh 11:00–12:15

239B. 3 units, Win (Kalman) TTh 11:00–12:15

239C. Dynamic Optimization (deterministic). (Enroll in O.R. 348.) Mathematical theory of optimization problems with respect to dynamical systems: unified treatment of necessary conditions via convexity methods, Pontryagin’s theorem, theory of the second variation. Prerequisites: 239A,B or equivalent or consent of instructor.

3 units, Aut (Kalman) TTh 2:45–4:00, alternate years, given 1968–69
239D. Dynamic Optimization (stochastic). (Enroll in O.R. 349.) Optimal prediction and filtering theory of linear systems; realization of theory of random processes, nonlinear prediction, plus some recent research results. Prerequisites: 239A, B or equivalent or consent of instructor.

3 units, Aut (Kalman) TTh 2:45-4:00, alternate years, given 1969-70

240A. Aircraft and Missile Structural Analysis — Elements of one- and two-dimensional linear and nonlinear elasticity theory; reductions to strength of materials theory; strength of thin-walled structures in bending, shear, torsion; introduction to shear lag and diagonal tension behavior; potential energy principle, direct and indirect methods of the calculus of variations, deflection analysis of straight and curved beams, effects of nonuniformity of loading and sectional properties. Prerequisite: C.E. 114.

3 units, Aut (Mayers) MWF 11

240B. Aircraft and Missile Structural Analysis — Potential energy principle applied to elastically restrained beams and plates, stability of plates in compression and shear; Galerkin procedure and applications; complementary energy principle, redundant structures, bending and torsion of nonuniform plates, shear lag; Reissner's variational principle and applications. Prerequisite: 240A.

3 units, Win (Mayers) MWF 2:15

240C. Aircraft and Missile Structural Analysis — Further applications of the variational principles to nonlinear behavior of beams, plates and shells; thermal effects; orthotropic and sandwich structures; dynamic behavior of structural elements in bending and torsion; finite difference and matrix methods, influence coefficients. Prerequisite: 240B.

3 units, Spr (Mayers) MWF 10

241A. Introduction to Structural Systems Synthesis and Analysis — The interaction of structures relative to aerodynamics, propulsion, guidance, payload and ground support for a given mission; the factors (system characteristics or operational requirements) involved in systems synthesis; assignment of priorities to system characteristics; effect of nondisciplinary constraints (e.g., producibility, economy, maintainability, simplicity, safety) on design aimed at system optimization; preliminary design philosophy; parametric studies and configuration evolution; environments (cumulative and noncumulative) and basic loads (static, dynamic, aerodynamic and thermal); structural analysis versus stress analysis; weight control; structural materials; factors and margins of safety; allowable stresses; design of experiments; prototype testing; behavior predictions versus experiment; design flexibility and growth factor; reliability and structures. Prerequisite: fundamental knowledge of elementary structures, aerodynamics and vibrations.

3 units, Aut (——, Staff) MWF 2:15

241B, C. Introduction to Structural Systems Synthesis and Analysis — Application of the elements of structural systems synthesis and analysis to the preliminary design of a hypothetical manned aircraft or guided missile system subject to compromise between cost, schedule and performance; utilization of advanced structural analysis theory, methods and techniques to effect design definition of major structural assemblies taking into account the influences on structural idealizations of fabrication processes, tolerances, material anisotropy, eccentricities, misalignments, subsystem interactions, and substructure joints and fittings (boundary conditions). Prerequisites: 240C and 241A; 243B, 248B and Computer Science 136 recommended.

241B. 3 units, Win (Staff) MWF 11

241C. 3 units, Spr (Staff) MWF 2:15


3 units, Aut (Anliker) TTh 7:35-8:50

242B. Classical Dynamics II — Brief review of the dynamics of systems of particles and rigid bodies. Generalized coordinates, holonomic and nonholonomic mechanical sys-

3 units, Spr (Anliker) TTh 7:35–8:50


3 units, Aut (Anliker) MWF 8

243B. Theory of Vibrations — Eigenvibrations of beams, membranes, plates and shells. Effect of rotatory inertia and shear on the lateral vibrations of beams. Approximate methods of evaluating the eigenfrequencies and the dynamic response of continuous systems in general. Parametric resonance, Floquet theory and Hill's equation. Introduction to statistical methods and their application to the dynamic response of linear systems to random excitation. Prerequisite: 243A.

3 units, Win (Anliker) MWF 8

244A. Aeroelasticity — Presentation of the field of aeroelasticity from a unified viewpoint applicable to all types of flight vehicles. Dynamics of continuous elastic structures, with typical examples in one and two dimensions. Normal coordinates. Introduction to aeroelastic operators and unsteady aerodynamics. Forced response, static and dynamic eigenvalues of a simplified system. Prerequisite: 104 or equivalent.

3 units, Win (Ashley) MWF 3:15

244B. Aeroelasticity — (Continuation of 244A.) Aeroelastic analysis of representative one-dimensional and two-dimensional structures. The unrestrained elastic flight vehicle. Modern unsteady aerodynamic theory. Special topics of current interest, with emphasis on aerodynamic operators. Prerequisite: 244A.

3 units, Spr (Ashley) MWF 3:15


3 units, Aut (Chao) MWF 9


3 units, Win (Chao) MWF 10

245C. Advanced Theory of Elasticity—(Enroll in A.M. 204.) Topics from stress concentration, crack propagation, contact stress, thermal stress, instability and finite deformation, selected in relation to current research. Prerequisites: 245B or equivalent.

2 units, Spr (Chao) TTh 1:15–3:05


3 units, Win (Flugge) MWF 9


3 units, Spr (Flugge) MWF 9


3 units, Spr (Flugge) MWF 9

248B. Spacecraft Structural Analysis—(Continuation of 248A.) Application of general shell theory in lines-of-curvature coord-

3 units, Win (Steele) MWF 1:15


3 units, Spr (Steele) MWF 1:15, alternate years, given 1968–69

248D. Spacecraft Structural Analysis—Continuation of 248B. Linear and nonlinear stability of shells. Snap-through of shallow domes. Buckling of cylindrical, conical and spherical shells. Recent developments. Prerequisite: 248B.

3 units, Spr (Hoff) MWF 1:15, alternate years, given 1969–70

249. Modern Developments in Shell Theory—Elements of differential geometry and tensors. The shell theory obtained from a reduction of the equations for a three-dimensional continuum. The alternate theory of a Cosserat surface. General behavior of solutions. Prerequisites: 245A and either 247 or 248A.

3 units, Spr (Steele) TTh 11:00-12:15, alternate years, given 1969–70

250A. Thermal Effects in Structures—Heat transfer from boundary layer to surface of structure in supersonic airflow, analysis of distribution of temperature in structure. Prerequisite: C.E. 114 or equivalent.

2 units, Win (Hoff) TTh 10


2 units, Spr (Chao) TTh 10


2 units, Win (Chao) TF 3:15


2 units, Spr (Chao) TF 3:15

255. Creep Effects in Structures—Phenomenon of creep; its effect on distribution of stresses in structural elements; buckling caused by creep; concept of structural safety in presence of creep.

3 units, Aut (Hoff) MWF 11, alternate years, given 1968–69

260A. Aircraft and Missile Structures Laboratory—Systems and associated techniques required by transducers, recorders and controllers commonly used in both static and dynamic aeronautical structural testing are studied; techniques required in ground servicing and maintenance inspection are indicated; electrical resistance wire gauges, semi-conductor gauges, displacement, velocity and pressure transducers, thermocouples, thermistors, heat-flow discs, radiation transducers, accelerometers, oscillographic and strip chart recorders, scanners, analog-to-digital converters, and digital data systems.

3 units, Aut (——) lec. T 9; lab. TTh 2:15-4:05

260B. Aircraft and Missile Structures Laboratory—Continuation of 260A; visual and optical techniques, including thermally sensitive paints; strain transfer techniques, photo grid methods, interferometric methods, optical projectors and comparators; brittle lacquers, photoelastic coating tests, analog and model techniques; nondestructive test systems for field use including liquid penetrant, eddy-current, magnetic and ultrasonic tests.

3 units, Win (——) lec. T 9; lab. TTh 2:15-4:05

260C. Aircraft and Missile Structures Laboratory—Continuation of 260B; radiant, inductive and convective heat systems; automatic test systems for heat problems of high speed flight and pressure cabin loadings.

3 units, Spr (——), lec. T 9; lab. TTh 2:15-4:05

Three-dimensional analyses. Brittle lacquers. Static and dynamic strain measurements. Prerequisite: C.E. 114.

3 units, Win (Hetényi) TTh 8 and one lab. by arrangement

271. Automatic Control of Space and Aerospace Vehicles — Basic dynamics of vehicles in three dimensions. The environment of space and aircraft vehicles, and its role in their control. Passive attitude control, such as gravity gradient, magnetic, solar, spinning, etc. Sensors and active control moment devices (jets, reaction wheels, gyro, magnetic devices, etc.). Space vehicle control system synthesis and techniques. Aircraft stability and response. Automatic flight-control-system synthesis. Prerequisites: 242A or A.M. 222, and E.E. 163H.

3 units, Spr (Cannon) TTh 11:00-12:15


3 units, Win (Cannon) TTh 11:00-12:15


3 units, Spr (Lange) TTh 11:00-12:15

274. Numerical Methods in Flight Mechanics — The application of digital computation to the solution of the trajectory problems of powered and coasting aerospace vehicles at speeds up to several times orbit speed; the problems associated with the boost and entry phases of space flight with applications to such areas as trajectory selection to maximize payload or to minimize heating and acceleration loads and the determination of the guidance and navigation requirements during these critical phases. Selected homework problems illustrative of the methods essential to current vehicle performance analysis will be run on the IBM 360-67 digital computer. Prerequisite: some knowledge of matrix algebra desirable.

3 units, Aut (Lange) MWF 8


275A. 3 units, Win (Lange) MWF 8

275B. 3 units, Spr (Lange) MWF 8

278A. Mathematics of Trajectory Optimization — Trajectory error propagation; guidance; performance improvement; the maximum principle; rendezvous and interception in flat space; constraints on control variables and on state variables; singular arcs; examples from economics. Steepest descent methods; neighboring optimum control; 2nd variation and the Jacobi condition; dynamic programming. Prerequisite: E.E. 363A or equivalent.

3 units, Aut (Breakwell) MWF 11

278B. Mathematics of Trajectory Optimization — Differential games; pursuit games; games of kind and degree; games with incomplete information. Tests for singular arcs; optimal transfer in an inverse-square field; transfer between neighboring non-coplanar orbits. Stochastically optimal guidance. Prerequisite: 278A.

3 units, Win (Breakwell) MWF 10

279A. Space Mechanics — Orbits of near-earth satellites and interplanetary probes; transfer and rendezvous; decay of satellite orbits; influence of earth's oblateness. Stabilization by gravity gradient. Prerequisite: 242A or equivalent.

3 units, Win (Breakwell) MWF 12

279B. Advanced Space Mechanics — Motion in earth-moon space; expansion-matching for lunar and interplanetary trajectories. Hamilton-Jacobi theory; canonical perturbation theory; application to non-linear oscillations; 2nd order perturbation of earth satellite orbits; methods of Brouwer, Carne, finkel and Vinti-Izsak; critical inclination
resonances with longitudinal harmonics; lunar orbiters. Prerequisite: 279A.
3 units, Spr (Breakwell) MWF 11

280A. Rocket Propulsion Fundamentals — Introductory rocket dynamics; fundamentals of nozzle flow; use of performance parameters; thermochemical calculation of performance; heat transfer in rockets; basic design procedures. Prerequisites: Thermodynamics or elementary gas dynamics equivalent to M.E. 132 or M.E. 138A, or consent of instructor.
3 units, Win (Seifert) MWF 11

280B. Advanced Chemical Propulsion — Topics selected from hybrid rockets, air-breathing propulsors, combustion, gas-particle flows, ablative heat transfer and thrust vector control. Prerequisite: 280A.
2 units, Spr (Seifert, Staff) TTh 9

280C. Chemical Rocket Design and Technology — Comparative study for liquid and solid rockets of system optimization, liquid propellant feed systems, solid propellant charge design; plus nozzle, heat transfer, structural, thrust control, and ignition design problems of chemical rockets. Prerequisite: 280A.
4 units, Spr (Seifert, Colahan, Freij, Sampson) TTh 11:00–12:15

281. Electric Propulsion — Ballistics of low-thrust, long-duration propulsion. Introductory theory of reaction propulsion by electrostatic, electrothermal, and electromagnetic means. Sources of electrical power in space. Prerequisite: Equivalent of 285A or E.E. 243, or consent of instructor.
3 units, Aut (Seifert) MWF 8, alternate years, given 1968–69

282. Nuclear Propulsion — Nuclear energy systems applied to rocket propulsion. Reactor design based on radioisotope, fission and fusion heat sources. Topics include material selection, heat transfer problems, control, effect of radiation environment, performance analysis. Prerequisite: 280A and equivalent of M.E. 171 or M.E. 271A.
3 units, Aut (Seifert) MWF 8, alternate years, given 1969–70

3 units, Win (Chang) MWF 10

3 units, Spr (Chang) MWF 11

286. Conducting Fluids in a Magnetic Field — Behavior of liquid metals and gas plasmas in electric and magnetic fields: Hartmann channel flow, shock waves, wakes, energy conversion. Primary emphasis on physical insight into processes of engineering interest; power generation, propulsion, flowmeters. Prerequisite: 284 or equivalent familiarity with plasma theory.
2 units, Aut (Griffith), WF 3:15

288. Experimental Plasma Physics II — (Enroll in Engineering 213.) Continuation of 188. Prerequisites: 188 and 188A.
2 units, Spr (Staff)
SCHOOL OF ENGINEERING

288A. Experimental Plasma Physics Laboratory II — (Enroll in Engineering 213A.) Continuation of 188A. Prerequisites: 188 and 188A. Concurrent registration in 288 required.

2 units, Spr (Staff) by arrangement

290. Problems in Aeronautics and Astronautics—Investigation, experimental or theoretical, of problems in aeronautics and astronautics. Offers opportunity to students to work in any field of special interest.

1 to 5 units, any quarter (Staff) by arrangement

291A. Linear Transforms and Their Applications to Engineering Problems I—Introduction to linear integral transforms: Fourier, Laplace, Hankel, Mellin transforms. Applications to boundary value problems in solid and fluid mechanics, heat conduction, wave propagation. Inverse transformation, contour integration, approximations. Methods of steepest descent and stationary phase. Prerequisite: Mathematics 106 (may be taken concurrently).

3 units, Win (Chao) T 9 and Th 9:00–10:40


3 units, Spr (Chao) T 9 and Th 9:00–10:40


3 units, Aut (Chao) MWF 3:15

294A. Introduction to Nonlinear Continuum Mechanics — (Enroll in A.M. 214A.) Definitions of general states of stress and deformation of continua. Discussion of constitutive equations, and influence of material symmetries. Applications of the theory with particular reference to finite elasticity. Prerequisite: 293 or 245A.

3 units, Win (Lee) TTh 11:00–12:15, alternate years, given 1969–70


3 units, Spr (Lee) MWF 10, alternate years, given 1969–70

295. Seminar in Solid Mechanics — (Enroll in A.M. 295.) Problems in all branches of solid mechanics. All Ph.D. candidates in solid mechanics are normally expected to attend. Registration for one unit of credit, without letter grade, is open to students having the Master's degree; a letter grade is given for students presenting talks.

1 unit, Aut, Win, Spr (Goodier, Hetényi, Lee) Th 3:15

296. Seminar in Fluid Mechanics—(Enroll in A.M. 296.) Problems in all branches of fluid mechanics. All Ph.D. candidates in fluid mechanics are normally expected to attend. Registration for one unit of credit, without letter grade, is open to students having the Master's degree; a letter grade is given for those students presenting talks.

1 unit, Aut, Win, Spr (Van Dyke, Vincenti) T 4:15

297. Seminar in Flight Control and Guidance—Problems in all branches of vehicle control, guidance and instrumentation. The major purpose of the seminar is to give students who are planning or engaged in thesis research an opportunity to become acquainted with the work of other researchers, both on and off the campus. Students engaged in or anticipating research activity in these areas normally attend. Others are invited. Registration for a unit of credit, without letter grade, is optional; a letter grade is given for students who make presentations.

1 unit, Aut, Win, Spr (Cannon) F 4:15

298. Seminar in Aerospace Technology — Engineering and management problems in the design, development and production of current and future aerospace systems. Guest lecturers. Regularly scheduled meeting the first Wednesday only of each month, with occasional special meetings. Registrants may accumulate one unit of credit without letter grade by attending at least eight lectures in three quarters.

1 unit, Aut, Win, Spr (Staff) W 4:15
299. Plasma Physics Seminar — (Enroll in Engineering 214.) Discussion of research problems and current literature in plasma physics offered by faculty, students and outside specialists.

1 unit, Aut, Win, Spr (Staff)


2 to 15 units, any quarter (Staff) by arrangement


2 to 15 units, any quarter (Staff) by arrangement

DIVISION of APPLIED MECHANICS

Emeriti: Irmgard Flügge-Lotz, Lydik S. Jacobsen, Stephen P. Timoshenko (Professors)

Executive Committee: Miklós Hetényi (Chairman), Wilhelm Flügge, James N. Goodier, Miklós Hetényi, Thomas R. Kane, Erastus H. Lee, Donovan H. Young (Professors)

Affiliated Faculty


Associate Professors: Max Anliger, Chi-Chang Chao, Byrne Perry, Cedric W. Richards, Robert L. Street, Alan S. Tetelman

OFFERINGS AND FACILITIES

Provisions are available for one, two, or three years of advanced training in solid and fluid mechanics, dynamics, and control theory leading to abundant career opportunities in industrial and governmental research establishments, in technical development in industry, and in the universities and institutes of technology. Programs of study are also offered for mechanical, aeronautical, and civil engineers who find that their work involves them in advanced mechanics, and necessitates a year or more of graduate study to acquire a deeper grasp of fundamental concepts and advanced methods.

The Timoshenko Center of Applied Mechanics provides facilities for special experimentation in conjunction with other Laboratories in the School of Engineering. Individual accommodation is provided for the work of each research student. Weekly seminar meetings acquaint the students with a great variety of subjects in their field, and give opportunity to practice speaking on a selected topic.

Government-sponsored research projects are also conducted in Applied Mechanics. Qualified students participate in these as research assistants, engaged in thesis research, in close working association with the faculty director and fellow students. The projects include original experimental and theoretical investigations in the strength and deformability of elastic and anelastic elements of machines and structures, vibrations and nonlinear dynamics, mathematical system theory, and the flow dynamics of liquids and gases.

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

Applied Mechanics operates exclusively on the graduate level and requires the B.S. degree for admission. Suitable preparation for graduate study can be found in the undergraduate curriculum of Engineering Science, and the supplementary requirements of the Department of Civil Engineering and the Department of Mechanical Engineering.

MASTER OF SCIENCE

The University’s basic requirements for the Master’s degree are discussed in the section “Degrees” in this bulletin. The following are Applied Mechanics requirements.

To secure the recommendation of Applied Mechanics for the Master’s degree, a candidate must include a minimum of 6 graduate units in each of the four sections: (1) Advanced Dynamics, (2) Elasticity and Plasticity, (3) Fluid Mechanics, and (4) Mathematics. (Candidates who have a strong interest in Control Engineering may be allowed
to substitute appropriate Electrical Engineering courses for one of the sections "(2)" and "(3)." Similarly, candidates strongly interested in the mechanical behavior of materials may be allowed to substitute appropriate Materials Science courses for one of the sections "(1)" and "(3)" above.) In addition to these 24 units of required courses, the program calls for a minimum of 12 units in approved electives and 9 units in free electives, making in all 45 units of course work. No thesis is required. In all of this work a minimum grade point average of 2.75 is required.

The program assumes that, at the time of admission, the student is adequately prepared for graduate study in Applied Mechanics, particularly as to Mechanics of Materials, Ordinary Differential Equations, and Dynamics. Otherwise the student will be required to remedy the deficiency by taking appropriate courses during his graduate study. In this case more than the three quarters of residence normally required to complete the program may be necessary.

ENGINEER

The University's basic requirements for the degree of Engineer are discussed in the section "Degrees" in this bulletin. A minimum grade point average of 3.00 is required in courses. The program of courses and thesis are arranged in consultation with the student's adviser, and require the approval of the Executive Committee of Applied Mechanics. The requirements for the M.S. degree (see above) must be met.

DOCTOR OF PHILOSOPHY

The University's basic requirements for the Ph.D. degree are discussed in the section "Degrees" in this bulletin. The requirements of Applied Mechanics include qualifying oral examinations early in the second year of graduate study, and the presentation of a satisfactory program after consultation with the faculty member who will direct the dissertation research. Preparation for research usually requires that this second year be devoted mainly to courses. The requirements for the M.S. degree (see above) must be met. The language requirement of the Graduate Division must be fulfilled by either German or Russian.

FELLOWSHIPS AND ASSISTANTSHIPS

University Fellowships are open to all (prospective) graduate students. See "Student Aid Funds" in the Information Bulletin obtainable from the Registrar. In addition, several special fellowships and assistantships are offered. Information and application forms (due March 1) may be obtained through the Secretary of Applied Mechanics.

COURSES


3 units, Aut (Young) MWF 8


3 units, Aut (Chao) MWF 9


3 units, Win (Chao) MWF 10


2 units, Win (Goodier) TF 3:15

203B. Stress Waves in Solids—Continuation of 203A. Application in impact, explosive loadings, seismology. Effect of high speed moving loads. Similarity solutions. Recent developments. Prerequisite: 203A.

2 units, Spr (Goodier) TF 3:15

204. Advanced Theory of Elasticity—Topics from stress concentration, crack propagation, contact stress, thermal stress, instability and finite deformation, selected in relation...

3 units, Win (Hetényi) TTh 8 and one lab by arrangement

206A. Elastic-Plastic Instabilities—Instabilities of structural elements under steady or sudden loading. Types of elastic buckling analysis in small and large deformations. Compressed bars. Dynamic instability within the longitudinal pressure wave. Prerequisites: C.E. 114 and Mathematics 130 or equivalents.

2 units, Aut (Goodier) TTh 11, alternate years, given 1968-69

206B. Elastic-Plastic Instabilities—Continuation of 206A. Lateral and torsional buckling of bars. Frequencies and critical rotational speeds under destabilizing loads. Compressed plates and shells. Prerequisite: 206A.

2 units, Win (Goodier) TTh 11, alternate years, given 1968-69

206C. Elastic-Plastic Instabilities—Continuation of 206B. Relation of dynamic buckling and nonlinear oscillation. Dynamic instabilities from impulsive loading into plastic range. Instability of plane and cylindrical free surfaces of solids in sustained plastic flow. Prerequisite: 206B.

2 units, Spr (Goodier) TTh 11, alternate years, given 1968-69


3 units, Win (Flügge) MWF 9


3 units, Spr (Flügge) MWF 9


3 units, Aut (Flügge) MWF 11


3 units, Aut (Chao) MWF 3:15


3 units, Aut (Flügge) MWF 10


3 units, Win (Flügge) MWF 11

214A. Introduction to Nonlinear Continuum Mechanics—Definitions of general states of stress and deformation of continua. Discussion of constitutive equations, and influence of material symmetries. Applications of the theory with particular reference to finite elasticity. Prerequisite: 210 or 202A.

3 units, Win (Lee) TTh 11:00-12:15 alternate years, given 1969-70

214B. Introduction to Nonlinear Continuum Mechanics—Application of theory of continua to nonlinear viscoelastic materials. Thermodynamic effects including thermoelastic coupling for nonlinear elasticity at finite strain. Prerequisites: 209 and 214A.

3 units, Spr (Lee) MWF 10, alternate years, given 1969-70

215. Mechanical Properties of Materials—Elastic behavior of materials and compos-
ites. Yield criteria; plastic instability. Viscoelastic behavior; dynamic effects; rheological models. Fatigue; creep. Prerequisite: C.E. 114.

3 units, Spr (Richards) TTh 10 and one lab. by arrangement

216A. Micro Structure and Mechanical Strength—Atomic structure of solids. Imperfections. Dislocation theory and applications to problems of yielding, strain hardening, recovery, recrystallization, creep, fiber composites.

3 units, Aut (Tetelman) TTh 10 and T 11


3 units, Win (Tetelman) M 2:15–4:05 and W 2:15–3:05


3 units, Aut (Flugge) MWF 2:15

218A. Advanced Theory of Viscoelasticity—Equivalent mathematical representations of stress-strain relations for linear response and connections between them. Stress analysis problems for simple boundary conditions, mixed conditions, and consideration of moving boundaries. Temperature effects. Prerequisites: 202A, 217, and 250.

3 units, Win (——) MWF 2:15, alternate years, given 1968–69

218B. Advanced Theory of Viscoelasticity—Dynamic problems including wave propagation. Basic mathematical structure of the linear theory, conditions for uniqueness of solution. Variational principles. Prerequisite: 218A.

3 units, Spr (——) MWF 2:15, alternate years, given 1968–69

221. Dynamics—Partial rates of change of position and orientation. Generalized particle and rigid body kinematics. Generalized active and inertia forces for holonomic and nonholonomic systems.

3 units, Aut (Kane) T 2:15 and Th 9–11

222. Dynamics — Inertia properties, potential energy, dissipation functions, kinetic energy, virtual work. Lagrange's form of D'Alembert's principle, Lagrange's equations of motion.

3 units, Win (Kane) T 2:15 and Th 9–11

223. Dynamics — Initial value problems, constraint forces and forces of interaction, impulsive motions. Moment and energy integrals, Hamilton's canonic equations, canonic variables and transformations, the Hamilton-Jacobi partial differential equation, variation of parameters.

3 units, Spr (Kane) T 2:15 and Th 9–11

224. Rigid Body Space Mechanics — Description of orientation, angular velocity, and angular acceleration in terms of Euler angles, Euler parameters, and direction cosines. Forces acting on space vehicles. Attitude stability of satellites in circular and elliptic orbits. Gyroscopic devices, energy dissipation. Prerequisite: 222 or A.A. 242B.

3 units, Spr (Kane) T 2:15


3 units, Aut (Anliker, Staff) MWF 2:15


3 units, Win (Anliker, Staff) MWF 2:15

231. Nonlinear Oscillations — Derivation and classification of nonlinear differential equations governing various phenomena of mechanics. Phase plane trajectories and inte-
grals of the equations of motion of autonomous systems.

3 units, Aut (Kane) T 9–11 and Th 2:15


3 units, Win (Kane) T 9–11 and Th 2:15


3 units, Win (——) MWF 9


239A. 3 units, Aut (Kalman) TTh 11:00–12:15
239B. 3 units, Win (Kalman) TTh 11:00–12:15

239C. Dynamic Optimization (Deterministic)—(Enroll in Operations Research 348.) Mathematical theory of optimization problems with respect to dynamical systems: unified treatment of necessary conditions via convexity methods, Pontryagin's theorem, theory of the second variation. Prerequisites: 347A,B, or equivalent or consent of instructor.

3 units, Aut (Kalman) TTh 2:45–4:00; alternate years, given 1968–69

239D. Dynamic Optimization (Stochastic)—(Enroll in Operations Research 349.) Optimal prediction and filtering theory of linear systems; realization on theory of random processes, nonlinear, plus some recent research results. Prerequisites: 347A,B, or equivalent or consent of instructor.

3 units, Aut (Kalman) TTh 2:45–4:00; alternate years, given 1969–70


3 units, Aut (——) MWF 1:15


3 units, Win (——) MWF 11


3 units, Spr (——) MWF 9


3 units, Win (Perry) MWF 11


3 units, Spr (Perry) MWF 2:15

250. Mathematical Methods in Applied Mechanics — Development of the basic concepts of analytic functions and conformal mapping, and application to problems in several engineering disciplines. Use of the Laplace transform with particular emphasis on vibration and wave problems. Prerequisite: Mathematics 43 or equivalent.

3 units, Aut (——) MWF 11

3 units, Win (Street) MWF 8


3 units, Spr (Flügge) M 1:15 and TTh 8


2 units, Aut (Hetényi) TTh 10

270. Special Problems in Applied Mechanics — Directed study for graduate students on subject of mutual interest to student and a staff member. Student must find faculty sponsor before registering.

1 to 5 units, any quarter (Staff) by arrangement


3 to 6 units, Spr (Hetényi) by arrangement

295. Seminar in Solid Mechanics — Problems in all branches of solid mechanics. All Ph.D. candidates in solid mechanics are normally expected to attend. Registration for one unit of credit per quarter.

1 unit, Aut, Win, Spr (Goodier, Hetényi, Lee) Th 3:15

296. Seminar in Fluid Mechanics — Problems in all branches of fluid mechanics. All Ph.D. candidates in fluid mechanics are normally expected to attend. Registration for one unit of credit, without letter grade, is open to students having the Master's degree; a letter grade is given for those presenting talks.

1 unit, Aut, Win, Spr (Van Dyke, Vincenti) T 4:15

297. Seminar on the Theory of Systems— (Enroll in E.E. 360.) Discussion of research problems and current literature in the theory of systems as applied to control, communication, and computation by faculty, students, and outside specialists. Plus is given for attendance only; a letter grade is given to students presenting talks. All Ph.D. candidates in Controls and Systems Engineering are expected to attend. Prerequisite: E.E. 363A or equivalent.

1 unit, Aut, Win, Spr (Franklin, Staff) Th 4:15


Aut, Win, Spr (Staff) by arrangement


Aut, Win, Spr (Staff) by arrangement

CHEMICAL ENGINEERING*

Executive Head: David M. Mason

Professors: Andreas Acrivos, Michel Boudart, David M. Mason, Douglass J. Wilde

Assistant Professors: John E. Lind, Jr., Robert J. Madix

Lecturers: John M. Ausman, Pierre Van RysSELBERGHE

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

The B.S. Chemical Engineering program, supplemented with courses in chemistry, physics, mathematics, and engineering, provides a broad preparation for design, operation, and management in the chemical, biological, pharmaceutical, or aerospace industries, as well as for postgraduate research in Chemical Engineering leading to research positions in industry and to academic careers.

Transfer to Chemical Engineering from * The curriculum leading to the B.S. Degree in Chemistry is described elsewhere in this bulletin.
other engineering programs or from chemistry can be made without loss of time or credit during the first two years. Allowance of foreign language credit (12 units of German or 8 units of any other modern language) permits attendance at any of the overseas campuses with graduation at the end of the winter quarter of the fourth year, including one summer abroad. Nine hours of ROTC may be credited as elective by students to be commissioned upon graduation.

Two balanced programs of minimum requirements for graduation in 12 quarters are given below. Program 1 should be followed by Chemical Engineering majors or other Engineering majors who may wish to transfer to Chemical Engineering; Program 2, by those desiring to transfer from chemistry. Chemical Engineering 10 may be taken in the autumn of the third year by persons entering the program in their junior year or going overseas as sophomores.

Program 1 permits attendance at an overseas campus during the spring quarter of the second year and omission of the senior spring quarter. Necessary language courses for absence in the second year can be scheduled by taking History 1, 2, and 3 freshman year.

Program 2 allows attendance at an overseas campus during the autumn quarter of the third year and omission of the senior spring quarter. One must shift History 1–3 and Chemistry 121–123, filling out gaps with engineering courses. Detailed overseas programs are available from Chemical Engineering advisers.

PROGRAM 1:

| First Year |
| Subject | A | W | Sp |
| Course No. | | | |
| English 1, 2, 3. Freshman English | 3 | 3 | 3 |
| Engr. 9. Introduction to Engineering Design | 4 | — | — |
| Engr. 11. Engineering Mechanics (Statics) | — | — | 2 |
| Math. 41, 42, 43. Analytical Geometry and Calculus | 5 | 5 | 5 |
| Physics 51, 52, 53, 54. Mechanics and Electricity | — | 5 | 5 |
| General Studies | 3 | 2 | — |
| Totals | 15 | 15 | 15 |

| Second Year |
| Subject | A | W | Sp |
| Course No. | | | |
| Ch.E. 10. Introduction to Chemical Engineering* | — | — | 3 |

* May be deferred until autumn of third year.

PROGRAM 2:

| First Year |
| Subject | A | W | Sp |
| Course No. | | | |
| Ch.E. 10. Introduction to Chemical Engineering* | — | — | 3 |

* May be deferred until autumn of third year.
German 1, 2, 3. German (elective) 4 4 4
Math. 10, 11, 21. Calculus (long sequence) 3 3 3
Totals .......................... 14 14 15

**Second Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
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</thead>
<tbody>
<tr>
<td>Ch.E. 10.</td>
<td>Introduction to Chemical Engineering*</td>
<td>3</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Chem. 121, 122, 123. Organic Chemistry and Laboratory</td>
<td>4</td>
<td>6</td>
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<tr>
<td>History 1, 2, 3. Western Civilization</td>
<td>4</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Math. 22, 23. Calculus</td>
<td>3</td>
<td>—</td>
<td>3</td>
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<tr>
<td>Physics 51, 52, 53, 54. Mechanics and Electricity</td>
<td>—</td>
<td>5</td>
<td>5</td>
<td></td>
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<tr>
<td>General Studies</td>
<td>2</td>
<td>—</td>
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Totals .......................... 16 15 15

* May be deferred until spring or third year.

**Third Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
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<tbody>
<tr>
<td>Ch.E. 116A, B, C. Unit Operations Laboratory</td>
<td>1</td>
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<td>1</td>
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<tr>
<td>Ch.E. 120. Chemical Engineering Thermodynamics</td>
<td>—</td>
<td>3</td>
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<tr>
<td>Ch.E. 150. Chemical Reactor Design (or Ch.E. 128. Kinetics)</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td></td>
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<tr>
<td>Chem. 171, 173, 176. Physical Chemistry and Laboratory</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Engr. 11. Engineering Mechanics (Statics)</td>
<td>—</td>
<td>2</td>
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<tr>
<td>Engr. 161. Engineering Economy</td>
<td>—</td>
<td>3</td>
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<tr>
<td>Math. 24. Calculus</td>
<td>3</td>
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<tr>
<td>Math. 130. Differential Equations (Elective)</td>
<td>—</td>
<td>3</td>
<td>—</td>
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<tr>
<td>Physics 55, 56. Light and Heat</td>
<td>5</td>
<td>—</td>
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<tr>
<td>General Studies</td>
<td>—</td>
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Totals .......................... 15 15 16

**Fourth Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
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</thead>
<tbody>
<tr>
<td>Ch.E. 116D. Special Projects Laboratory</td>
<td>3</td>
<td>—</td>
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<tr>
<td>Ch.E. 160. Process Design or Ch.E. 190. Research</td>
<td>—</td>
<td>2</td>
<td>—</td>
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<tr>
<td>Engr. 9. Introduction to Engineering Design</td>
<td>4</td>
<td>—</td>
<td>—</td>
<td></td>
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<tr>
<td>Engr. 15. Mechanics of Materials</td>
<td>3</td>
<td>—</td>
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<tr>
<td>Engr. 41, 41A. Circuits and Electronics</td>
<td>—</td>
<td>—</td>
<td>5</td>
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<tr>
<td>Speech 20. Public Speaking</td>
<td>—</td>
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<td>3</td>
<td></td>
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<tr>
<td>General Studies</td>
<td>—</td>
<td>5</td>
<td>5</td>
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<tr>
<td>Electives*</td>
<td>5</td>
<td>3</td>
<td>3</td>
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Totals .......................... 15 14 16

* The total of 31 elective units must include 3 of the courses following: Ch.E. 121, 130A, 130B, 150, 155.

**Master of Science and Doctor of Philosophy**

The M.S. and Ph.D. degrees in Chemical Engineering are offered to students who are primarily interested in research or teaching. The University regulations for these advanced degrees are described in the section “Degrees” in this bulletin. The departmental requirements are summarized below.

**Basic Lecture Courses**—A minimum of 30 units of graduate lecture courses are required which may include the following areas: (a) chemical engineering, (b) mathematics, (c) physical chemistry or physics, (d) Colloquium, Ch.E. 280 plus assigned research seminars. A grade point average of at least 3.00 should be maintained in these courses.

**Additional Requirements for the M.S. Degree** — To obtain some experience in research, approximately 6 units of work in Graduate Chemical Engineering Research, Ch.E. 290, is normally taken by the M.S. candidate. Although no formal thesis is required, satisfactory completion of Ch.E. 290 involves a formal written discourse which must be approved by the research adviser and graduate committee. Students who have had post-graduate research experience in industry may petition to waive this requirement. Students continuing toward the Ph.D. degree will be eligible to receive the M.S. degree upon successful completion of the basic lecture courses and upon recommendation of the research adviser and approval of the graduate committee.

**Additional Requirements for the Ph.D. Degree** — A Ph.D. student, in addition to completing 30 units of the above basic graduate lecture courses, should normally take 30 additional units of lecture courses chosen from among the following five areas: (a) chemical engineering, (b) chemistry, (c) mathematics, (d) physics, (e) other engineering subjects. Three courses each in at least two of these areas are required and a grade point average of at least 3.20 or higher in
each quarter should be maintained. Undergraduate chemical engineering courses may not be included in fulfilling the 60-unit requirement without approval of the graduate committee.

During the last quarter of his first year of residence, a doctoral candidate is expected to present orally to the chemical engineering faculty a comprehensive review and analysis of a technical paper chosen by him in collaboration with the graduate committee. Upon satisfactory performance in this presentation the candidate will be permitted to proceed with his research and he should be prepared at this time to choose a research topic and research adviser.

A dissertation based on a successful investigation of a fundamental chemical engineering problem is required and the student will ordinarily register in Ch.E. 290 while pursuing his research. It is expected that in three calendar years or less of residence the candidate will have fulfilled all requirements for the Ph.D. degree including submitting his completed dissertation to his research adviser. Permission to continue beyond this period must be obtained by petition to the graduate committee.

Research investigations are currently being carried out in the following fields: applied chemical kinetics; adsorption and catalysis; fluid mechanics; heat and mass transfer; optimization theory; process dynamics and control; surface reactivity. Further detailed descriptions of research programs are available upon request to the Department.

FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships and assistantships are awarded each year. Application forms may be procured by writing the Department of Chemical Engineering. Applications should be made as early as possible and no later than March preceding the start of the academic year for which the award is to be made. By mutual agreement of the graduate schools of North America, the student need not commit himself to fellowship or scholarship award offers before April 15.

COURSES PRIMARILY FOR UNDERGRADUATE STUDENTS


3 units, Aut, Spr (Lind, Wilde) MWF 10

115A. Unit Operations: Fluid Flow—The energy balance and fluid friction in laminar and turbulent flow systems; dimensional analysis; flow measurement; pumps and compressors; phase separations based on fluid mechanics.

3 units, Aut (Staff) MWF 9

115B. Unit Operations: Heat and Mass Transfer—Heat transfer in forced and free convection; heat exchange equipment. Theory of molecular diffusion; transfer of material between phases; simultaneous heat and mass transfer; principles of design in processes involving absorption, humidification and drying.

3 units, Win (Lind) MWF 9

115C. Unit Operations: Separation Processes—Application of the equilibrium-stage concept to design of mass-transfer devices; phase relationships; countercurrent multi-stage extraction and distillation processes, simplified graphical and computer design methods; chromatographic separations, thermal diffusion, reverse osmosis, zone refining.

3 units, Spr (Acrivos) MWF 9

116A. Fluid Mechanics Laboratory—Experiments in fluid mechanics. To be taken concurrently with Ch.E. 115A.

1 unit, Aut (Staff) by arrangement

116B. Heat and Mass Transfer Laboratory—Experiments in heat and mass transfer. To be taken concurrently with Ch.E. 115B.

1 unit, Win (Lind) by arrangement

116C. Separations Processes Laboratory—Experiments in separations processes. To be taken concurrently with Ch.E. 115C.

1 unit, Spr (Acrivos) by arrangement

116D. Special Projects Laboratory—Student may choose from selected projects in gas phase chromatography, distillation, transport phenomena, kinetics, control, reactor design, and computer simulation.

3 units, Aut (Madix) TTh 1:15–5:00

120. Chemical Engineering Thermodynamics—The thermal properties of matter; the first law; the second law; general conditions
of equilibrium in thermodynamic systems; phase and chemical equilibrium. Applications to engineering systems.

3 units, Win (Madix) MWF 10


3 units, Spr (Lind) MWF 1:15


3 units, Spr (Boudart) MWF 10 (given 1969-70)

130A. Transport Phenomena: Momentum Transport — An introduction to the field of transport phenomena. Viscosity and the mechanism of momentum transport; velocity distributions in laminar flow; equations of change for isothermal systems; turbulent flow.

3 units, Aut (Staff) MWF 11

130B. Transport Phenomena: Energy Transport — Thermal conductivity and the mechanism of energy transport; unsteady-state conduction in solids and fluids in laminar flow; the equations of change for nonisothermal systems; heat transfer in fluids in turbulent flow. Radiative heat transfer.

3 units, Win (Mason) TTh 2:15

150. Chemical Reactor Design — Use of chemical rate theory and empirical relationships to develop expressions for use in the design of homogeneous and catalytic static and flow reactors. Characteristics of the batch reactor, steady-state tubular and backmix flow reactor, and semibatch reactor; choice of reactors for product discrimination; optimization of reactor design.

3 unit, Spr (Mason) TTh 2:15


3 units, Aut (Wilde) MWF 1:15

160. Chemical Engineering Process Design — Various topics in the design of chemical processes. Economic goals are developed and used to guide design decisions.

2 units, Win (Ausman) by arrangement

190. Undergraduate Chemical Engineering Research — Laboratory or theoretical work for undergraduate students on assigned chemical engineering problems. It is advisable for National Science Foundation Undergraduate Research Participants to enroll in this course.

(Staff) by arrangement

COURSES PRIMARILY FOR GRADUATE STUDENTS

202. Foundations of Optimization — Finding the optimum values of design or operating variables affecting a given economic objective. Classical indirect methods, constrained derivatives, nonlinear and generalized polynomial optimization, direct elimination and climbing techniques, partial optimization of serial, branching, and cyclic systems. The Optimum Principle in control theory.

3 units, Win (Wilde) MWF 11


3 units, Aut (Madix) by arrangement

204A. Kinetics of Chemical Processes — Elementary steps; sequences at the steady-state. Reaction Networks. Theoretical principles and application to the study of chain and catalytic reactions.

3 units, Aut (Boudart) MWF 10

204B. Kinetics of Chemical Processes — Study of individual processes from a quantitative kinetic standpoint.

2 units, Spr (Boudart) by arrangement

205. Transport in Reacting Systems — Physical problems of engineering interest where transport of mass, energy and momentum in multicomponent systems is accompanied by homogeneous or heterogeneous chemical reactions: absorption; temperature and con-
centration profiles in a porous catalyst; thermal properties of reacting fluids; combustion theories; electrode processes.

3 units, Aut (Mason) TTh 2:15


3 units, Win (Lind)

210. Viscous Flow Theory (with Applications to Heat and Mass Transfer)—An intensive course dealing with the fundamental principles of momentum, heat and mass transfer, and their application to processes of interest to chemical engineers. Derivation and analysis of the Navier-Stokes equations, the energy equation, and the equation for mass transport; creeping flow phenomena and Stokes law; the method of singular perturbation expansions; laminar boundary layer theory and applications to heat and mass transfer.

3 units, Aut (Acrivos) MWF 8

211. Hydrodynamic Stability—The application of hydrodynamic stability theory to diverse flow problems; buoyancy-driven and surface-tension-driven convection; the Orr-Sommerfeld equation; stability of parallel shear flow; non-linear theory and energy methods. Prerequisite: Ch.E. 210.

3 units, Win (Acrivos) MWF 8

230A. Thermodynamics of Irreversible Processes—A course dealing with the main developments in the thermodynamic treatment of irreversible chemical and electrochemical processes, transport processes, coupling phenomena, etc., with special emphasis on topics and methods of interest to students of chemical engineering, materials science, physical chemistry, biophysics, etc.

3 units Aut (Van Rysselberghe) by arrangement, alternate years, given 1969–70

230B. Thermodynamics of Irreversible Processes—Complements 230A; separately open to qualified students.

2 units Win (Van Rysselberghe) by arrangement, alternate years, given 1969–70

231. Electrochemical Concepts and Conventions—(Enroll in Chemistry 265.) A survey of the fundamentals of electrochemistry, sign conventions, etc.

1 unit, Win (Van Rysselberghe) by arrangement, alternate years, given 1969–70

232A. Electrochemical Thermodynamics and Kinetics — (Enroll in Chemistry 267.) Thermodynamic treatment of reversible cells, electrodes; irreversible phenomena in electrochemical systems, kinetics of electrode processes, polarization and overvoltage Tafel law, etc.; electrochemical procedures in physical, analytical chemistry.

2 units, Win (Van Rysselberghe) TTh 9, alternate years, given 1968–69

232B. Electrochemical Thermodynamics and Kinetics — (Enroll in Chemistry 269.) Continuation of 232A.

2 units, Spr (Van Rysselberghe) TTh 9, alternate years, given 1968–69

270–276. Seminar—Discussion of recent developments and current research in specialized fields. Open to qualified students with consent of instructor, units by arrangement. Aut, Win, Spr

270A,B,C. Fluid Mechanics (Acrivos)
271A,B,C. Adsorption and Catalysis (Boudart)
272A,B,C. Applied Chemical Kinetics (Mason) Th 4
274A,B,C. Optimization and Control (Wilde) T 4
275A,B,C. Selected Topics in Chemical Kinetics (Madix)
276A,B,C. Transport and Equilibrium Properties of Fluids (Lind)

280. Colloquium—Students enrolled in this course will be expected to attend the colloquia of the Department of Chemical Engineering as well as selected colloquia of other departments recommended by their advisers. Must be taken every quarter by candidates for advanced degrees in Chemical Engineering.

1 unit, Aut, Win, Spr (Staff)

290. Graduate Chemical Engineering Research—Laboratory or theoretical work for graduate students on chemical engineering problems leading to partial fulfillment of requirements for M.S. or Ph.D. degrees. Credits are not given until a satisfactory report is received for M.S. students or until a dissertation is approved for Ph.D. students. (Staff) by arrangement
CIVIL ENGINEERING

Emeriti: Eugene L. Grant, Alfred S. Niles, Stephen P. Timoshenko, James B. Wells, Harry A. Williams (Professors); Eugene V. Ward (Lecturer)

Executive Head: James M. Gere
Associate Executive Head: Joseph B. Franzini
Assistant Executive Head: Robert L. Street


Associate Professors: James Douglas, En Y. Hsu, Paul Kruger (on leave 1968-69), Henry W. Parker, Byrne Perry, Vincent J. Roggeveen (on leave 1968-69), Cedric W. Richards, Haresh C. Shah, Robert L. Street, William Weaver, Jr.

Assistant Professors: Norman H. Crawford (on leave 1968-69), Kaare Hoeg. Acting: George Tchobanoglous

Lecturers: John W. Alltucker, John A. Blume, Charles Curione, Paul Eller, Ben C. Gerwick, Jr., Grant P. Gordon, Clarence A. Grubb, Richard R. Kennedy, Robert R. Matheu, Bennet L. Raffin

OFFERINGS AND FACILITIES

The undergraduate Civil Engineering program provides a well-balanced program stressing the fundamentals common to all special fields of civil engineering. Elective units permit the student to make a further selection of general courses or, if his interests are well defined, to specialize slightly in a definite branch, such as construction, highways, hydraulics, public works administration, or structures. Well-equipped laboratories are available to supplement the lecture courses. At least one year of graduate study is becoming increasingly important in the preparation of engineers for professional practice and is strongly recommended. Students who contemplate advanced study at Stanford should discuss their plans with advisers early in their senior year.

The Civil Engineering Department, in collaboration with other departments of the University, offers graduate programs with particular strength in:

- Civil Engineering Materials
- Construction Engineering
- Engineering-Economic Planning
- Transportation
- Water Resources
- Hydraulic Engineering
- Hydromechanics
- Hydrology
- Nuclear Hydrology
- Sanitary Engineering
- Soil Mechanics and Foundations
- Structural Engineering

Research work under these programs is carried out in four major facilities — the newly renovated hydraulics laboratory, the George Havas Building which houses water quality, and sanitary laboratory facilities, the materials laboratory complex that houses the materials, concrete, and soil mechanics laboratories, and the Ryan Nuclear Laboratory. Office space is provided for most of the graduate students who are acting as research or teaching assistants.

The Program in Engineering-Economic Planning is directed toward preparation for planning and management positions in the public works area. One-year internships with the Federal Government are available for students in the advanced stage of a Ph.D. program.

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

In addition to the basic University requirements for the B.S. degree, students in civil engineering must complete the specific course requirements for all engineers and for Civil Engineering. Because of the considerable amount of time allotted to other than civil engineering in the undergraduate program, qualified students should seriously consider graduate study to equip themselves for advanced professional work.

MASTER OF SCIENCE

Programs are available leading to the degree of M.S. in civil engineering with special designation on the diploma as follows: Civil Engineering Materials, Construction, Engineering-Economic Planning, Hydraulic Engineering, Nuclear Hydrology, Sanitary En-
gineering, Soil Mechanics, and Structural Engineering. A general M.S. in civil engineering without special designation is also given. Detailed statements of the requirements for all Master's degrees and the specific course requirements for a degree with special designation may be secured by request to the Civil Engineering Department.

Students having undergraduate degrees in civil engineering normally can satisfy requirements for the M.S. degree with three quarters of graduate work of satisfactory quality. Students with undergraduate degrees in other fields may need longer residence for the M.S. degree as they will be required to make up specified basic undergraduate civil engineering subjects. A minimum grade point average of 2.75 is required for candidates to be recommended for the M.S. degree.

ENGINEER

A minimum of six quarters of graduate work including a thesis is required for the degree of Engineer in Civil Engineering. This degree is recommended for students planning a career in professional practice. The student normally should start his thesis in the first quarter of graduate work beyond the M.S. degree. Programs leading to the degree of Engineer are offered in the fields of specialization mentioned above. A minimum grade point average of 3.00 is required for candidates to be recommended for the degree.

DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is offered under the general regulations of the University as set forth in the section "Degrees" in this bulletin. This degree is recommended for those engineers who expect to engage in a professional career in research, teaching, or technical work of an advanced nature in the planning, design, and analysis of civil engineering systems. The Ph.D. program is rigorous and should be undertaken only by students with ability for independent work. It requires a minimum of three years (nine quarters) of graduate study, at least two years of which must be at Stanford.

The first year is represented by the M.S. program described above. The second year will be devoted partly to additional courses of graduate study and partly to the preliminary work toward a dissertation. The third and subsequent years will be applied to further course work and to the completion of an acceptable dissertation. Dissertation research in absentia is not permitted.

The program of study will be arranged by the prospective candidate at the beginning of the second year with the advice of a faculty committee whose members are nearest in the field of interest to that of the student. The chairman of the committee will serve as the student's pro tem. adviser until such time as a member of the faculty has agreed to direct the dissertation research. Insofar as possible the program of study is adapted to the interests and needs of the student within the framework of the requirements of the Department and the University. In the second year of graduate study the student is expected to pass the Departmental Qualifying Examination and to complete a substantial amount of the required foreign language work in order to be admitted to candidacy.

FINANCIAL ASSISTANCE

The Department maintains a large and continuing program of financial aid for graduate students. Fellowship or scholarship awards range from $500 to $5,000. Teaching assistantships (normally awarded only to Engineer and Ph.D. candidates) carry stipends for as much as one-third time work as teaching aides during the academic year. Research assistantships are also available. Engineer and Ph.D. candidates may be able to use research results as a basis for a thesis. Assistantships and other basic support may be supplemented by fellowship and scholarship awards. Continued support is generally available for further study toward the Engineer or Doctor of Philosophy degree subject to performance of student, availability of research funds, and requisite staffing of current projects. Detailed information may be obtained by writing to the Department of Civil Engineering.

UNDERGRADUATE COURSES

20. Elementary Surveying — Care and use of instruments; leveling; transit-tape and stadia traverses; topographic surveying; triangulation; plotting and adjusting of field data; computing of areas and topographic
mapping. (Limited to 36 students per section.)

3 units, Spr (Douglas) TTh 1:15–5:05


3 units, Aut (Vennard) TTh 9; lab. Th 1:15–4:05

114. Mechanics of Materials — Continuation of Engineering 15; combined loads and stresses, bending of curved bars, two-dimensional axially symmetric stress problems, strain energy, statically indeterminate systems, beams of two materials, special problems. Prerequisite: Engineering 15.

3 units, Aut (Richards) MWF 8 Spr (Young) MWF 11

116. Plain Concrete — Physical properties of concrete and its constituents. (Limited to 24 students per section.)

3 units, Aut, Win (Parker) W 1:15–5:05 and F 1:15–4:05

118. Materials Engineering — Mechanical behavior of solids; effects of stress distribution; dynamic and thermal effects; creep and relaxation; fatigue; statistical methods. Prerequisites: Engineering 15, Chemistry 2, and Engineering 50.

3 units, Win (Richards) TTh 10; lab. M 1:15–4:05

126. Advanced Surveying — Highway reconnaissance and location, horizontal and vertical curves, earthwork computations, photogrammetry, construction surveys, adjustment of instruments, city and land surveying, plane table, engineering astronomy. Prerequisite: 20.

4 units, Aut (Parker) TTh 11; lab. TTh 1:15–4:05

138. Specifications and Contracts — Principles of contract law as applied to civil engineering; varieties of construction contracts; specification writing; composition, arrangement of typical sets of specifications; legal problems in administering construction contracts; engineering ethics. Prerequisite: junior standing.

3 units, Aut (Oglesby) MWF 11 Win (Fondahl) MWF 11

144. Construction Estimates and Costs — Estimates, costs from viewpoint of contractor, construction engineer; details of estimating, emphasis on labor, material, equipment, overhead costs.

3 units, Aut (Douglas) MWF 10 Win (Parker) TTh 8 and M 1:15

145. Construction Equipment and Methods — Construction procedures, equipment; job planning and scheduling, selection and efficient use of excavation and hauling equipment, related problems. (May be taken concurrently with 150 or 151.)

3 units, Aut (Douglas) TTh 8; lab. M 1:15–4:05 Spr (Parker) TTh 9; lab. M 1:15–4:05

150. Transportation Engineering — Basic principles of planning and design of highways, airports, railroads, mass transit, etc. Trip generation, desires, capacity, geometric design, pavements, tracks, finance, economy, relationships with land use, interrelationships between modes, systems analysis. Prerequisite: junior standing.

3 units, Win (Oglesby) MWF 10

151. Highway Engineering — Soils, soil conditioners, asphalts, and concrete as highway materials; design and construction procedures for highway embankments, undercourses, and pavements. Prerequisite: junior standing.

3 units, Spr (Oglesby) TTh 8; lab. M 1:15–4:05

160. Water-Resources Engineering — Introduction to hydrologic measurements, runoff computations, groundwater, water law, reservoir design, frequency analysis, dams, spillways, conduits, economy of water-resources development. Prerequisite: 107.

4 units, Win (Franzini) MTThF 9


2 units, Win (Vennard) TTh 11

165. Hydrometeorology — Basic physical meteorology; general circulation, atmospheric heat budget, equation of state, precipitation,
types of weather systems; emphasis on practical application of meteorological techniques in hydrology.

2 units, Aut (Staff) TTh 10

#170. Man and His Environment—Man's interaction with the air, water, and land environment in which he lives; the role of engineering in environmental control of pollution for the health and welfare of mankind.

3 units, Spr (Eliassen) MWF 8

171. Environmental Radioactivity—Review of the sources of radioactivity in man's environment from space, nature, fallout, nuclear power, etc.; the transport of radioactivity throughout the biosphere; and the means of controlling the radiation hazard to man. Prerequisites: 170, or Chemistry 3, or Physics 57, or equivalent with consent of instructor.

3 units, Aut (Staff) TTh 11

172. Nuclear Science — (Enroll in Engineering 172.) Properties of nuclei and radioisotopes; nuclear reactions; fission, fusion, reactors and accelerators; radiation detection and measurement; radiation safety; radiation chemistry, radio-tracers, radioactivation analysis, and their applications. Prerequisites: Chemistry 3, Mathematics 23, or Physics 57.

3 units, Win (P. Kruger) TTh 11

175. Nuclear Measurements Laboratory— (Enroll in Engr. 175.) Principles and techniques of radiation detection and measurement: ionization chambers, proportional, Geiger-Muller, and scintillation detectors, solid state detector; statistical analysis of counting; beta and gamma spectrum analysis; radiation safety. Prerequisite: concurrent 171 or 172, or consent of instructor.

3 units, Aut, Win (Staff) lab. one afternoon by arrangement

176. Radiochemistry Laboratory — (Enroll in Engineering 176.) Nuclear reactions, radiochemical separations, radioactivity genetics, radioisotope production, neutron activation analysis and flux measurements; nuclear fission, radiotracers in physical chemistry and engineering. Prerequisite: Engineering 172 or 175 or consent of instructor.

3 units, Spr (Staff) Th 1:15 and one lab. by arrangement

180. Elementary Structural Analysis—Analysis of beams, trusses, frames; influence lines for beams, girders, trusses; 3-dimensional trusses; deflections by virtual work, moment-area, elastic loads; indeterminate analysis by superposition equations, slope-deflection, moment distribution. Prerequisite: Engineering 15.

4 units, Spr (Young) MTThF 10

181. Design of Steel Structures — Elastic and plastic design of steel beams, girders, columns; trusses, frames; design of riveted, bolted, welded connections; design of steel buildings and bridges. Prerequisite: 180.

3 units, Aut (Weaver) MWF 9

182. Design of Reinforced Concrete Structures — Reinforced concrete beams, slabs, columns, footings; straight-line and ultimate strength theory; introduction to pre-stressed concrete and shell roof design. Prerequisites: 114, 180, and 181.

3 units, Win (Shah) MWF 8

183. Design of Timber Structures — Loads, structural elements, fastenings, connectors; design of timber trusses, glued-laminated frames and arches, plywood shell roofs; lateral analysis using sheathed diaphragms. Prerequisites: 180 and 181.

2 units, Spr (Staff) TTh 11

190. Soil Mechanics and Foundations—Soil as an engineering material; application of soil mechanics to foundation design; principle of effective stress; seepage; slope stability and settlements. Prerequisite: Engineering 15.

4 units, Aut (Højeg) MWF 10 and lab. T or W 1:15-4:05

197. Engineering Synthesis — Utilization of students' previous course work and creative abilities with objective of producing problem solutions and workable designs for a comprehensive project. Stress placed on job planning, coordination and efficient use of group talent. Prerequisite: senior standing.

4 units, Aut (Douglas, Staff) MW 2:15-4:05

199. Directed Reading and Special Studies in Civil Engineering—Open to senior students by permission.

1 or more units, any quarter (Staff) by arrangement
SCHOOL OF ENGINEERING

COURSES PRIMARILY FOR GRADUATE STUDENTS

205. Hydromechanics of Real Fluids — Boundary layer theory for incompressible flows, approximate solutions for boundary layer equations, supplemented with laboratory experiments. Prerequisite: 107.

3 units, Win (Hsu) TTh 10 and one lab. by arrangement

206. Advanced Hydraulic Laboratory — Prerequisite: 207, or equivalent. Enrollment is limited.

2 units, Spr (Vennard) by arrangement

207. Advanced Hydraulics—Steady flow in pipes, in open channels, and through porous media. Similitude and dimensional analysis. Prerequisite: Engr. 21, or equivalent.

3 units, Aut (Vennard) MWF 11

208. Hydraulics of Pipe Lines—Mainly unsteady flow problems featuring surge and water hammer. Prerequisite: 207.

3 units, Win (Vennard) MWF 11

209. Hydraulics of Open Channels—Uniform, gradually-varied, and rapidly-varied flow. Prerequisite: 207.

3 units, Spr (Vennard) MWF 11


3 units, Win (Hetényi) TTh 8 and one lab. by arrangement


3 to 6 units, Spr (Hetényi) by arrangement


3 units, Spr (Richards) TTh 10 and one lab. by arrangement

217A. Concrete Seminar — Structure and properties of fresh and hardened concrete.

1 unit, Win (Richards, Staff) T 4:15

217B. Concrete Seminar — Continuation of 217A.

1 unit, Aut, Win, Spr (Richards) by arrangement

222. Water Resources Planning — Integration of technical, economic, political and social factors in decisions relating to water resources. Prerequisite: E.E.S. 211 or consent of instructor.

3 units, Spr (Linsley) TF 2:15–3:30

223. Highway Planning—A study of the decision process in highway planning as influenced by engineering, economic, political and social problems. Prerequisite: E.E.S. 211 or consent of instructor.

3 units, Spr (Oglesby) MWF 9


3 units, Spr (Staff) MWF 10

225. The Institutional Setting for Public Works Planning—The role of administrative organization, interest groups, legislative bodies and technical experts in democratic decision-making.

3 units, Win (Staff) TTh 11

226. Social Considerations in Public Works Planning—Social factors as they relate to public works planning: the diffusion of innovations, the dynamics of planned change, establishing effective communication with the body politic, Homans' theory of exchange, Heider's balance theory, status and stratification, sample surveys, scaling techniques, and the philosophy of social research.

3 units, Win (Staff) M 1:15–3:05 and W 1:15–2:05
231. Problems in Engineering Economy — Independent study or research of a selected problem in engineering economy of public utilities or public works. Prerequisite: permission of instructor.

2 or more units, Aut, Win, Spr (Staff)
by arrangement

232. Maintenance Management — Policy, level, identification, reception, planning, performance, evaluation, and analysis of maintenance work. Contract administration, legal or claim implications, and typical maintenance contracts included. Course designed for civil engineering management of public works or construction activities in industry or government. Prerequisite: senior standing.

2 units, Spr (Grubb) by arrangement

233. Statistical Models in Civil Engineering — Applications of probability and statistical analysis to civil engineering; model construction from probability theory; descriptive statistics; estimation with small samples; recognition of variation including professional elements; models for reliability studies of civil engineering designs; construction of complex models. Open to graduate students only.

3 to 4 units, Aut (Shah) TTh 11:00-12:15
Win (Benjamin) MWF 8

234. Decision Making in Civil Engineering — Applications of statistical decision theory in civil engineering practice; decision theory; value; prior, posterior; expected value; model of engineering office practice; formulation of problems; economic analysis. Prerequisite: 233.

3 units, Spr (Benjamin) MWF 8

235. Stochastic Process Models in Civil Engineering—Introductory course in applications of stochastic processes to problems in Civil Engineering; the traffic model; generalized transportation models; structural dynamics models; creep and one-cycle problems; diffusion models; fitting of data to models and the estimation problem. Prerequisite: 233, 234, or equivalent.

2 units, Aut (Benjamin) T 2:15-4:05

240. Operations Analysis for Work Improvement in Construction—Application of crew balance, process charts, time-lapse motion pictures, and operations research techniques to construction operations. Accident prevention. Prerequisite: graduate standing.

2 units, Aut (Oglesby) TTh 2:15-3:05
lab. T or Th 1:15-2:05 and 3:15-4:05

241. Concrete Construction—Economy and procedures in plant and equipment selection, form design, and field operations. Special techniques in forming and handling concrete.

3 units, Aut (Fondahl) TTh 10 and one evening by arrangement

242. Construction Equipment Policy—Application of sound management principles in establishing equipment policy; treats depreciation and obsolescence, standardization, preventive maintenance, and fiscal aspects of equipment ownership; includes use of computer for economic analysis of equipment problems. Prerequisites: Engineering 161, C.E. 243, and computer programming.

3 units, Win (Douglas) MWF 8


4 units, Win (Fondahl) MWF 10 and one evening by arrangement

244. Construction Planning and Scheduling—Planning, scheduling, and progress control of construction operations. Emphasis on the Critical Path Method including network diagramming, calculations based on time data, and scheduling variations to optimize cost. Manpower and equipment leveling. Course includes both non-computer and computer techniques. Prerequisite: graduate standing.

3 units, Aut (Fondahl) MWF 9
Spr (Fondahl) MWF 8

245. Advanced Construction Equipment and Methods—Methods and equipment selection and application in heavy construction. Excavation, tunneling, conveyors, rigging, underwater foundations, pile driving, contractor’s temporary facilities. Prerequisite: 145.

4 units, Spr (Parker) MWF 9
and one evening by arrangement
SCHOOL OF ENGINEERING

246A. **Heavy Construction Estimates**—Estimating and bidding construction work, with emphasis on procedures adapted to large engineering projects. Prerequisites: 144, 145 or equivalent in general knowledge of construction methods and equipment, and graduate standing in construction option. 4 units, Win (Parker) TTh 1:15–3:05

246B. **Estimating for Building Construction**—Estimates and costs attached to construction of large buildings, such as apartment houses, warehouses, and other commercial and industrial type structures. Limited enrollment. Prerequisites: 138 and 144. Graduate standing in construction option. 3 units, Spr (Staff) by arrangement

248. **Human Factors in Construction Management**—Seminar dealing with the problems of working and communicating with individuals and groups. Enrollment limited to 15 students per section from the graduate construction program. 2 units, Win (Oglesby) T, W, or Th 3:15–5:05

249. **Construction Problems**—Analysis of individually selected problem in construction techniques, equipment, or management, followed by preparation of oral and written report. Students are expected to consult specialists from construction industry as well as make use of University facilities. Prerequisites: 240, 241, and 243. 3 units, Spr (Staff) by arrangement

251. **Transportation Problems**—Individual investigation. Prerequisite: permission of instructor. 2 or more units, Aut, Win, Spr (Staff) by arrangement

260A. **Advanced Hydrology**—Meteorology, climatic data, precipitation, evapotranspiration, and streamflow, techniques of measurement and interpretation. 4 units, Aut (Staff) MWF 9; lab. T 1:15–4:05

260B. **Advanced Hydrology**—Methods of applied hydrology: runoff relationships, unit hydrographs, flood routing, frequency analysis, etc. Prerequisite: 260. 4 units, Win (Linsley) MWF 10; lab. T 2:15–5:05

261A. **Nuclear Hydrology**—Applications of nuclear methodology and techniques to hydrologic investigations and measurement devices in hydrology; radiotracer investigations of surface and ground water flow and transport; future of nuclear explosives in water resource development; transport of radioactive materials in water. 3 units, Win (Staff) TTh 9

261B. **Nuclear Hydrology Laboratory**—Comparison of nuclear and standard hydrologic measurement methods, illustrated by discussion, field experiments, student reports, practical problem solving, and digital simulation methods. 3 units, Spr (Staff) F 1:15 plus 1 lab. by arrangement

262. **Advanced Hydraulic Engineering**—Integration of procedures in hydraulic projects illustrated by discussion, student reports, and design problems. Prerequisite: 261. 4 units, Spr (Linsley) TTh 10 and two afternoons by arrangement

263. **Sedimentation Problems**—Erosion, character of sediments, sediment transport and deposition. Regimen of rivers, reservoir sedimentation. Effects of watershed management and engineering control works. Prerequisite: 107 or equivalent. 2 units, Spr (Franzini) MW9

264. **Oceanographical and Coastline Engineering**—Fundamentals of water waves and their effects. Wave generation, storm swell, tsunamis, coastal processes. Effects of structures on waves and functional design of marine structures including sea water intakes and ocean outfalls. Prerequisites: 107, equivalent, or consent of instructor. 3 units, Spr (Street) MWF 11

265A. **Flow in Permeable Media**—Fluid mechanics of subsurface flow. Basic concepts, Darcy’s law, potential flow theory with application to groundwater and seepage flow. Formulation of boundary-value problems and solution by analytical and computer techniques. Prerequisite: knowledge of ordinary differential equations. 4 units, Aut (Perry) MTThF 10

265B. **Applied Hydromechanics**—Theory of ideal fluid flow applied to problems in hydraulic engineering. Nozzles and jets, weirs
and spillways, shapes to control cavitation, properties of water waves. Prerequisite: 265A.

3 units, Win (Perry) by arrangement

265C. Applied Hydromechanics—Propagation of waves and hydraulic bores, unsteady flow in open channels, breaking of a dam, overland flow, steady and unsteady seepage flow. Prerequisite: 265B.

3 units, Spr (Perry) by arrangement


2 units, Spr (Linsley) TF 1:15

268. Mechanics of Flow through Soils—Capillarity and hysteresis; relation between hydraulic conductivity, capillary suction and moisture content; unsteady flow in unsaturated soils; experimental procedures, numerical methods; application to infiltration and other phases of the hydrologic cycle. Prerequisite: 107 or equivalent.

3 units, Spr (Franzini) MWF 10

269. Water-Resources Engineering Seminar—Discussions on all phases of water-resources engineering including reports on current research at Stanford.

1 unit, Win, Spr (Staff) T 4:15–6:05

270. Water Quality Control I—Natural and man-made characteristics of water quality; effect of quality on the use of water; unit operations and processes of water quality control, including desalination, for municipal and industrial use. Prerequisite: 170 or equivalent.

3 units, Aut (Eliassen) MWF 8

271. Water Quality Control II—Characteristics of waste waters; chemical and biological unit processes for the treatment of sewage and industrial wastes; water quality requirements in stream pollution control. Prerequisite: 270.

3 units, Win (Eliassen) MWF 9

272. Design of Water Quality Control Systems—Application of physical, biological, and chemical unit operations and unit processes to the functional design of treatment plants for water, sewage, and industrial wastes. Prerequisites: 270 and 271.

2 units, Spr (Eliassen) W 1:15–5:05

273. Water Resources Chemistry—Application of basic principles of analytical, physical, and organic chemistry to the analysis and treatment of water, sewage, and industrial wastes.

3 units, Aut (Tchobanoglous) TTh 8; lab. M 1:15–4:05

274. Water Resources Microbiology — The ecology of streams, lakes and other water resources; identification and control of microorganisms in water and wastes; fundamental aspects of microbiology and biochemistry as related to stream pollution and water quality control. Prerequisite: 273.

3 units, Win (Tchobanoglous) TTh 10; lab. W 1:15–4:05

275. Water Quality Control Processes—Laboratory and pilot plant studies of physical, chemical, and biological processes for the treatment of water, sewage, and industrial wastes. Prerequisite: 274.

3 units, Spr (Tchobanoglous) M 1:15–5:05 and Th 1:15–4:05


2 units, Spr (Tchobanoglous) TTh 8


2 units, Win (P. Kruger) TTh 4:15

278. Radioactivation Analysis—The use of radioactivation as a research tool: radioactivation, properties of radioisotopes, sources of irradiations, activation analysis, practices
and uses in biology, chemistry, and engineering.

2 units, Spr (Staff) TTh 11

279. Water Quality Control Seminar—Discussions on all phases of sanitary engineering including reports on current research at Stanford.

1 unit, Win, Spr (Staff) W 4:15-6:05


3 units, Aut (Young) MWF 8

281A. Matrix Analysis of Structures—Introduction to matrix algebra; use of matrix methods in the analysis of statically and kinematically indeterminate structures; flexibility and stiffness methods. Prerequisite: 114.

3 units, Aut (Gere) MWF 11

281B. Matrix Analysis of Structures—Continuation of 281A. Emphasis on the stiffness method, including implementation of the method on a digital computer. Prerequisite: 281A.

3 units, Win (Weaver) MWF 10

283. Advanced Structural Analysis—Membrane stresses in tank, roof shells; discontinuity stresses in domes, tanks; barrel shell roofs; introduction to plane plate theory. Prerequisite: 281.

4 units, Spr (Fliigge) TTh 11 and M 2:15-5:05 and F 1:15-4:05

284. Design of Prestressed Concrete Structures — Analysis and design of prestressed slabs, beams, and columns; special problems; design and testing of beam in laboratory. Prerequisite: 182.

2 units, Aut (Shah) TTh 10

285. Advanced Structural Design — Structural geometry; analysis of structures by deflected structures, statics; structural models; bridge analysis, design; bridge types, characteristics; design problems.

4 units, Aut (Benjamin) TTh 8; lab. W 1:15-4:05


4 units, Win (Benjamin) TTh 9; lab. W 1:15-4:05

287. Advanced Structural Design—Continuation of 286. Design of buildings in steel, timber; lateral load analysis, design; shear walls; diagonal sheathing; framing problems. Prerequisites: 285 and 286.

4 units, Spr (Benjamin) TTh 8; lab. W 1:15-4:05

288. Structural Engineering Seminar — Problems in all phases of structural engineering.

1 unit, Aut, Win, Spr (Staff) alternate W 4:15

290. Soil Mechanics — A re-examination of fundamentals of soil mechanics; application of theoretical soil mechanics; stress distributions; deformations and limiting equilibrium. Prerequisite: 190.

3 units, Win (Hoeg) TTh 11 and M 4:15

291. Earth Structures—Problems concerned with earth dams and embankments; site investigation; soil composition and properties; seepage and pore water pressures; static and dynamic stability. Prerequisite: 190.

3 units, Spr (Hoeg) TTh 9 and one hour by arrangement

292. Experimental Soil Mechanics—Topics can be selected to suit individual or class interests. Open by permission only.

1 unit, Spr (Hoeg) by arrangement

293. Foundations—Selection and design of foundations for different structures; soil exploration; shallow and deep foundations; bearing capacity and settlements. Prerequisite: 190.

3 units, Aut (Hoeg) MWF 10

295. Harbor Structures—Wharves and piers of timber and concrete; sea walls, bulkheads, moles and groins; dredging and channel construction; factors affecting design, construction of waterfront facilities. Prerequisite: 190.

3 units, Win (Douglas) MWF 11

296A. Structural Dynamics—Vibration theory, particular reference to structures; response of structures to pulse loads and earth-
quakes, vibration of beams. Prerequisites: Engineering 12 and C.E. 280.
3 units, Win (Young) MWF 9

296B. Structural Dynamics — Dynamics of framed structures having many degrees of freedom using matrix methods, normal mode analysis, and digital computer solutions. Prerequisites: 218B and 296A.
3 units, Spr (Weaver) TTh 1:15

296C. Introduction to Random Vibrations — Complex frequency response with viscous and structural damping. Statistical features of random excitations. Harmonic analysis and spectral density. Response to random excitation. Prerequisite: 296A.
2 units, Spr (Shah) MW 9

298. Stability Problems — Beam-columns; elastic buckling of columns; non-prismatic columns; inelastic bending and buckling of bars; torsion of bars of open section; lateral buckling of beams; buckling of frames. Prerequisites: 114 and ordinary differential equations.
3 units, Spr (Gere) MWF 10

299. Directed Reading and Special Studies in Civil Engineering—Graduate students by special permission.
Aut, Win, Spr (Staff) by arrangement

300. Thesis — Investigation of some engineering problems; required of candidates for degree of Engineer.
Aut, Win, Spr (Staff) by arrangement

301. Thesis—Dissertation; required of candidates for degree of Doctor of Philosophy.
Aut, Win, Spr (Staff) by arrangement

322. Introduction to Regional Planning — Concepts and criteria of regional and urban land use planning, including preparation of master plans, zoning, urban renewal and area redevelopment.
3 units, Spr (Staff) MWF 1:15, alternate years, given 1968–69

323. Transportation Planning—Planning of facilities for all modes of transportation with emphasis on current developments, particularly systems analysis and urban land use—transportation models.
3 units, Spr (Roggeveen) MWF 1:15, alternate years, given 1969–70

324. Public Works Problems of the Developing Nation—Study of the special problems involved in planning public works in the developing nations.
3 units, Aut (Staff) MWF 1:15, alternate years, given 1968–69

3 units, Spr (Staff) MWF 11

2 units, Aut (Hetényi) TTh 10

391. Predoctoral Seminar—Required of all post-masters students to serve as orientation to the selection of a research topic.
1 unit, Aut (Staff) by arrangement

Civil engineering graduate students with interests in special fields will also take appropriate courses in other schools and departments of the University including the Graduate School of Business, Division of Applied Mechanics, the Departments of Electrical Engineering, Engineering - Economic Systems, Industrial Engineering, Mechanical Engineering, Mathematics, Geology, Geophysics, Materials Science, Statistics, Political Science, Architecture, Biology and Chemistry.

ELECTRICAL ENGINEERING

Emeriti: Leland H. Brown, Joseph S. Carroll, Frederick E. Terman (Professors)
Executive Head: John G. Linvill
Associate Executive Head: Ralph J. Smith
Associate Executive Head (Admissions): Robert L. Pritchard


Assistant Professors: Michael A. Arbib, Joseph W. Goodman, Bruce B. Lusignan.

Acting: Noel P. Thompson

Senior Research Associates: Raymond C. Cumming, Donald A. Dunn, Donald J. Grace, H. Taylor Howard, William R. Kincheloe


PROGRAMS OF STUDY

UNDERGRADUATE

Students desiring to specialize in electrical engineering during their undergraduate period may do so by following the curriculum given earlier in the general discussion of the School of Engineering. Variations of this curriculum are encouraged if there is good reason for change. Attention is also called to the General Engineering and Engineering Science curricula in the same general section.

ADVANCED DEGREES

The practice of the profession of electrical engineering demands a strong foundation in the physical sciences, a broad knowledge of engineering techniques, and skill in working with men. Curricula at Stanford are planned to offer the breadth of education and depth of training necessary for leadership in the profession. For those who wish to engage in this profession with competence, four years of undergraduate study and at least one year of postgraduate study are strongly recommended. For those who plan to work in highly technical development or fundamental research, additional graduate study is desirable.

The Electrical Engineering Department offers graduate courses in the following areas:

- Bioelectronics
- Computers and Control
- Electromagnetic Theory and Microwaves
- Electronic Circuits and Devices
- Network Theory
- Plasmas
- Quantum Theory
- Radioscience
- Solid State Materials and Properties
- Systems Theory

Descriptions of courses will be found in the following pages.

A one-year program of graduate study in electrical engineering may lead to the degree of Master of Science. A two-year program, offering wider selection of engineering course work, more opportunity for study in the related fields of physics, mathematics, and engineering, and in particular more independent work and individual guidance, may lead to the degree of Engineer.

The degree of Doctor of Philosophy is offered under the general regulations of the University. The doctoral program, requiring a minimum of three years (nine quarters) of graduate study, is recommended for those with the desire and ability to make a life work of research or teaching.

MASTER OF SCIENCE

University regulations governing the degree of Master of Science are described in the “Degrees” section in this bulletin; note that this Department has waived the thesis requirement. Applications for admission with graduate standing in Electrical Engineering are made to the Director of Admissions of the University and are reviewed by this Department. Inquiries may be addressed to the Associate Executive Head for Admissions, Department of Electrical Engineering.

Modern electrical engineering is a broad and diverse field, and graduate education in this Department may satisfy a great variety
of objectives. Students with undergraduate degrees in physics, mathematics, or related sciences, as well as in various branches of engineering, are invited to apply for admission. Such students will ordinarily be able to complete the Master's degree in one calendar year. Students with undergraduate degrees in other fields may also be admitted for graduate study (see below).

The Master's degree program may provide advanced preparation for professional practice, or it may serve as the first step in graduate work leading to the degree of Engineer or Doctor of Philosophy. The faculty does not prescribe specific courses to be taken. Each student with the help of his program adviser prepares his own program and submits it to the faculty for approval. This is done before completion of the first 12 units of graduate study (modifications may be made later). A Supplementary Information Sheet providing detailed instructions, and including a worksheet for preparing a program proposal, is available in the Department Office.

Programs of at least 42 quarter units that meet the following guidelines will normally be approved:

1. A sequence of three or more electrical engineering courses numbered above 200, to provide depth in one area. (See preceding list of graduate course areas.)

2. At least one electrical engineering course numbered above 200 in each of three additional areas, outside of the area selected under item 1, to provide breadth.

3. At least 9 units of electrical engineering courses numbered above 300 and additional courses in electrical engineering numbered above 200 to bring the total units under guidelines 1, 2, and 3 to 21.

4. At least three courses in departments other than electrical engineering.

5. At least three quarters of E.E. 200 or 201, Seminar (unless there is a schedule conflict).

6. Additional courses to bring the total to 42 or more quarter units, at least 36 units of which must be courses in which letter grades are given.

It is emphasized, however, that any properly prepared student with a specific objective in mind may submit for approval a program which meets his particular needs but does not conform to the normal pattern. Such a program should be accompanied by a clear statement of objective and a description of how the proposed program achieves the stated objective and should carry the endorsement of the student's program adviser.

Able students without formal undergraduate preparation in electrical engineering may also be admitted for graduate study. Such students may have graduated in any field and may hold either the B.S. or A.B. degree. Each student, with the help of his adviser, prepares a program of study to meet his particular needs and submits it to the faculty for approval. A student with adequate preparation in mathematics through calculus and college physics including electricity can usually complete the M.S. degree requirements within two academic years. A student with some additional preparation in electrical engineering, equivalent to that listed under Supplementary Requirements, Electrical Engineering on page 69 of this Bulletin, may be able to complete the M.S. requirements in only one academic year.

Graduate study in Electrical Engineering is demanding and it is essential that students be adequately prepared in physics, mathematics, circuits, fields, electronics, electromechanics, and laboratory work. The ability to take advantage of modern computing facilities is an essential skill for electrical engineers, and an increasing number of our courses routinely require it. Every student should acquire this skill early in his program, either by taking one of the regular Computer Science courses or one of the special "short courses" given by the Computation Center, or by self-study.

It is the student's responsibility, in consultation with his adviser, to determine whether he has met the prerequisites for advanced courses. Prerequisite courses ordinarily taken by undergraduates may be included as part of the graduate program of study. However, if the number of these is large, the proposed program should contain more than the typical 42 to 45 units, and the time required to meet the degree requirements may be increased.

**Engineer**

The degree of Engineer requires a minimum of two academic years of study beyond the B.S. degree (three academic quarters beyond the M.S.). University regulations governing the degree of Engineer are de-
scribed in the “Degrees” section in this bulletin.

Work toward the degree of Engineer in Electrical Engineering is more individual and independent than work toward the Master’s degree. The applicant has almost complete freedom of selection of courses beyond the requirements for the M.S. degree. The equivalent of approximately one quarter is devoted to independent study and thesis work with faculty guidance. The thesis is often of the nature of a professional report on the solution of a design problem. The degree of Engineer differs from the Ph.D. primarily in looking toward professional engineering work rather than toward theoretical research.

Permission to study beyond the Master of Science degree must be obtained from the appropriate Department committee. The decision of the committee is based on its evaluation of the applicant’s academic record, performance in independent work, and potential for advanced study, and on the ability of the faculty to support and supervise such study.

A tentative application for candidacy, including a proposed program of study, must be filed in the Department Office before the end of the first quarter of post-M.S. study at Stanford. The program of study is prepared by the student with the help of his adviser and submitted to the faculty for approval. A formal application for candidacy including the signature of a thesis supervisor must be filed in the Department Office before completion of 25 units of work beyond the Master’s degree.

**Doctor of Philosophy**

A complete statement regarding the degree of Doctor of Philosophy will be found in the section “Degrees” in this bulletin. The requirements are administered by the University Committee on the Graduate Division.

Admission to the graduate school does not imply that the student is a candidate for the Doctor of Philosophy degree. Only after the Application for Doctoral Candidacy has received official Departmental approval does the student become a candidate for the degree.

In the first quarter after receiving the Master of Science degree the student should submit to the Department office one copy of the Application for Doctoral Candidacy form for preliminary Departmental approval. Official Departmental approval will be given after successful completion of the qualifying examination and passing an examination of reading knowledge of one foreign language.

Not later than the first autumn quarter after receiving the Master of Science degree the student should submit an application to take the Department qualifying examination (given each winter quarter).

Requirements may be summarized as follows: The student is to complete successfully (1) a minimum of three years of residence with graduate standing, one year of which must be in residence at Stanford; (2) one or more qualifying examinations given by the faculty of the Electrical Engineering Department; (3) an examination to show reading knowledge of a foreign language (usually French, German, or Russian, although another language may be substituted if it is of greater value in the student’s research); (4) an approved program of courses in electrical engineering and allied subjects; (5) an oral examination near the completion of the doctoral program; (6) a dissertation, based on research, which must be a contribution to knowledge.

About one-fourth of the program of graduate study should be in departments other than Electrical Engineering. Courses shall be selected to form an integrated program, to be approved by the Department. A student wishing to fulfill the requirements for a formal minor may elect to do so.

**Ph.D. Minor**—For a minor in Electrical Engineering the candidate will take 15 quarter units of course work in the Electrical Engineering Department following a program to be approved by the Department committee on doctoral candidates. He will take and pass a specified portion of the qualifying examination.

**Special Programs**

**Medical Electronics Program**—The Master of Science degree carrying the designation “Electrical Engineering: Medical Electronics” on the diploma may be conferred upon students who wish to combine training in biological or medical sciences with an electronics program in the Department of Electrical Engineering. Such a student
should so indicate when he submits his application for candidacy for the degree. His proposed program of study for the degree should show at least 42 units of work.

The minimum amount of time required to obtain this degree is one academic year. Candidates with inadequate preparation in mathematics, physics, and electrical engineering will require more time. A candidate with a Bachelor of Science degree in electrical engineering would normally devote approximately half his time to graduate courses in electrical engineering and the balance of his time to courses in biology or medicine. A candidate for the Doctor of Medicine degree who plans to apply his academic year of "University Time" toward this Master's degree would devote about half of his time to undergraduate courses in electrical engineering, mathematics or physics, and the other half to graduate courses in electrical engineering.

E.E. 202 Medical Electronics, E.E. 204 Brains, Machines and Mathematics, E.E. 206 Man-Machine Systems, E.E. 288 Biological Information Processing, and E.E. 304 Neurocybernetics should prove of especial interest to students in this area. These courses provide preparation for doctoral research in various topics in Biological Systems.

Electrical Engineering Administration — By a special arrangement, graduate students of engineering may take courses in the Graduate School of Business. This may be done to an extent that depends on the interests of the student, and three arrangements may be distinguished.

While working toward the degree of Master of Science in electrical engineering, it is possible to take about one course each term in the School of Business without interfering with completion of the technical studies necessary for the degree. Industrial engineering courses are also useful. (Please note that classes in the School of Business have different times from those in the rest of the University and are often difficult to schedule.)

The Master's degree carrying the designation "Electrical Engineering: Administration" on the diploma is conferred upon students who combine not less than 25 units of study in electrical engineering with about 25 units of study in industrial engineering or business. Four academic quarters are required to complete this program, which combines the technical education that is represented by the Master's degree in electrical engineering with a substantial amount of work in industrial engineering or business.

The degree of Engineer is also offered for an administration program. Six academic quarters are required, and a thesis is to be written. Work toward this degree is usually divided about evenly between business and engineering. The thesis may be in either department, with proper approval.

Students wishing a degree with the designation "Electrical Engineering: Administration" should so indicate on the application for candidacy for the degree.

Fellowships, Scholarships, and Assistantships

The Department each year awards a number of fellowships, traineeships, and assistantships that are available to graduate students. Inquiries concerning these should be addressed to Associate Executive Head for Admissions, Electrical Engineering Department.

Areas of Research

Candidates for advanced degrees participate in the research activities of the department as paid research assistants or as students of individual faculty members. At any one time, certain areas of research will have more openings than others. A new applicant should express a second choice of research interest in the event that there are no vacancies in his primary area of interest. At present faculty members and students are actively engaged in research in the following areas.

Radioscience
Radiation and Refraction of Radio Waves by Ionized Media
Solar-Terrestrial Interactions
Radio Astronomy and Radio Telescopes
Radar Astronomy
Space Science and Engineering (also see Index)

Solid State
Semiconductor and Solid State Physics
Electronic, Magnetic, and Optical Properties of Solids
Crystal Preparation: Epitaxy and Ion Implantations
Solid State Devices
Integrated Circuits
Courses for Undergraduate Students

41, 42. Circuits, Electronics, and Electromechanics—(Enroll in Engineering 41, 42.)
41A. Laboratory I—(Enroll in Engineering 41A.)
42A. Laboratory II—(Enroll in Engineering 42A.)

101. Circuits I—Analysis of simple circuit models, with a view to discovering their fundamental characteristics as transmission networks. Forced and natural components of response, natural frequencies, the complex frequency plane, resonance; transfer functions and the roles of their poles and zeros. Introduction to the use of analog and digital computers in circuit analysis. Elementary signal-flow graphs. Impulse response: its calculation and its use in obtaining response to other excitations; the superposition (convolution) integral. Prerequisites: Engineering 41 and Mathematics 44.

3 units, Aut (---) MWF 10
         Win (---) MWF 8

102. Circuits II—The Laplace transformation, development and application of Fourier series. Sampling and bandwidth concepts. The sinusoidal steady state: plots, charts and loci that exhibit frequency dependence, impedance matching, transformers. Circuit theorems and analytical techniques, including the use of digital computers. Prerequisites: E.E. 101 (or, by permission, Engineering 10 plus supplementary reading) and Computer Science 136 or equivalent.

3 units, Win (---) MWF 10
         Spr (---) MWF 8


4 units, Aut (---) MTThF 9
         Spr (---) MTWF 10

111, 112, 113. Electronics—Basic electronic devices and circuits and an introduction to their applications in electronic systems. Physical principles of charge motion in conductors, semiconductors, vacua and plasmas
and their application to the development of the operating principles and terminal characteristics of electronic devices, particularly semiconductor diodes and transistors. Development of various modeling techniques which are useful in electronic circuit theory (piecewise-linear, graphical, and analytical). Applications of electronic devices in rectification, detection, modulation, amplification, oscillation, switching, and wave-shaping circuits. Prerequisite: previous or concurrent registration in E.E. 101 (or consent of the instructor, in special cases).

111. 3 units, Aut (——) MWF 8
   Win (——) MWF 11

112. 3 units, Win (——) MWF 8
    Spr (——) MWF 11

113. 3 units, Aut (——) MWF 11
    Spr (——) MWF 8


121. 2 units, Win (——) Th 1:15 and 3-hour lab. weekly by arrangement

122. 2 units, Spr (——) T 1:15 and 3-hour lab. weekly by arrangement

124. Computer Circuit Laboratory—Laboratory projects in digital-computer circuits and applications. Logic design with integrated circuits, analog-to-digital conversion, use of digital computers for the control and testing of external devices. Prerequisite: senior standing.

3 units, Win, Spr (——) 1 lecture and 2 labs. weekly by arrangement


3 units, Aut (——) TTh 9 and 3-hour lab. weekly by arrangement

127. Electronic Measurements and Design — Continuation of E.E. 126, with emphasis on design, construction, and testing. Topics include noise, modulation, feedback, and design problems. Prerequisite: E.E. 126 (E.E. 142 and 276 are suggested in addition).

3 units, Win (——) TTh 9 and 3-hour lab. weekly by arrangement

139. Design Project (Measurements) — Independent design projects in the general field of electronic measurements. Possible topics include: measurements of time, frequency, slant range, bandwidth, polarizations, dielectric constant, noise figure, modulation parameters, impedance, VSWR. The projects will have direct application in such fields as radar and space communications. A wide range of choice of topics will be offered; projects suggested by students will be considered and will be accepted when possible.

3 units, Spr (Villard)

141. Electromagnetic Fundamentals — The field concept, vector analysis, boundary-value problems, electrostatics, images, conformal mapping, magnetostatics, dielectric and magnetic media, time-varying fields, Maxwell's equations, plane waves. Prerequisite: Engineering 41.

3 units, Aut (——) MWF 8
   Win (——) MWF 9


3 units, Win (——) MWF 8
   Spr (——) MWF 9

143. Radio Propagation and Antennas — Propagation through the atmosphere and reflection from the ionosphere. Elementary antenna theory. Consideration of the overall radio system as a communication link. Prerequisite: E.E. 142.

3 units, Spr (——) MWF 8

145. Microwave Measurements — Power sources, modulation; crystal and bolometer characteristics and their use in standing-wave detectors and power meters. Measurements of VSWR, impedance, attenuation, and coupling. Resonators; wavemeters, measurement of Q, frequency, and radiation from horns. Prerequisite: E.E. 142 (may be taken concurrently).

3 units, Spr (——) TTh 9 and 3-hour lab. weekly by arrangement
146. Electromechanics—Theory of electro-mechanical energy conversion and its applications in common use. Rotating machines (d-c and a-c, both steady and dynamic operation), electromagnets, loudspeakers, microphones, and vibration pickups are considered as elements of systems. The dynamic response of such systems is also considered. Prerequisite: Engineering 42. Elementary Laplace transforms are used, but previous acquaintance is not prerequisite.

3 units, Aut (———) MWF 9


3 units, Aut (———) MWF 10
Win (———) MWF 8
Spr (———) MWF 11


3 units, Win, Spr (Staff) Th 1:15 and one 3-hour lab. weekly by arrangement

179. Electronic System Design — Design projects to provide experience in a diversity of engineering problems and decisions. Students work in teams on the definition and description of an engineering problem, plan and conduct a project, and make appropriate reports and presentations. Topics from previous years include: utilization of the radio spectrum, evaluation of an electronic navigation system, development of electronic instruments. Limited to 12 students, with priority to seniors (and first-year graduate students).

3 units, Spr (———)

190. Special Studies and Projects in Electrical Engineering—Independent work (laboratory, experimentation, directed reading, etc.) under direction of a faculty member. Individual or team projects that emphasize the design or creative use of electrical devices or systems to meet specifications. No letter grade is given.

By arrangement

191. Special Studies and Reports in Electrical Engineering—Independent work under direction of a faculty member. A term paper or report is required and a letter grade is given.

By arrangement

192. Special Seminars—Seminars associated with and supplementing various courses are offered when there is sufficient interest.

COURSES FOR UNDERGRADUATE OR GRADUATE STUDENTS

200A,B,C. Seminar—Special section of E.E 201A,B,C (see description below) open to students holding assistantships and registering under limited tuition grants.

200A. 0 units, Aut (Pritchard, Staff) Th 11
200B. 0 units, Win (Pritchard, Staff)
200C. 0 units, Spr (Pritchard, Staff)

201A,B,C. Seminar — Weekly discussion of special topics of current interest in electrical engineering. Speakers from faculty and from outside the University. Normally taken by graduate students each quarter for 3 quarters.

201A. 1 unit, Aut (Pritchard, Staff) Th 11
201B. 1 unit, Win (Pritchard, Staff)
201C. 1 unit, Spr (Pritchard, Staff)

202. Medical Electronics — (Formerly E.E 205) This course is an introduction to physiology for engineers, with discussions of problems unique to biomedical instrumentation. Various medical, electrical, and chemical transducer systems and the accompanying electronics are briefly considered. Prerequisite: familiarity with electrical instrumentation techniques.

2 units, Aut (Thompson)


3 units, Aut (Staff)

206. Man-Machine Systems — (Formerly E.E. 286H) The study of systems that require a quantitative analysis of the human component in the system. Emphasis on the quantitative modeling of this human component. Specific system areas considered include control, monitoring, decision-making, auto
mated instruction, and medical diagnosis. Dependence of future systems on the man-
and-machine relationship. Corequisites: Statistics 116 or E.E.S. 221 or equivalent, or consent of instructor.

2 units, Aut (Smallwood)

208. Biological Information Processing — (Formerly E.E. 288H) Sensory information processing from the viewpoint of communication and control system theory. The neuron and neuron models; analysis of some neural networks including lateral inhibition and various types of receptive fields; sensory information processing models from behavioral experiments and related neurophysiological evidence.

3 units, Spr (Bliss)

211. Principles of Pulse and Timing Circuits — Switching, timing, wave-shaping, and logic circuits to generate the diversity of waveforms and functions used in pulse systems, instrumentation, and computers. Emphasis on techniques of analysis and obtaining appropriate circuit models for solid state devices in these highly nonlinear circuits. Prerequisite: E.E. 113 or equivalent.

3 units, MWF10

213. Electron Tubes and Associated Circuits—Problems and requirements in modern applications of electron tubes in high-frequency and high-power systems. Short review of fundamentals of vacuum triodes and tetrodes; introduction to electron guns and beams. Tuned power amplifier circuits; klystron amplifiers, reflex klystrons, and traveling-wave tubes. Prerequisites: E.E. 103 and 113 (may be concurrent).

3 units, MWF10


3 units, MWF10

216. Principles and Models of Semiconductor Devices—Quantitative description and modeling of the physical processes of transport, storage, generation and recombination of carriers in semiconductors. Development, based on the models of the physical processes, of circuit or functional models of transistors and diodes, with emphasis on forms appropriate to integrated circuits. Emphasis is placed on lumped models applicable to small- and large-signal cases. Prerequisite: E.E. 113 or graduate standing in electrical engineering.

3 units, Aut, Win (Angell, J. Linvill, Meindl)


3 units, Win (McWhorter, Staff)


3 units, Spr (McWhorter, Staff)

231, 232. Introduction to Lasers and Masers — An introduction to the principles of laser and maser operation based on classical concepts and electrical-engineering analogies. Consideration of practical devices and applications. Classroom demonstrations and the explanation of experimental results with simple analytical models. Prerequisites: Physics 57 and E.E. 142 (which may be concurrent) or equivalent. (Statistics 116 and Engineering 50 or E.E. 238 suggested.)

3 units, Win, Spr (Siegman) TTh 9:00–10:30

238. Electric and Magnetic Properties of Solids—The electric and magnetic properties of solids are examined from a fundamental point of view. The necessary elementary concepts of quantum mechanics are introduced. Free electron theory, band theory, effective mass approximation, dielectric and ferroelectric materials, magnetic materials,
ferromagnetism, and superconductivity. Prerequisites: Physics 57 and preferably E.E. 111 or Engineering 50.

3 units, Aut, Spr (——) MWF 1:15

241. Electrodynamics — Motion of charged particles and current-carrying conductors in prescribed electric and magnetic fields, relativity concepts, fluid and discrete-charge models of electron beams and plasmas, space-charge waves, applications to d-c and a-c rotating machinery, mhd generators, klystrons, ion propulsion, beam-plasma amplifiers, electron and plasma diodes. Prerequisite: E.E. 142.

3 units, Spr (Dunn) MWF 9


3 units, Aut (Kino) Win (Eshleman)


3 units, Win (Kino) Spr (Eshleman)

261. The Fourier Transform and Its Applications—A discussion of the topic from a moderately advanced point of view, with emphasis on applications to physical situations. Fourier’s theorem, convolution, impulse and related functions, other transforms; applications to electric networks, sampling, antennas, television image formation, statistics, noise waveforms, heat flow. Prerequisite: E.E. 102.

3 units, Aut (——) MWF 2:15 Spr (——) MWF 2:15

266. Introduction to Network Synthesis—A one-quarter survey of the principal ideas of network theory, for both passive and active networks. Properties of networks, practical limitations on their performance, and procedures for their synthesis. (The study of network synthesis is continued in E.E. 368 for those interested in advanced work in the subject.) Prerequisite: E.E. 103 and ability to use digital computation facilities.

3 units, Aut (Newcomb)

271, 272. Nonlinear Network Analysis—Introduction to the analysis (steady-state and transient) of networks containing nonlinear elements, both passive and active. Energy considerations. Discussion of methods of analysis with emphasis on approximate methods (graphical, numerical, analytical) particularly averaging techniques. Resonance. The describing function. Oscillators (waveshapes, amplitude limitation), elementary control systems. Use of the digital computer in appropriate cases. Prerequisites: E.E. 103, 113, 163, and ability to use digital computation facilities.

271. 3 units, Win (Tuttle) given 1969–70
272. 3 units, Spr (Tuttle) given 1969–70

276. Information Transmission and Modulation—(Formerly E.E. 176) Signals and circuits for information transmission in electronic systems; signal processing, modulation, demodulation, frequency conversion, multiplexing, and noise; spectrum, envelope and instantaneous frequency relations; information measure, channel capacity, and comparison of systems from an information theory standpoint. Prerequisites: E.E. 103, E.E. 113, and Statistics 116.

3 units, Win (Cumming) MWF 8

278. Random Signals and Noise—Introduction to the random process model for undetermined signals and noise waveforms, statistical descriptions of signals, power spectral density and autocorrelation function analysis of linear networks with random inputs, some elementary results with nonlinear elements, physical sources of noise, noise figure. Prerequisites: E.E. 102 and Statistics 116 or equivalent.

3 units, Win (——) MWF 2:15
280A, B, C. Computer Applications Laboratory — "Hands-on" experience in real-time application of digital computers as signal processors or portions of control systems. Previous topics include pattern recognition with computer-controlled sound sources, and blood pressure control using a computer-simulated model of an animal reaction to a pressure-elevating drug. Projects developed in cooperation with electrical engineering and other research laboratories. Should be taken for two consecutive quarters.

3 units, Aut, Win, Spr (Widrow, Staff)

281. Theory of Switching — Analysis and synthesis of digital circuits with emphasis on basic design techniques and general concepts. Boolean algebra; simplification of switching functions; sequential circuits; simplification of sequential machines.

3 units, Aut (McCluskey, Peterson)


3 units, Win (Peterson, Staff)


3 units, Spr (Pritchard)

287. Computer Organization and Information Structures — (Enroll in Computer Science 139.)

289. Theory of Automata — (Enroll in Philosophy 162.)

COURSES FOR GRADUATE STUDENTS

300. Topics and Methods in Solid State Research — Discussion of technical topics in solid state electronics and related mental processes and thinking tools.

Win (Shockley) by arrangement

301. E, D, H, B and Electromagnetic Forces in Crystals — Non-quantum concepts of electric and magnetic fields, polarizations, and forces in crystals developed to illustrate thinking tools such as simplest cases of conceptual models, meaning of objective reality in science, and operational definitions. Prerequisites: E.E. 243 and 244 or Physics 120, 121, 122 or equivalent.

3 units, Aut, Spr (Shockley)

304. Neurocybernetics — Detailed mathematical treatment of such brain modeling problems as control of movement, reliability in neural networks, statistical interaction patterns in the brain. Prerequisites: E.E. 363A or equivalent mathematical background; E.E. 204 or equivalent background in biology or psychology.

3 units, Win (Arbib) alternate years, given 1968–69

312. Integrated Circuits — A combination laboratory and lecture course in the fundamentals of semiconductor monolithic integrated circuits: guidelines for design of integrated circuits and components, actual circuit design project, and laboratory instruction in photolithographic techniques; minimum of report preparation. Registration by permission of instructor. Prerequisite: general familiarity with p-n junction devices, e.g., E.E. 216; working knowledge of chemistry and/or photographic laboratory techniques is desirable.

3 units, Aut, Spr (Pritchard)

315. Solid State Circuits Laboratory — Experimental projects, usually of 10-weeks duration, on electrical properties, performance, and circuit design for various state-of-the-art solid state devices (including transistors, field-effect transistors, varactors, tunnel diodes), with emphasis on relationship of performance to physical mechanisms; instrumentation techniques, and a realistic minimum of report preparation. Prerequisites: previous or concurrent registration in any one of the following: E.E. 214, 216, 218, 219, 316, and permission of instructor.

3 units, Aut, Win, Spr (Angell)

316. Transistor Electronics — (Formerly E.E. 308) Discussion of performance figures of merit and limitations of linear and parametric amplifiers, active circuits, nonlinear switching and regenerative circuits based on the network theory of E.E. 214 and the cir-
circuit models developed for transistors in E.E. 216, considering both discrete component and integrated circuit technologies. Prerequisites: E.E. 214 (or 266 may be acceptable after consultation with instructor) and 216.

3 units, Spr (Angell, Meindl)

320. Solid State Electronics Seminar—Discussion by faculty, students, and guest specialists of research topics and current literature in the physical, device, and circuit aspects of solid state electronics.
1 unit, Aut, Win, Spr (Angell, Moll)

321. Magnetic Phenomena in Solids—Physical basis of magnetic phenomena in solids. Emphasis on the microscopic and atomic origin of the magnetic parameters characterizing magnetic materials, with especial attention to ferromagnetic and ferrimagnetic materials. Prerequisite: E.E. 238, or Materials Science 152, or elementary quantum mechanics.

3 units, Spr (White)

322A. Basic Quantum Mechanics—Introduction to the concepts of quantum mechanics; the postulates of quantum mechanics; observables, wave functions, and probability density; the Schrödinger equation; complementary variables and the uncertainty principle; the harmonic oscillator and particles in a box; the hydrogen atom; angular momentum; the matrix formulation of quantum mechanics; the Dirac notation. Prerequisites: Physics 57, 110, 111. Mathematics 130, and 131, or equivalent. Mathematics 113 recommended.

3 units, Aut (Heffner, White)

322B. Basic Quantum Mechanics—Time independent perturbation theory; time dependent perturbation theory; transition probabilities; spin, identical particles, and exchange; energy levels of atoms; elementary band structure; the symmetry properties of wave functions. Prerequisite: E.E. 322A.

3 units, Win (Heffner, White)

324A. Applications of Quantum Theory—A unified approach involving the density matrix to lasers, semiconductors, Raman effect, field quantization, and multiple quanta effects. Emphasis on the techniques for obtaining the appropriate equations of motion, rather than on detailed investigation of specific devices. Topics included are photoconductivity, rate equations, spontaneous emission, laser action, infrared absorption, and multiple photon absorption. Prerequisite: E.E. 322B or Physics 231.

3 units, Spr (Pantell)

324B. Applications of Quantum Theory—Quantum mechanics applied to the analysis of systems of interest to the engineer and applied physicist. Topics include: multiple photon processes, field quantization, Brillouin and Raman scattering, and electrons in crystals. Prerequisite: E.E. 324A.

3 units, Aut (Pantell)

326A. Wave Phenomena in Active Media—(Enroll in Applied Physics 250.)

326B. Wave Phenomena in Active Media—(Enroll in Applied Physics 251.)

328A. Semiconductor Theory—Physical basis for band structure in solids and application to semiconductors. Conduction mechanisms in metals and semiconductors. Extrinsic and intrinsic semiconductors. Static and dynamic behavior of p-n junctions and junction transistors. Prerequisites: Physics 57, Mathematics 130, and E.E. 322A or 338A.

3 units, Win (Moll)

328B. Semiconductor Theory—Physical basis for carrier mobility in semiconductors as limited by lattice and impurity scattering, nonlinear high field mobility, negative differential mobility, secondary ionization, and avalanche breakdown of junctions and the theory of tunnel or Zener breakdown and Esaki diodes, semiconductor surfaces. Prerequisite: E.E. 328A.

3 units, Spr (Moll)

329A,B,C. Solid State Electronics Laboratory—Experimental projects on semiconductor crystal growth, gaseous diffusion of impurities, Hall effect, minority-carrier diffusion and drift mobility, thermoelectricity, electroluminescence, Gunn effect, optical absorption, plasma reflection, etc. Registration by permission of instructor. Prerequisite: E.E. 328A or Physics 172, or Materials Science 122.

3 units, Aut, Win, Spr (Pearson)

332. Optical Properties of Solids—Basic theory with emphasis on the relationship between electronic structure and optical properties of solids. Representative semiconductors, insulators, and metals will be discussed, including Ge, GaAs, CdS, NaCl.
 ruby, Cu, and Al. Prerequisites: One group of the following: E.E. 322A and 322B (may be concurrent); Physics 230 and 231 (may be concurrent); or Materials Science 233 (E.E. 338A).

3 units, Win (Staff)

335. Seminar in Quantum Electronics and Optics—Discussion by staff and students of selected topics, such as optical coherence theory; nonlinear optical effects; optical resonators; lasers; light modulation and demodulation.

1 unit, Aut, Win, Spr (Siegman, Staff)

338A. Introduction to Solid State Quantum Theory—(Enroll in Materials Science 233.)
338B. Electrical Transport Processes in Crystals—(Enroll in Materials Science 234.)
338C. Photoelectronic Processes in Crystals—(Enroll in Materials Science 235.)

342. Radiation — Spectra; wave packets; mode density; Maxwell stresses; radiation pressure. Green's function; delta-function; retarded potentials; multipole fields; bremsstrahlung. Huygen's principle; Fresnel diffraction; dispersive and anisotropic media. Prerequisite: E.E. 244 or equivalent.

3 units, Spr (Buneman)

344. Guided Waves — Microwave network theory and normal mode theory; the Foster reactance theorem; reciprocity; equivalent circuits for a cavity; impedance of a diaphragm; variational techniques; quasi-static techniques. Perturbation theory of cavities and wave guides; applications to measurements. Mixed TE-TM modes, the sheath helix. Periodic systems, the disc loaded wave guide, and the tape helix. Wave guides filled with anisotropic media. Coupled modes. Scattering matrices. Prerequisite: E.E. 244 or equivalent.

3 units, Spr (Buneman) alternate years, given 1968–69

346. Principles of Nonlinear Optical Devices — Wave propagation in anisotropic, nonlinear, and time-varying media. Tensor description of nonlinear susceptibilities; coupled wave equations; harmonic generation; parametric amplification and oscillation; Manley-Rowe relations; interaction with vibrational waves, Brillouin and Raman scattering; electro-optic and acoustic frequency translation; light modulation; optical scanning; parametric interaction in active media. Optical resonators and waveguides. Prerequisite: E.E. 244 or equivalent.

3 units, Spr (Harris)

347. Introduction to Fourier Optics—Application of Fourier theory to the analysis and synthesis of optical imaging and data-processing systems. Topics treated include diffraction, lenses, coherent and incoherent imaging, optical data processing and holography. Prerequisite: E.E. 261 or equivalent.

3 units, Spr (Goodman)

348. Ionospheric Processes—Brief description of neutral atmosphere; production, loss and diffusion processes in the ionosphere; some aspects of geomagnetism; dynamo theory and ionospheric storms. Prerequisite: E.E. 243 or equivalent.

3 units, Spr (Staff) alternate years, given 1969–70

350. Radioscience Seminar — Student-faculty discussion of research problems in the fields of ionospheric and magnetospheric physics; radio propagation in, and radio emission by, ionized media; solar terrestrial relations; and radio and radar astronomy.

1 unit, Aut, Win, Spr (Bracewell)

354. Introduction to Plasma Physics—Plasma as a new medium; its significance in space and fusion research, individual and collective phenomena; ionization, charged particle orbits, collisions, plasma oscillations; Maxwell-Boltzmann distributions, Debye length, Landau damping, magnetionic propagation and dispersion. Sheath and probe theory, magnetic confinement, pinches, adiabatic motion, mirrors, pressures, stresses magnetogasdynamics. Prerequisite: E.E. 243 or equivalent.

3 units, Spr (Buneman)

355. Plasma Physics Seminar — (Enroll in Engineering 214.)

357A. Electromagnetic Measurements I — (Enroll in Applied Physics 350.)
357B. Electromagnetic Measurements Laboratory I — (Enroll in Applied Physics 351.)
358A. Electromagnetic Measurements II — (Enroll in Applied Physics 352.)
358B. Electromagnetic Measurements Laboratory II — (Enroll in Applied Physics 353.)
359A. Electromagnetic Measurements III — (Enroll in Applied Physics 354.)
359B. Electromagnetic Measurements Laboratory III — (Enroll in Applied Physics 355.)
360. Seminar on the Theory of Systems — Discussion of research problems and current literature in the theory of systems as applied to control, communication, and computation by faculty, students, and outside specialists. Prerequisite: E.E. 363A or equivalent.

1 unit, Aut, Win, Spr (Flügge-Lotz, Arbib)

363A. System Theory: Deterministic — Introduction to linear system concepts; impulse response, convolution, transfer functions; state-variable descriptions, analog computer realizations, normal modes, controllability and observability. Operational calculus: Fourier, Laplace and related transforms. Prerequisite: E.E. 102 or Engineering 104.

4 units, Aut, Win, Spr (Franklin, Staff)


3 units, Win (Kailath, Staff)


3 units, Spr (Luenberger, Staff)

365. Network Theory Seminar—Discussion of recent results in network theory. Prerequisite: E.E. 366 or permission of instructor.

1 unit, Spr (Newcomb)

366. Advanced Network Theory—A study in depth of topics in modern network analysis and synthesis: n-ports and properties; positive and bounded-real matrices; topological methods; scattering and imittance matrix synthesis; distributed, active, variable parameter, and equivalent networks. Prerequisites: E.E. 266 and E.E. 363A.

3 units, Win (Newcomb) alternate years, given 1968–69

367. Active Integrated Network Synthesis —Investigation of synthesis techniques for linear microelectronic structures: Thin film and integrated circuit characteristics; active-passive, lumped-distributed RC structures; operational and feedback amplifier, gyrator, and negative-impedance converter synthesis. Research topics as pertinent. Some lectures are joint with E.E. 312. Prerequisite: E.E. 366 or permission of instructor.

3 units, Spr (Newcomb) alternate years, given 1968–69


3 units, Spr (Franklin)


3 units, Spr (Widrow)

374. Contactor Control and Optimal Control—(Enroll in Applied Mechanics 236.)

375. Information Theory Seminar — Student-faculty discussion of research problems in the general field of information theory, communication theory, pattern recognition, coding theory.

1 unit, Spr (Kailath, Cover)
376. Information Theory — Information sources. The measure of entropy, information, and mutual information properties of codes; coding information sources; Huffman coding. Information channels; reliable messages through unreliable channels; Shannon’s noiseless and noisy coding theorems; channel capacity; restricted primarily to discrete channels.

3 units, Aut (Cover, Bliss)  


3 units, Win (Cover)  


3 units, Spr (Cover)  


3 units, Spr (Kailath)  

380. Seminar on Digital Systems — Discussion of current research in the area of digital systems including logic design, switching theory, and machine organization.

1 unit, Aut, Win, Spr (McCluskey, Peterson)  

381A,B. Systems Programming and the Theory of Formal Languages—(Enroll in Computer Science 236A,B.)

382. Structure of Digital Computers—(Enroll in Computer Science 231.)


3 units, Spr (McCluskey)  

384. Switching Theory and Automata — Mathematical foundations of switching theory and introduction to problems of current interest. Complexity of switching networks, difficulty of computation, cellular structures and iterative nets; regular expressions; the state assignment problem. (Topics will vary with the instructor.) Prerequisite: E.E. 281 or Philosophy 162 (E.E. 289).

3 units, Win (Staff)  


388A,B. Space Systems Engineering—(Enroll in Engineering 235A,B.)

390. Special Studies and Reading in Electrical Engineering — Special studies, under direction of a faculty member, for which academic credit may properly be allowed. (This course number is used to give credit for laboratory work, directed reading, etc. A grade of + indicates satisfactory work; no letter grade will be assigned.)

By arrangement

391. Special Studies and Reports in Electrical Engineering—Special studies, under direction of a faculty member, leading to written report or end-quarter examination. Letter grade indicates quality of written work; if letter grade based on written work is not applicable, student should enroll in E.E. 390.

By arrangement

392. Special Seminars — Each year special seminars are given on topics of current interest. These seminars are usually announced one or two quarters prior to their presentation and are given by specialists in the field. See the Time Schedule for detailed announcements.

395. Electrical Engineering Instruction: Practice Teaching—Open to a very limited number of Electrical Engineering students who plan to make teaching their career.

(Skilling) by arrangement

396A,B. Seminar on Engineering Teaching. (Enroll in Engineering 296A,B.)
397. Faculty Seminar—Discussion meetings arranged by a faculty member or initiated by interested students and sponsored by a faculty member.

1 unit, by invitation

400. Thesis and Thesis Research—Limited to students who have established candidacy for the degree of Engineer or Ph.D. A grade of + indicates satisfactory work; no letter grade is assigned.

By arrangement


430. Band Structure and Photoemission Seminar—Groups of articles will be selected from the literature and discussed. The more advanced students will assume responsibility for presenting the material for discussion.

1 unit, Aut, Win, Spr (Moll, Staff)

431. Quantum Electronics—Topics in quantum theory relevant to lasers and quantum electronics: interaction of radiation and atoms; stimulated transitions; nonlinear atomic responses; density matrix formalism; inhomogeneously broadened transitions; spontaneous emission and quantum noise. This course fills in the quantum-mechanical background and details lying behind the simplified semi-classical models presented in E.E. 231–232. Prerequisites: quantum theory to the level of E.E. 322B or Physics 231, and electromagnetic theory to the level of E.E. 142 or Physics 122. E.E. 231–232 is not a prerequisite, but reading in this course material may be necessary.

3 units, Aut (Siegman) alternate years, given 1968–69

438A. Theory of Solids—(Enroll in Applied Physics 377.)


444. Magneto-Ionic Theory and Its Applications—Introduction to plasma wave propagation in cold and warm plasmas; applications to propagation in the ionosphere from very low to high frequencies, including the whistler mode. Prerequisite: E.E. 244 or permission of instructor.

3 units, Spr (Crawford)


3 units, Aut (Bracewell) alternate years, given 1968–69

448. Theory and Application of Radio Wave Scattering—Theory of radio wave scattering from electron ensembles (e.g., meteor trails), and from turbulent and thermal fluctuations in a plasma. Scattering from metallic and dielectric spheres, cylinders, and laminas, of small and large size. Propagation through planetary atmospheres and scattering from planetary surfaces. Emphasis on physical descriptions and on applications to communications, radar astronomy, and space probes. Prerequisite: E.E. 244 or permission of instructor.

3 units, Aut (Eshleman) alternate years, given 1969–70

451. The Laboratory Plasma—(Enroll in Engineering 211.)

452. Experimental Plasma Physics I—(Enroll in Engineering 212.)

452A. Experimental Plasma Physics Laboratory I—(Enroll in Engineering 212A.)

453. Experimental Plasma Physics II—(Enroll in Engineering 213.)

453A. Experimental Plasma Physics Laboratory II—(Enroll in Engineering 213A.)


3 units, Win (Buneman) alternate years, given 1968–69

455. Astrophysics Seminar—(Enroll in Engineering 210.)
456A. Introduction to Astrophysics I: Solar-Terrestrial Relations—(Enroll in Engineering 207.)

456B. Introduction to Astrophysics II: The Sun—(Enroll in Engineering 208.)

456C. Introduction to Astrophysics III: Stars and Galaxies—(Enroll in Engineering 209.)


464C. Dynamic Optimization (Deterministic)—(Enroll in Operations Research 348.)

464D. Dynamic Optimization (Stochastic) —(Enroll in Operations Research 349.)

472A,B. Mathematics of Trajectory Optimization—(Enroll in Aeronautics and Astronautics 278A,B.)


478. Communication Channels — Fundamental principles of communication engineering; general techniques for the calculation of channel capacity and channel reliability functions; applications to signal selection, input and output quantization, probabilistic decoding, feedback schemes; primary emphasis on continuous channels. Prerequisite: second-year graduate standing or permission of instructor.
3 units, Aut (Staff)

479. Statistical Communication Theory — Study of several specific communication problems; nonlinear processing of signals and noise, modulation and demodulation techniques, algebraic coding, stochastic differential equations, zero crossing and first passage time problems. (Different choice of topics each year.) Prerequisites: E.E. 278, 363B, or permission of instructor.
3 units, Spr (Staff)

3 units, Spr (Arbib)
BACKGROUND REQUIRED

Students admitted for graduate study in Engineering-Economic Systems must have a background of undergraduate work that indicates a level of mathematical maturity customarily found in an intensive undergraduate engineering or physical science program. Although not a requirement, most students entering the Department will have completed a Master's degree in engineering, science, or business. Undergraduate coursework in economics is not required, but will prove helpful in graduate study in this field.

PROGRAMS OF STUDY

There are three programs of study, all at the graduate level, leading to the degrees of Master of Science, Engineer, and Doctor of Philosophy in Engineering-Economic Systems.

MASTER OF SCIENCE

University regulations governing the degree of Master of Science are described in the "Degrees" section of this bulletin. Department requirements provide great flexibility for meeting individual objectives. The Master's degree may be viewed as a terminal degree program to provide a professional focus, or it may be used as an exploratory vehicle to formulate and select a more advanced graduate school program. Course programs are approved individually by Engineering-Economic Systems faculty. In addition to meeting university requirements, programs must involve at least six core courses in Engineering-Economic Systems. Internships are not required in Master's degree programs.

ENGINEER

Graduate work to this level is the minimum for adequate qualification as a "System Engineer." In addition to the University's basic requirements as described in the "Degrees" section of this bulletin, all Engineer degree candidates must demonstrate their proficiency in solving practical problems by either the completion of a field project or the equivalent experience outside the University.
DOCTOR OF PHILOSOPHY

The doctoral program in Engineering-Economic Systems involves more academic breadth and deeper research activity than the Engineer degree. The "Degrees" section of this bulletin discusses the University's basic requirements for the Ph.D. degree. To be admitted to the Engineering-Economic Systems doctoral program, students must pass an examination given during the winter quarter of the first graduate year. Later, in addition to the University oral examination, comprehensive area examinations are given covering the candidate's graduate systems courses.

MINORS IN ENGINEERING-ECONOMIC SYSTEMS

Doctoral students throughout the University may complete a minor in Engineering-Economic Systems by taking 15 units of core systems courses selected from the list below. The selection must be approved by the student's department adviser and by the Engineering-Economic Systems faculty. The primary aim of this minor is to develop system analysis and decision-making capabilities for graduate students who anticipate careers associated with system problems. Candidates for a minor in Engineering-Economic Systems will be required to pass an examination on the material they have taken in the core course program. The standard of achievement in these examinations is the same for minor as for major candidates.

SYSTEM INTERNSHIPS

Since system problems cannot be captured within a university, internships are offered to help the student develop his ability to solve system problems in the field environment. Those students who have not had adequate previous experience typically serve one or more internships under the general supervision of the Engineering-Economic Systems staff.

Problems of broad scope requiring a system viewpoint and thus suitable for the internship experience are found in large industrial firms, in companies and research groups concerned with the design and operation of civilian and military systems, and in government agencies planning and executing public works and economic development projects. Opportunities also exist to participate in economic and industrial planning in developing countries.

The duration of internship will normally be between six and twelve months, but depends upon the time required to complete each project successfully. While interning, the student will live on location and work as an employee responsible to the company or agency concerned. The Engineering-Economic Systems faculty will locate and screen suitable internship opportunities in a variety of areas, but the student bears the responsibility for selecting an appropriate problem and for arranging conditions of employment. The faculty will review each proposed project to verify its educational value.

The student's internship work in the field is mainly directed toward the successful solution of a real-world problem. Consequently, the student will gain an appreciation for the approximations and compromises with rigor that characterize applied research. After returning to the University, the student will complete a given casework phase of his program by reexamining his field work in the light of the fundamental principles of system analysis, pointing out the shortcomings of the existing theory in this application, and abstracting from his experience the general insight that he expects to be useful in future studies.

One internship project or equivalent practical experience is standard in both degree programs. There is wide flexibility in the Ph.D. program to accommodate the particular interest of the student. The internship experience develops the student's appreciation for the relation between general and applied work and guides him in selecting a meaningful research topic.

The variety of internships available will vary in time as new problem areas become of interest. The aim is to undertake projects that are technically challenging, practically significant, and theoretically enlightening.

AREAS OF APPLICATION

Although system concepts are portable and their generality must be emphasized, studies in depth in specific fields are important. A practitioner, to be responsible and effective, must combine general system knowledge of vital factors relevant to his particular specialty. Technical specialties
are developed through the internship program, exploratory projects done on the campus, applied research projects, and special applied courses of less permanent nature than core courses.

Industrial system studies involve problems of organizing the complex activities of a production-distribution system and of selecting a strategy for corporate research, development, marketing, and facility expansion.

Public systems are involved with both local and national problems of our society. Problems of transportation, water resources, power resources, communication, justice and crime prevention, health services systems, military systems and public administration are examples.

Development systems are related to problems of local, regional, and national development both within the United States and in foreign countries. Infrastructure development involves transportation, communication, banking and finance, water resources, electric power, and education.

Human systems studies involve problems of man-machine systems, communication, automated instruction, educational system planning, human resource development, motivation and personal development.

The above list of application areas is not intended to be exclusive or exhaustive. New system areas will be undertaken whenever technically interesting and practically significant problems arise in these areas and there is adequate faculty and student interest and commitment to sustain them.

Courses of Study

Study programs are selected to give a broad coverage as well as work in depth in one or more specific areas. There are four categories of courses: (1) foundation courses from physical sciences, social sciences, and mathematics; (2) general core courses in engineering-economic systems; (3) casework courses for the various practical areas; and (4) other elective courses.

Foundation Courses

System analysis is a young discipline that draws many of its models and methods from mathematics, physical science, and social science. Future developments in system analysis will often be an outgrowth of concepts born in these foundation fields. The course program includes a selection of foundation material from the offerings of many departments so that the system student will have the breadth to contribute to the growth of his profession both now and for years to come. The stronger a student's background in foundation courses, the greater will be his flexibility to move from area to area as career opportunities develop. The list of relevant foundation courses is very long, including a wide variety of mathematics as well as the basic material of the physical and social sciences. A partial list includes:

Mathematics
113, 114. Linear Algebra
115, 116. Analysis
120, 121. Modern Algebra
137, 138. Numerical Analysis
205A,B,C. Real Variables
206A,B,C. Complex Variables
220A,B,C. Methods of Mathematical Physics

Physics
210, 211, 212. Introductory Theoretical Physics

Economics
202. Price and Allocation Theory
241. Public Finance and Taxation

Business
200, 201. Business Economics

Core Courses in Systems

Engineering is distinguished from science by its emphasis on decisions concerning commitment of resources. The engineering-economic systems profession is characterized by its broad concern with the physical, economic, social, and political implications of systems decisions. The central focus of graduate study in systems is a set of portable concepts or tools of thought that apply to a broad spectrum of system problems. The three primary aspects in system work are: (1) intersystem relationships—how system planning decisions depend on a system's relationship to other systems at the same and other levels of the systems hierarchy; (2) decision analysis—logical balancing of the factors that affect a decision; and (3) system analysis—development of the models for structuring and procedures for optimizing that formalize the selection among system alternatives. Core concept courses are divid-
ed into these categories. Although students are not required to take any specific courses, material relevant to these categories is covered in comprehensive area examinations and will be found in the following courses:

1. **Intersystem Relationships**: E.E.S. 210, 211, 212A,B, 260.
2. **Decision Analysis**: E.E.S. 231A,B.
3. **System Analysis**—
   a) **Modeling**—
      1) **Introductory System Analysis**: E.E.S. 201A,B,C.
      2) **Probabilistic Models for Problems of Uncertainty**: E.E.S. 221, 251A,B.
   b) **Optimization**—
      1) **Concepts of Optimization**: E.E.S. 243, 263A,B.
   c) **Laboratory and Applications**—
      1) **System Analysis Laboratory**: E.E.S. 220.
      2) **Man-Machine Systems**: E.E.S. 223.

**FINANCIAL ASSISTANCE AND ADMISSION**

A limited number of fellowships and research assistantships are awarded annually. The fellowships are usually awarded to newly entering students; the assistantship is used primarily for advanced graduate students. Applicants for all forms of assistance may obtain the necessary application forms from the University Admissions Office. Applications for fellowships must be made by the fifteenth of January preceding the fall quarter that admission is desired and must be accompanied by application for admission. Research Assistantships, however, are awarded by the individual faculty research supervisors, not by the Department, and have no such deadline. Applicants, because of the individual nature of these awards, are advised to contact directly the faculty member under whom they wish to work. Formal applications to the Department for research assistantships will be referred to the individual faculty research supervisors. Research assistants can, and normally do, carry out their thesis work and write their theses as an integral part of the commitments of their assistantship.

Except in unusual circumstances, admission to the Department of newly entering graduate students is confined to the fall quarter because the course offerings are arranged sequentially with basic courses and prerequisites falling early in the academic year.

**COURSES**

**CORE COURSES**

**Intersystem Relationships**

210. **Introduction to Price Theory and Resource Allocation**—Theory of economic organization, operations of markets, prices as guides for a decentralized economy, criteria for evaluation of performance, planning rules for efficient organization and operation.

3 units, Aut (Staff) MW 11:00–12:15

211. **Economics of Public Works**—Analysis of government production of services, criteria for investment, price and non-price rationing of services, financing of services, particular attention to resources development, transportation and public planning. Prerequisite: 210 or consent of instructor.

3 units, Win (Margolis) MW 11:00–12:15

212A.B. **Price and Income Theory** — This two-quarter sequence in economic theory is designed for the student with little or no previous knowledge of economics, but who has a strong background in mathematics (minimum of advanced calculus; some matrix theory is desirable). The objective of this sequence is to give the student a knowledge of economic theory sufficient for him to read in the professional literature and to comprehend the material presented at a graduate level in other areas of economics such as econometrics, public finance, economic development, and international trade.

3 units, Win, Spr (Lind) MW 11:00–12:15

260. **Governmental Systems: Political and Administrative** — Development of a set of models to characterize the behavior of governmental bodies. Economic analysis (allocation theory and strategic analysis) will be the principal tools. Units to be studied include administrative, legislative, executive, and judicial bodies. Processes to be studied include budgetary, electoral, functional changes, political leadership, centralization, information, political exchanges, and corruption. Criteria to evaluate structural changes suggested by welfare economics and political philosophy will be considered.

3 units, Aut (Margolis) MW 11:00–12:15
DECISION ANALYSIS

231A,B. Decision Analysis — Development of a normative rationale for action in the face of uncertainty and of the procedures necessary to reduce the rationale to practice. Encoding of uncertainty, values, and criteria. Discussion of utility measures of risk preference and discounting measures of time preference. Analysis of problems using decision trees that include risk and time preference. Determination of the economic value of perfect and imperfect information on one of several variables in a decision problem. Design of economic information-gathering experiments. Relationship of this approach to classical procedures. Presentation of examples that range from design change to competitive bidding. Applications drawn from private and public sectors of the economy. First quarter self-contained; second quarter emphasizes project in which teams of students analyze current decision problems drawn from a variety of sources. Pre-requisite: E.E.S. 221 or equivalent.

3 units, Win, Spr (Howard) TTh 9:30-10:45

SYSTEM ANALYSIS

MODELING

201A,B,C. Introductory System Analysis — Introduction to analytical concepts of modeling and optimization necessary for system engineering. Static equilibrium models, least squares and data analysis, static allocation problems, constraints and Lagrange multipliers, primal and dual problems. Introduction to linear dynamic system concepts. The superposition concept, Fourier and Laplace transforms, the Z-transform. State variable concepts, flow-graph manipulation, eigenvalue analysis and normal coordinates. Resolvents and functions of matrices. Comparison of discrete and continuous systems, iterative procedures for solving simultaneous equations, numerical solution to differential equations. Applications. Concurrent registration in Mathematics 113 and 114 desirable. This sequence includes the material formerly in E.E.S. 240 and 250A,B.

3 units, Aut, Win, Spr (W. Linvill, Staff) TTh 7:35-8:50

221. Probabilistic System Analysis—A self-contained development of probability theory that is both theoretically sound and suited to application. Appropriate either as a terminal course or as a foundation for further graduate work in applied areas. Theory presented axiomatically with emphasis on sample space representation for both discrete and continuous random variables. Discussion of basic concepts, description of random variables, changes of variable, transform techniques, named distributions, and computer simulation. Goal is to provide student with same understanding and competence in analysis of probabilistic problems that he already possesses in dealing with deterministic problems.

3 units, Aut (Howard) TTh 9:30-10:45


3 units, Win, Spr (Smallwood) TTh 11:00-12:15

CONCEPTS OF OPTIMIZATION


3 units, Spr (Luenberger) MWF 10

263A. System Optimization — Introduction to functional analysis; linear vector spaces, normed spaces, Hilbert space. The projection theorem in Hilbert space with applications to approximation, control and estimation theory. Dual spaces and linear functionals, the Hahn-Banach theorem. Prerequisite: Mathematics 113 or E.E.S 201B.
Mathematics 115 is recommended but not required.

3 units, Aut (Luenberger) MWF 2:15

263B. System Optimization — Linear operators; inverses; adjoints, pseudo-inverses. Minimization of functionals; calculus of variations, Feuchel duality. Constrained optimization: Lagrange multipliers, Kuhn-Tucker theorem, duality, optimal control theory. Iterative techniques of optimization. Prerequisite: E.E.S. 263A.

3 units, Win (Luenberger) MWF 2:15

LABORATORY AND APPLICATIONS

220. System Analysis Laboratory—A laboratory course to develop practical judgment and physical insight prerequisite to the successful application of the formal models and mathematical methods of system analysis. The student is presented a simulated real world problem and asked to plan an approach to the problem, formulate the problem in quantitative terms, model the physical processes relevant to the problem, design experiments consistent with the economics of the problem, and finally to write a report that describes his solution in a manner helpful to the manager or designer of the hypothetical system.

2 units, Spr (Murray, Smallwood)

223. Man-Machine Systems — Investigation into those systems that require a quantitative analysis of the human component in the system. Emphasis on quantitative modeling of this human component. Specific system areas considered include: manual control, monitoring, decision making, automated instruction, and medical diagnosis. Discussion of the paramount importance of this area to future systems. Prerequisite: E.E.S. 221 or equivalent. Familiarity with Laplace transforms is recommended.

2 units, Aut (Smallwood) TTh 3:15

CASEWORK, SEMINARS, RESEARCH

290. Applications Workshop—Student participation in an ongoing program applying the complementary knowledge of University faculty, graduate assistants, and visiting fellows to a problem of importance to society. Lectures by faculty and visiting fellows survey the substantive issues, the approach being taken, and the research in progress. Class discussion defines additional studies that can contribute to the program. Sample topics are: health systems planning, educational systems planning, regional development, energy resource development, and transportation planning. Prerequisite: consent of instructor.

Aut, Win, Spr (Staff)

291. System Research Seminar — Group study of an area of current system research. Topics may include areas of optimization theory, decision theory, economics, numerical analysis, etc. Topics will be announced on a quarterly basis.

1 unit, Aut, Win, Spr (Staff)

292. Directed Reading and Research in Engineering-Economic Systems — Directed study and research on subject of mutual interest to student and staff member.

1 or more units, any quarter (Staff) by arrangement

300. Thesis and Thesis Research—Limited to students who have established candidacy for the degree of Engineer or Ph.D. A grade of + indicates satisfactory work; no letter grade is assigned.

Any quarter (Staff) by arrangement

341A,B,C. Seminar in Public Finance — (Enroll in Economics 341A,B,C.)

GENERAL ENGINEERING

Program Advisers: James M. Gere (Chairman), Robert H. McKim, Ralph J. Smith, Alan S. Tetelman, David A. Thompson

PROGRAM OF STUDY

Each student majoring in General Engineering, with the exception of students following prescribed Product Design or Resource Strategy programs, must submit a petition to the General Engineering Committee explaining his career objectives, academic plans, and proposed program of courses. Petitions should be prepared by the student in consultation with one of the Program Advisers for General Engineering, and will be approved by the Committee only if the proposed program is adequate in quantity and quality of course work. Students transferring to General Engineering from another curriculum must also petition as described
above. All petitions for General Engineering should be filed preferably during the last quarter of the junior year, but in any case not later than the middle of the third quarter preceding graduation. Petitions submitted later will not normally be considered. (For additional information about the petition, consult the Office of the Dean of Engineering.)

A program in Product Design is offered within General Engineering by the Design Division of the Department of Mechanical Engineering. The Product Design program is directed to the student who would combine technical and human interests into a practicing philosophy of design. It is recommended that the undergraduate program in Product Design should not be considered terminal; the Master's program in Product Design is described in the section on Mechanical Engineering. The undergraduate program in Product Design is as follows:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.E. 4</td>
<td>Materials and Processes</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 50</td>
<td>Mechanisms</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 112A,B,C. Rapid Visualization, Introduction to Product Design, and Environmental Design</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>M.E. 114A</td>
<td>Mechanical Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 116A,B,C</td>
<td>Advanced Product Design</td>
<td>9</td>
</tr>
<tr>
<td>C.E. 114</td>
<td>Mechanics of Materials</td>
<td>3</td>
</tr>
<tr>
<td>Art 1</td>
<td>Introduction to Art</td>
<td>3</td>
</tr>
<tr>
<td>Art 40</td>
<td>Basic Drawing and Painting</td>
<td>3</td>
</tr>
<tr>
<td>Art 50</td>
<td>Basic Sculpture</td>
<td>3</td>
</tr>
<tr>
<td>Art 60</td>
<td>Basic Design</td>
<td>3</td>
</tr>
<tr>
<td>Art 140</td>
<td>Drawing I</td>
<td>3</td>
</tr>
<tr>
<td>Art 150</td>
<td>Sculpture I</td>
<td>3</td>
</tr>
<tr>
<td>Art 160</td>
<td>Comprehensive Design I</td>
<td>3</td>
</tr>
<tr>
<td>Art 161</td>
<td>Comprehensive Design II</td>
<td>3</td>
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<tr>
<td>Electives</td>
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<td>3 or more</td>
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<tr>
<td></td>
<td></td>
<td>57 or more</td>
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</table>

A program in Resource Strategy is offered for engineering students interested in the techniques of applying modern science and technology to the problems and resources of developing regions. The program is intended to provide a broad educational background which, with experience, will enable the engineering graduate to analyze the needs of a political or geographical area, to evaluate the available resources, and to devise an optimum plan of development.

It is expected that graduates would be suited for service with international development agencies of the Federal Government, in the Peace Corps, in the Department of the Interior, with state and local governments, in international operations of private concerns, or with foreign governments. The program is particularly suited to foreign students seeking to prepare themselves for positions of leadership in their home countries.

In satisfying the General Studies requirements, Anthropology 1, Economics 1, and Philosophy 5 are recommended. The required 25 units of Engineering should be selected to provide special competence in an area such as transportation, communication, industrial enterprise, or civil works. Up to 12 units of elective courses may be devoted to a foreign language. The remaining elective units should be selected by the student in consultation with his adviser. Attention is called to the availability of the following courses:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthr. 131</td>
<td>Comparative Social Systems</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 150</td>
<td>Transportation Engineering</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 170</td>
<td>Man and His Environment</td>
<td>3</td>
</tr>
<tr>
<td>Econ. 118</td>
<td>Underdeveloped Economies</td>
<td>5</td>
</tr>
<tr>
<td>Ed. 206A</td>
<td>Comparative Education</td>
<td>3</td>
</tr>
<tr>
<td>Engr. 181A,B,C. Seminar in Resource Strategy</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>E.E.S. 212</td>
<td>Water-resources Planning</td>
<td>3</td>
</tr>
<tr>
<td>I.E. 100</td>
<td>Industrial Organization</td>
<td>4</td>
</tr>
<tr>
<td>I.E. 263</td>
<td>Engineering and Organization of Small Businesses</td>
<td>3</td>
</tr>
<tr>
<td>Pol.Sci. 107</td>
<td>Seminar in Government and Natural Resources</td>
<td>5</td>
</tr>
<tr>
<td>Sociol. 175</td>
<td>The Evolution of Underdeveloped Societies</td>
<td>5</td>
</tr>
</tbody>
</table>

**INDUSTRIAL ENGINEERING**

Emeritus: Eugene L. Grant (Professor)
Executive Head: W. Grant Ireson.

Professors: W. Grant Ireson, Robert V. Oakford

Associate Professors: David V. Heebink, Roy E. Lave, Jr., David A. Thompson

Assistant Professor: Hugo A. DiGiulio

**PROGRAMS OF STUDY**

**BACHELOR OF SCIENCE**

The program leading to the degree of Bachelor of Science in Industrial Engineering is given earlier under School of Engineering. This curriculum is planned to serve those students whose long-run objective is the planning, designing, and implementing of complex economic and technological...
management systems where a scientific and engineering background is necessary or desirable. The fundamentals of engineering are stressed; 68 percent of the program is common to all of the engineering curricula and an additional 16 percent is of technical nature in engineering, mathematics, and statistics. The Industrial Engineering program is designed to introduce the student to measurement and control theory, organization theory and behavior, management, economic analysis and modeling, facilities planning and design, and utilization of computers and information systems. The objective is to provide the student with systems concepts, the role and function of management, methods of analysis, and the human and economic factors that bridge the gap between pure engineering design and pure management.

ADVANCED DEGREES

The Industrial Engineering Department, in collaboration with other departments of the University, offers programs leading to the degrees of Master of Science, Engineer, and Doctor of Philosophy in Industrial Engineering. Options at the Master’s degree level are available in

1. Management Systems Design
2. Economic Systems Planning
3. Systems Analysis and Synthesis
4. Computer Utilization

Opportunities for special study are available under the first three of these options. The Management Systems Design option incorporates production systems, information systems, man-machine systems, program management, and managerial economics; the Economic Systems Planning option presents special work in planning, programming, and budgeting systems (PPBS), economic development, and engineering economy. Systems Analysis and Synthesis concentrates on analytical methods, systems synthesis, and control methods.

Applicants for admission as graduate students in Industrial Engineering must submit the results of the Graduate Record Examination.

MASTER OF SCIENCE

The Master of Science degree programs require a minimum of 45 units beyond the equivalent of a Bachelor of Science degree at Stanford. All programs represent substantial progress in the major field beyond the equivalent of a Bachelor’s degree. Suggested, or sample programs, leading to the degree of Master of Science in Industrial Engineering without specialization or with specialization in one of the four option areas previously listed are available. These sample programs and the requirements for the Master of Science degree may be obtained from the Department of Industrial Engineering.

All Master of Science degree programs must contain certain core courses unless the student has already had equivalent courses before entering the Industrial Engineering graduate program. Only 12 units of these core courses may be applied toward the 45 units required for the M.S. degree.

Any student admitted to graduate standing on the basis of a Bachelor’s degree in a field other than engineering must complete 45 units of work as outlined above, but must also have successfully completed the following courses or their equivalents:

Physics 51, 53, 54, 55 and 56,
and Math 41, 42, 43 and 44.

In addition, the student must have successfully completed or must take whatever courses are required as prerequisites for the courses listed on his program for the M.S. degree.

ENGINEER

The Engineer degree normally requires two years of academic work beyond the Bachelor’s degree. Normally a program of study for the Engineer degree will include the courses required for the M.S. plus approximately 30 units of additional courses of a more advanced level and a dissertation. Up to 15 units may be allowed for the dissertation. The purpose of the dissertation is to prove the professional competence of the candidate and not necessarily to make an original contribution to knowledge.

DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is offered under the general regulations of the University. The program requires a minimum of three years (nine quarters) of graduate study, at least one year of which must be at Stanford. The first year is represented
by the M.S. program. The completion of an acceptable dissertation may occupy most of
the third year of study.

The program of study will be arranged
by the candidate with the advice of a Fac-
ulty Committee of three appointed by the
Department head and having as chairman
the faculty member who will direct the the-
esis work. The final program must be ap-
proved by the Department.

ASSISTANTSHIPS AND
SCHOLARSHIPS

A limited number of fellowships and as-
sistantships with stipends of $750 to $3,500
a year are awarded each year. Application
forms and detailed information may be ob-
tained by writing the Department of Indus-
trial Engineering. Applications should be
made by March 1 preceding the start of the
academic year for which the award is to be
made.

The University Information Bulletin
should be consulted for a description of the
procedure for making application.

UNDERGRADUATE COURSES

50. Human Values in a Technological So-
ciety—Seminar on the interaction between
personal and societal value systems and tech-
nology. Enrollment limited to 15 engineering
and humanities majors.

2 units, Aut, Spr (Thompson) M 2:15–
4:05

100. Industrial Organization and Behavior
—Organization theory; research in organiza-
tional behavior; relationships among organ-
zational functions; the industrial engineer
in organizations.

4 units, Aut (——) MTWF 8
Win (——) TWHF 11
Spr (——) MTWF 10

108. Work Design and Measurement
—Concepts and techniques of designing and
improving work performance and product-
tivity of men and man-machine systems.
Flow sequences, human physiological infor-
mation processing capabilities and resultant
work design principles, and measurement
and evaluation of work with respect to time
and wages. Prerequisite: 120 (or concurrent
registration).

3 units, Aut (Thompson) MWF 9
Spr (Thompson) MWF 11

120. Quality Control by Statistical Methods
—Use of statistical techniques in control of
quality and reliability of manufactured
product. Shewhart control charts. Lot-by-lot
sampling inspection. Application of proba-
bility theory to sampling acceptance proce-
dures. Economic criteria. Assumes knowl-
dge of basic probability and statistical con-
cepts. Prerequisites: Statistics 27 or 110 or
116.

3 units, Win (——) MWF 11

133. Industrial Accounting—Principles of
financial and cost accounting, fixed asset ac-
counting, cost control, standard costs, taxes.
Interpretation and use of accounting infor-
mation for engineering decisions. (Students
who have taken or are taking a university
course in elementary accounting are not ad-
mitted to this course.)

4 units, Aut, Win, Spr (——) MWF 8
plus one hour by arrangement
Sum (——) MTWT/F 10

141. Utilization of Computers—Background
necessary for effective use of computers in
industrial engineering and management
problems; machine characteristics; automa-
tic languages. Data processing. Numerical
techniques. Systems applications. Prerequi-
site: Engineering 5 or Computer Science
50A or 136.

3 units, Aut (——) MWF 9
Win (——) MWF 1:15
Spr (DiGiulio) MWF 8

141A. Utilization of Computers—Same con-
tent as 141 with additional basic material on
programming. Intended primarily for grad-
uate students who have had no prior com-
puter programming experience.

4 units, Aut (——) MWF 1:15
and F 2:15

152. Introduction to Operations Research I
—(Enroll in O.K. 152.) Introduction to de-
terministic models in operations research.
Linear, nonlinear, and dynamic program-
ing. Network analysis, inventory theory,
simplex method, transportation problem,
dual theorem, convex programming, integer
programming, structure of deterministic
dynamic programming problems, minimax
theorem. Matrix notation will be introduced. (Not open to graduate students. See 252.) Prerequisite: Differential Calculus.

3 units, Win (Lieberman) MW 4:15–5:30


3 units, Spr (Iglehart) MW 4:15–5:30

161. Design of Production Systems—First of a two-quarter sequence on the design, scheduling, and control of production systems based on mathematical, computational, and other modern analytical techniques. The first quarter will be devoted to the design and selection of production systems including: creation of new facilities, the expansion or modernization of existing facilities, and the determination of plant location and size. (Not open to graduate students; see I.E. 260). Prerequisites: 141, 153, and Statistics 110.

3 units, Aut (——) MWF 8

162. Scheduling and Control of Production Systems—Continuation of I.E. 161. Operational problems of production systems including: control of purchased materials inventory; scheduling of job shop, hatch, and continuous production processes for single and multi-item product lines; planning of work force and inventory under seasonal and stochastic demand. (Not open to graduate students; see I.E. 260). Prerequisite: I.E. 161.

3 units, Win (——) MWF 1:15

199. Senior Seminar — Includes a major term project by each student. Class discussion of projects and problems, case studies, guest speakers, industrial visits. Emphasis on broad problems requiring initiative, ingenuity, the judicious selection and integration of analytical techniques from all previous course work. Prerequisites: senior standing and 162.

3 units, Spr (——) TTh 1:15–3:15

Courses Primarily for Graduate Students

208. Biotechnology—Design and analysis of human and man-machine physiological information processing systems. Subjective decision making. Physical fatigue. Prerequisite: consent of instructor.

3 units, Aut (Thompson) MWF 10

220. Product Assurance—Current practices in program planning and control of quality and reliability in both industry and government. Design, production, testing and economic considerations. Plant visits to local industry. Prerequisite: 120.

3 units, Spr (Ireson) TTh 10; lab. Th 1:15–4:05


3 units, Spr (Veinott) MWF 2:15


2 units, Aut (——) TTh 12

230. Capital Budgeting — Formulation of the capital budgeting problem with and without complete information. Computational aspects of the capital budgeting problem—equivalence formulas and mathematical programming. Short-term and long-term borrowing as part of the capital budgeting problem. Prerequisite: Engineering 60, or 161, or I.E. 229.

3 units, Win (Oakford) MWF 1:15

Spr (Oakford) MWF 8

231. Problems in Engineering Economy—Independent study of selected problem in engineering economy. Prerequisites: Engineering 161 or I.E. 229 and consent of instructor.

1 or more units (Staff) by arrangement

232. Engineering Economy Cases—A series of case studies dealing with special problems in engineering economy. Emphasis will be on application of fundamental principles of
engineering economy to regulated publicly and privately owned utilities, transportation, benefit/cost studies, income tax, leases vs. ownerships, and replacement. Prerequisite: Engineering 60, or 161, or I.E. 229.

3 units, Win (Ireson) TTh 11

235A,B. Program Management—Offered in conjunction with Engineering 235. Provides integrative and managerial support necessary to accomplish the conception, design, and implementation of large, complex, technical programs. Emphasis on organization and management for R and D, economic analysis of benefits and costs of system under study, and techniques of planning and reporting status of progress of the system study.

3 units, Win, Spr (——) TTh 1:15–3:05 and two hours by arrangement

241. Electronic Computation and Data Processing — Advanced programming techniques, computer systems design, problem formulation and industrial engineering application of digital computers. Prerequisites: 141 or equivalent.

3 units, Win (DiGiulio) MWF 2:15 Spr (DiGiulio) MWF 11

243. Computation and Data Processing Laboratory—Application of electronic computation machinery to problems related to Industrial Engineering, business management, management science, and systems design. Student will choose problem, program solution, test program, prepare data input, obtain and analyze output. Prerequisite: 241.

1 or more units, any quarter (Staff) by arrangement

244. Seminar on Cybernetics and Management — The theories of control and communication will be developed with emphasis on computer aided management problems. The practical interpretations of stability and optimization will be discussed with specific examples from technological and economic models. Prerequisites: Two courses in computer programming and advanced calculus or consent of instructor.

2 units, Aut (DiGiulio) by arrangement

250. Deterministic Models in Operations Research—(Enroll in O.R. 250.) Formulation, solution, and analysis of mathematical programming models in operations research, including those of integer programming, nonlinear programming, network flow theory, dynamic programming, and game theory. Prerequisite: Linear Programming.

3 units, Win (——) TTh 4:15–5:30


3 units, Spr (——) MW 4:15–5:30

252. Operations Research—(Enroll in O.R. 252.) For graduate students who have not had the equivalent of I.E. 152 and 153. See I.E. 152 and 153 for course content. Prerequisites: Calculus and Statistics 27 or 110 or 116.

4 units, Aut (Cottle) MW 3:15–5:05 Win (Iglehart) MW 4:15–6:05

257. Data Processing in Operations Research—(Enroll in O.R. 257.) Seminar in selected topics in the application of electronic computers to operations research activities. Emphasis on the use of simulation techniques. Prerequisites: 141 and at least two courses in Operations Research. (Concurrent registration in one permitted.)

3 units, Win (Bonini) MW 4:15–5:30

260. Design of Production Systems — For graduate students who have not had the equivalent of I.E. 161 and 162. See I.E. 161 and 162 for course content. Not open to undergraduates. Prerequisites: 141, 153 or 252, and Statistics 110.

4 units, Win (——) MWF 10 plus one hour by arrangement

261. Advanced Production Engineering — Advanced problems in factory planning, materials handling, production-line techniques, automation, plant facilities. Prerequisite: 162, or 260, or consent of instructor.

3 units, Aut (Ireson) TTh 9 and Th 1:15–4:05, alternate years, given in 1969–70

262. Advanced Production Systems Design — Methods of modeling using Markov chains; illustrated with a wide range of applications with special emphasis on control systems. Use of the statistics obtainable from the Markov formulation, estimation meth-
ods, tests of hypotheses for fitting data, state reduction techniques, model validation and control, optimization with policy iteration and linear programming. Prerequisites: 152 and Statistics 110 and 116 or 27.

3 units, Aut (Lave) TTh 9; lab. Th 1:15–4:05 alternate years, given in 1968–69

263. The Engineering and Organization of Small Businesses—A laboratory for the development of a technical idea, embodied in a specific product, into an economic enterprise. Includes product selection, market analysis, pricing, engineering design, production design, economic analysis, establishment of marketing organization, financing and financial planning, design of management organization. Inputs from practicing small businessmen are obtained. Students, including qualified undergraduates, from all appropriate disciplines are encouraged to enroll. May serve as an orientation for a summer economic development project. Prerequisite: consent of instructor.

3 units, Win (——) TTh 9; lab. T 2:15–5:05

264. Models for Production Planning—Technical analysis of production planning problems, including long-range planning of production, workforce, inventory levels, capacity scheduling, location of facilities, design of assembly lines and materials handling systems, and inspection-maintenance-replacement policies, based on analytical techniques. Prerequisites: 252 and 260 or equivalent.

3 units, Spr (Hillier) MWF 10

280. Seminar in Biotechnology—Special topics concerning the biological technological interface, particularly compatible man-machine systems. May be taken twice for credit. Prerequisite: consent of instructor.

2 units, Win (Thompson) Th 2:15–4:05

291. Industrial Engineering Problems—Directed study on subject of mutual interest to student and staff member. Student must find a faculty sponsor.

1 or more units, any quarter (Thompson) by arrangement

300. Dissertation — Required for degree of Engineer.

Aut, Win, Spr (Staff) by arrangement

301. Dissertation — Required for degree of Doctor of Philosophy.

Aut, Win, Spr (Staff) by arrangement

312. Decision Problems in National Defense—A study of national defense planning and the factors controlling decision.

3 units, Spr (——) by arrangement


3 units, Win (Cottle) MWF 11


3 units, Aut (——) TTh 9–11


3 units, Aut (Hillier) TTh 4:15–5:30

Associate Professors: Arthur I. Bienenstock, William D. Nix, David A. Stevenson (on leave 1968–69), Alan S. Tetelman
Assistant Professor: Craig R. Barrett
Lecturers: Claus G. Goetzel, Egon E. Loeblner, Sydney O'Hara

Members of the faculties of other divisions of the University giving courses or cooperating in the offerings of the Department of Materials Science are Norman A. Parlee and George A. Parks.

Offerings and Facilities

Materials science is concerned with the relation between the structure and properties of materials, factors which control the internal structure of solids, and processes for altering the structure and properties of solids. It brings together in a unified discipline the developments in physical metallurgy, ceramics, and the physics and chemistry of solids. The undergraduate program of the Department, described under School of Engineering, provides training for the physical metallurgist or materials engineer and also preparatory training for graduate work in materials science. Able students are encouraged to take at least one year of graduate study to extend their course work and to obtain training in research. Graduate programs lead to the degrees of Master of Science, Engineer, and Doctor of Philosophy.

Facilities for Instruction and Research

The Materials Science Department occupies an area of 30,000 square feet in the Thomas F. Peterson Engineering Laboratory building. The laboratory includes modern facilities for teaching and research in physical metallurgy and materials science. Ordinary melting and heat treating furnaces are included as well as furnaces for vacuum melting, zone refining, and crystal growing. Mechanical testing equipment includes hardness measuring devices, variable strain rate machines for mechanical deformation studies, creep machines and equipment for dynamic elastic modulus and internal friction measurements. For studying the structure of solids, there are optical and electron microscopes as well as X-ray and electron diffraction machines, X-ray fluorescent equipment, gamma ray spectrometer, electron probe microanalyzer, nuclear magnetic resonance spectrometer and equipment for standard electrical, magnetic, and optical measurements.

The Department, together with Physics, Chemistry, and Solid State Electronics, participates in an interdisciplinary Center for Materials Research that has been established at Stanford by funds from the Advanced Research Projects Agency. The Center, with a budget of a million dollars a year, provides equipment, service facilities, and funds for faculty and student research. In addition the Center provides 35,000 square feet of space for materials research in the McCullough Building.

Programs of Study

Bachelor of Science

The undergraduate Materials Science program provides training in solid state fundamentals and in physical metallurgy. In addition to the General Studies requirements, the curriculum includes the “Courses Normally Taken by All Engineering Students” and the Materials Science supplementary requirements. Electives are available so that students with broad interests can combine Materials Science with work in another science or engineering department.

Advanced Degrees

Graduate students can specialize in any of the areas of Materials Science. In collaboration with other departments of the University, additional special programs are available. For example:

Materials Science—Electronic Materials
Materials Science—Applied Mechanics and Structures

Master of Science

The University’s basic requirements for the Master of Science degree are discussed in the section “Degrees” in this bulletin. The following are Departmental requirements:

1. Completion of the equivalent of the requirements for the B.S. degree in Mate-
rials Science. Deficiencies in previous training should be made up and not more than 15 units of such work may be counted as part of the minimum total of 45 units.

2. Completion of 45 units of an approved program. A minimum grade point average of 2.75 for course work is expected. The program should contain the following:

a) A minimum of 20 units of advanced courses in the general area of Materials Science (excluding research and special problems), including 3 of the following:
   Mat. Sci. 204. Wave Mechanics
   Mat.Sci. 222. Statistical Thermodynamics
   Mat.Sci. 232. Point Defects in Crystals
   Mat.Sci. 237. Dislocations in Crystals

b) A minimum of 9 units of courses outside of the Materials Science Department.

c) A minimum of 6 units and not more than 12 units of Mat.Sci. 200 (Special Problems) with a Master's Research Report approved by two faculty members. This requirement is optional at the discretion of candidate's adviser. Zero units of Mat.Sci. 200 are allowed if no Master's Report required.

3. Passing a comprehensive written examination to test the candidate's proficiency in Materials Science and related fields of knowledge.

ENGINEER

The University's basic requirements for the degree of Engineer are outlined in the section "Degrees" in this bulletin.

The following are Departmental requirements:

1. Completion of the substantial equivalent of the requirements for the Master of Science degree in Materials Science.

2. Obtain a high score on a comprehensive Materials Science written examination.

3. Pass a Departmental oral qualifying examination.

4. By completion of a course or by translation, a knowledge of a modern foreign language must be demonstrated before a student is admitted to candidacy for the Ph.D. degree.

5. The candidate must present the results of his dissertation at a Departmental seminar. The complete graduate program must have the approval of the major professor and one other faculty member. It should include at least 18 course units outside of the Materials Science Department, of which at least 6 must be taken at Stanford. A minimum of 60 course units beyond the B.S. degree requirements must be included in the program.

DOCTOR OF PHILOSOPHY

The University's basic requirements for the Ph.D. degree are outlined in the section "Degrees" in this bulletin.

The following are Departmental requirements:

1. Complete the substantial equivalent of the requirements for the Master of Science degree in Materials Science.

2. Obtain a high score on a comprehensive Materials Science written examination.

3. Pass a Departmental oral qualifying examination.

4. By completion of a course or by translation, a knowledge of a modern foreign language must be demonstrated before a student is admitted to candidacy for the Ph.D. degree.

5. The candidate must present the results of his dissertation at a Departmental seminar. The complete graduate program must have the approval of the major professor and one other faculty member. It should include at least 18 course units outside of the Materials Science Department, of which at least 6 must be taken at Stanford. A minimum of 60 course units beyond the B.S. degree requirements must be included in the program.

COURSES

50. Introductory Science of Materials — (Enroll in Engineering 50.) Introduction to the physical basis of the mechanical, electrical, and magnetic behavior of solids. Electron theory, imperfections in solids. Relations between structural features and properties. Prerequisite: Mathematics 23 or 43.

3 units, Aut (Barrett, Nix, Tetelman)
   MWF 9
   Win (Barret, Nix, Tetelman)
   MWF 11
   Spr (Barrett, Nix, Tetelman)
   MWF 10
   Sum (——) MTWTh 11

104. Crystallography — Analytical and graphical representation of crystal geometry. Symmetry elements and the crystal classes. Structural arrangements of common crystalline materials. Prerequisite: 50.

2 units, Aut (Schultz) TTh 11
105. Imperfections in Crystalline Solids —
Relation of lattice defects to physical properties. Introduction to dislocation theory. Point and line defects in metallic and nonmetallic crystals and relation to electrical, optical, and mechanical properties of solids. Structure and mechanics of interfaces. Prerequisite: 50.

3 units, Aut (Nix) TTh 9:00–10:30

106. Extractive Metallurgy Processes—(Enroll in Mineral Engineering 105.) Introduction to metallurgical thermodynamics, and fundamentals of the processes used in the production and refining of metals. May be taken as an introduction to metallurgical thermodynamics by enrolling for 2 units. Prerequisite: Chemistry 5. In addition, Chemistry 171 is recommended.

2 to 3 units, Win (Parlee) by arrangement

107. High Temperature Laboratory — (Enroll in Mineral Engineering 107.) Lectures and laboratory experiments relating to high temperature processes, atmosphere control and vacuum technology; thermodynamic and kinetic measurements. Prerequisite: Mineral Engineering 105 or Chemistry 173.

2 units, Spr (Bartlett, Parlee) TTh 1:15–4:05, alternate years, given 1967–68

120. Industrial Report—Report covering at least two consecutive months of industrial experience related to Materials Science.

1 unit, any quarter (Staff) by arrangement


3 units, Win (Pound) MWF 9

122. Solid State Thermodynamics—Systematic development of basic laws, mathematical techniques, definitions, and derivation of thermodynamic relations. Solution thermodynamics. The reaction isotherm, law of mass action, and applications. Imperfection equilibria. Heterogeneous equilibria. Prerequisite: Chemistry 171 or Physics 170. Computer Science 5 recommended.

3 units, Aut (Hirth) MWF 11


3 to 4 units, Win (Sherby) MWF 10 and lab. W 2:15–5:05


3 to 4 units, Win (Schultz) MWF 11, lab. Th 1:15–4:05

126. Materials Engineering Design—Properties of Engineering materials. Fabrication problems, economic and design factors relating to the selection of materials for particular service conditions. Prerequisite: 50 or equivalent.

2 units, Spr (Staff) TTh 9


3 units, Win (Barrett) TTh 11; lab. by arrangement

128. Materials Design—Application of the principles of Materials Science to the development of solids having optimum properties for practical applications. Case studies of the development of materials for structural, electrical, optical, or magnetic usage. Prerequisites: 125, 130, and 152.

3 units, Spr (Tetelman) MWF 8


3 to 4 units, Aut (Sherby) MWF 9; lab. by arrangement
140. Independent Study — Independent study in Materials Science under supervision of a faculty member. Prerequisites: junior or senior standing in science or engineering with high scholarship and approval of Materials Science Faculty.

2 units, any quarter (Tiller) and by arrangement

152. Electrical, Optical and Magnetic Properties of Materials — A broad course with phenomenological orientation covering thermal, dielectric, ferroelectric, dia-, para-, and ferromagnetic, electrical, optical, and superconducting properties in pure and imperfect crystal and polycrystalline solids. Prerequisite: Engineering 50.

3 to 4 units, Win (Staff) MWF 1:15; lab. by arrangement

200. Special Problems.
Any quarter (Staff) by arrangement

201. Principles and Methods of Crystal Growth — Broad look at the important phenomena involved in the growth and perfection of crystalline solids from melt, solution, vapor, electrodeposition, etc. Discussion of the merits of the various preparation methods.

3 units, Spr (O'Hara) MWF 9

203A. Crystalline Solids — Crystal structure and imperfections, use of X-ray and electron diffraction for the examination of materials, influence of crystal geometry and crystalline defects on properties. (Note: 203A, 203B and 203C provide an accelerated treatment of Materials Science fundamentals for students registered in other departments and for students who enter the Materials Science program with an M.S. degree in some other field. Open to others by permission.)

4 units, Aut (Schultz) MWF 11 and one hour by arrangement

203B. Thermodynamics and Phase Equilibria — Application of thermodynamics to the properties and behavior of materials. Heterogeneous equilibria with emphasis on solids. Prerequisite: Elementary thermodynamics. Computer Science 5 recommended.

3 units, Win (Hirth) MWF 11

203C. Rate Processes in Materials — Diffusion in solids, structural transitions including recrystallization and liquid-solid and solid-solid phase transformations, property control by microstructural control. Prerequisite: 203B.

3 units, Spr (Huggins) MWF 11

204. Wave Mechanics — Concepts and mathematical formalisms for treating waves, with applications to lattice vibrations, electromagnetic waves and optical properties, and electron waves in simple potential fields. Prerequisite: Mat. Sci. 152.

3 units, Spr (Bube) MWF 1:15

205. Microstructure and Mechanical Strength — (Enroll in A.M. 216A.) Atomic structure of solids. Imperfections. Dislocation theory and applications to problems of yielding, strain hardening, recovery, recrystallization, fiber composites. Prerequisites: 130 or 203A.

3 units, Aut (Tetelman) T 10 and Th 10–12

207. Physical Chemistry of Metal Purification — (Enroll in Mineral Engineering 207.) Refining processes and the physical chemistry underlying them. A systematic treatment of unit processes based on types of impurity phases, deals effectively with fundamentals of such widely different methods as the zone refining of semiconductors, the industrial refining of copper, steel making and the vacuum refining of high temperature alloys. Prerequisite: Mineral Engineering 103 or Chemistry 173 or equivalent.

3 units, Aut (Parlee) by arrangement

208. Radioactivation Analysis — (Enroll in Civil Engineering 278.) The use of radioactivation as a research tool: radioactivation, properties of radioisotopes, sources of irradiation, activation analysis, practices and uses in biology, chemistry, and engineering.


2 units, Spr (Goetzl) M 2:15–4:05, alternate years, given 1969–70


2 units, Spr (Goetzl) M 2:15–4:05, alternate years, given 1968–69
220. Phase Transformations in Solids — Thermodynamic, kinetic and crystallographic aspects of phase transformations in metals and alloys, with particular attention to martensitic transformations. Prerequisite: 125.

3 units, Spr (Shyne) MWF 10, alternate years, given 1969-70

222. Statistical Thermodynamics — Systematic development of the methods of statistical mechanics. Applications to problems in Materials Science. Prerequisite: 122.

3 units, Spr (Hirth) MWF 11

223. Advanced Seminar on Statistical Thermodynamics — A discussion of the Grand Canonical Ensemble approach to the statistical mechanics of statistical fluctuations and to the statistical mechanics of irreversible processes. Applications to the description of material systems and processes. Prerequisite: 222.

3 units, Aut (Pound) TTh 1:15-3:05

224. Physical Properties of Disordered Materials — Examination, at a microscopic level, of our understanding of the structural, thermal, electrical and mechanical properties of alloys and amorphous materials. Emphasis of the course will change from year to year. In 1968-69 it will be concerned with the structures and properties of amorphous solids. Prerequisites: Mat.Sci. 152 and 222 or equivalents.

3 units, Spr (Bienenstock) TTh 1:15-3:05

225A. Introduction to Surfaces and Interfaces — (Enroll in Mineral Engineering 225A.) An introduction to the properties of surfaces and interfaces and their manifestations in a variety of contexts including Chemical, Civil, Mineral and Petroleum Engineering; Biology, Geology and Materials Science. One two-hour lecture and a one-hour discussion session weekly. No absolute prerequisites, but prior exposure to thermodynamics is recommended.

3 units, Win (Hutchinson, Staff) by arrangement

225B. Surfaces and Interfaces — (Enroll in Mineral Engineering 225B.) Advanced treatment of selected topics in Surface Chemistry with emphasis on inorganic colloidal systems and adsorption. Independent study, lectures, and discussions. Term paper. Prerequisites: 225A or equivalent and Chemistry 173 or Materials Science 122 or equivalent.

3 units, Spr (Parks) 3 lecs. by arrangement alternate years, given 1968-69

226. Corrosion and Electrometallurgy — Electrochemical principles with applications to corrosion, electrolytic processes and energy conversion cells. Prerequisite: Chemistry 173.

3 units, Win (Staff) MWF 10

230. Materials Science Colloquium.

1 unit, Aut (Bienenstock) M 4:15
Win (Pound) M 4:15
Spr (Huggins) M 4:15
Sum (Tetelman) M 4:15

232. Point Defects in Crystals — Structure of both single and complex point defects. Defect equilibria; influence of temperature, chemical and electrical potentials, interfaces, dislocations. Association; relaxation effects. Effects of point defects on selected physical properties. Prerequisite: 105 or 203A.

3 units, Win (Huggins) MWF 10

233. Introduction to Application of Quantum Theory in Solids — Applications of wave mechanics to atomic systems, free electron theory, energy bands in one and three dimensions, lattice scattering of electrons, and optical absorption. Prerequisite: Mat.Sci. 204 or E.E. 322A.

3 units, Aut (Bube) MWF 1:15


3 units, Win (Bube) MWF 1:15, alternate years, given 1969-70

235. Photoelectronic Properties of Solids — Seminar on selected topics in photoelectronic properties of solids, including photoconductivity, luminescence, photovoltaic effects, and techniques and methods of photoelectronic analysis of imperfections in crystals. Prerequisite: Mat.Sci. 234.

3 units, Win (Bube) MWF 1:15

236. Advanced Diffraction and Spectroscopy — X-ray diffraction from perfect crystals, use of Fourier analysis in diffraction,
particle size line broadening, strain measurements, effect of stacking faults, diffuse scattering, low angle scattering, diffraction from non-crystalline materials, spectroscopy of solids. Prerequisite: 127.

3 units, Aut (Bienenstock) TTh 9; lab. by arrangement

237. Dislocations in Crystals — Isotropic elastic theory of isolated dislocations, elastic properties of dislocation arrays, kinetic behavior of dislocations, structure of dislocations, interaction of dislocations with impurities and precipitates. Prerequisite: 105 or 203A.

3 units, Win (Nix) MWF 8

238. Fracture of Solids — (Same as A.M. 216B.) Engineering and microscopic approaches, fracture testing, nucleation and propagation of cleavage and shear cracks. Effect of notches, fracture of steels, creep and fatigue failure, stress corrosion cracking and hydrogen embrittlement. Prerequisite : 130 or 205.

3 units, Win (Tetelman) M 2:15-4:05 and W 2:15-3:05

239. Seminar in Advanced Mechanical Metallurgy—Prerequisite : 238.

1 unit, Aut, Win, Spr (——) by arrangement, given 1968-69


3 units, Spr (Pound) MWF 10


3 units, Spr (Barrett) lec. TTh 10; lab. by arrangement

246. Crystalline Anisotropy — Seminar on the application of tensor notation to the description and analysis of the properties of crystalline materials.

2 units, Spr (Hirth) TTh 9, alternate years, given 1968-69


3 units, Spr (White)

249. Time-Dependent Plasticity — Theories and mechanisms of creep. Temperature and strain rate effects on plastic flow of solids. Relation of high temperature strength and ductility of materials to structure. Prerequisite : 130.

3 units, Spr (Sherby) TTh 1:15-2:45, given 1968-69

250. Seminar in Advanced Materials Science.

3 units, Sum (——) TTh 2:15-3:45

258. Optical Properties of Solids—(Enroll in E.E. 332.) Basic theory with emphasis on the relationship between electronic structure and optical properties of solids. Representative semiconductors, insulators, and metals will be discussed, including Ge, GaAs, CdS, NaCl, ruby, Cu and Al. Prerequisite: One group of the following: E.E. 322A and 322B (may be concurrent); Physics 230 and 231 (may be concurrent); or Materials Science 233.

3 units, Win (Staff)

259. Basic Quantum Mechanics—(Enroll in E.E. 322A.) Introduction to the concepts of quantum mechanics; the postulates of quantum mechanics; observables, wave functions, and probability density; the Schrödinger equation; complementary variables and the uncertainty principle; the harmonic oscillator and particles in a box; the hydrogen atom; angular momentum; the matrix formulation of quantum mechanics; the Dirac notation. Prerequisite: Physics 57 and 111, and Mathematics 131, or equivalent.

3 units, Aut (White)

260A. Basic Quantum Mechanics—(Enroll in E.E. 322B.) Time independent perturbation theory; time dependent perturbation theory; transition probabilities; spin identical particles, and exchange; energy levels of atoms; elementary band structure; the symmetry properties of wave functions. Prerequisite: Electrical Engineering 322A.

3 units, Win (White)

264. The Equilibrium Structure of Surfaces — Quantitative treatment of diffuse interfaces, gamma plots, thermal faceting, electric-
cal double layers, adsorption, equilibrium forms, interface attachment kinetics. Prerequisite: 122 or equivalent.

3 units, Aut (Tiller) TTh 3:15-4:35, alternate years, given 1969-70


3 units, Win (Pound) TTh 3:15-4:35, alternate years, given 1969-70

266. The Redistribution of Solute During Phase Transformations—Mathematical analysis of the solute distributions in a solid after a phase transformation. Consideration of diffusion in only one or both phases, applied electric field, shape of solid, time dependence of transformation velocity, dendritic interface, multi-phase interface, and fluid motion in one phase. Prerequisites : 240 and Mathematics 131.

3 units, Aut (Tiller) TTh 3:15-4:35, alternate years, given 1968-69

267. Seminar in Interface Morphology Control During Phase Transformation—Quantitative determination of growth rate, shape and perfection of crystals. Stability of planar, cylindrical and spherical crystals; dendritic growth; spherulite formation; eutectic and eutectoid transformations; volume change effects; interface attachment kinetic dominated growth forms. Prerequisites: 264 and 266.

3 units, Win (Tiller) TTh 3:15-4:35, alternate years, given 1968-69

300. Research.

Any quarter (Staff) by arrangement

MECHANICAL ENGINEERING

Emeriti: Boynton M. Green, Lydik S. Jacobsen, Stephen P. Timoshenko
Executive Head: William M. Kays
Division Directors: Stephen J. Kline (Thermosciences), Thomas J. Connolly (Nuclear), Peter Z. Bulkeley (Design)

Associate Professors: James L. Adams, Peter Z. Bulkeley, Joel H. Ferziger, James P. Johnston, Charles H. Kruger, Robert H. McKim, Morton Mitchner, Robert J. Moffat, Bernard Roth, Rudolph Sher
Assistant Professors: Anthony Leonard, John R. Manning
Lecturers: Frank R. Arnold, Joseph H. Keenan, Carl G. A. Rosen

OFFERINGS AND FACILITIES

The courses and degrees offered in Mechanical Engineering provide a background for careers in research, development, design, and manufacture in a wide variety of industries concerned with the handling of mechanical, thermal and nuclear energy (generation, transmission, conversion, metering, control, utilization), the handling of fluids, the construction of mechanical devices (tools, mechanisms, machines, mechanical instruments, control systems), and the conception of systems involving mechanical and thermal components together with electrical, chemical, and human components. Graduates at all degree levels typically go into the product manufacturing industries, aerospace industries (especially in propulsion systems), nuclear power industry, gas turbine and internal combustion systems industries, and to a lesser extent into the chemical and petroleum process, and transportation.

The Department is organized into three divisions — Thermosciences, Design, and Nuclear, each of which maintains its own laboratory, shops, and secretarial services. The Thermosciences Division offers courses and specialized work in the areas of thermodynamics, thermal power systems, energy conversion, fluid mechanics, and heat transfer. The Design Division is concerned with comprehensive systems design, product design, mechanical analysis and mechanism design, and design components. The Nuclear Division offers work in reactor physics and all aspects of nuclear reactor technology. It should be noted that this Department does not offer specialized work in the areas of engineering mechanics, and students in...
interested in concentrating in engineering mechanics should consult the Division of Applied Mechanics section of this bulletin. However, students studying for any of the degrees offered by the Department will ordinarily take courses in engineering mechanics, as well as in several other departments of the University.

**FACILITIES**

All three Divisions of the Department maintain modern laboratories which are used for both undergraduate and graduate instruction and graduate research work.

The Thermosciences Division Laboratories are equipped with representative power, fluid handling, refrigeration and heat and mass transfer equipment, a magneto-hydrodynamic power conversion system, shock tube, gasdynamics facility, and extensive special facilities for convective heat transfer and boundary layer research. A wide variety of instrumentation, extensive shop facilities, utilities, and research space are all available within the laboratories.

The Design Division maintains shops for both student instruction and construction of research apparatus, drafting rooms, an analog computer, and instrumentation and space for instruction and graduate research work in stress analysis, dynamics, mechanics, and control systems.

The Nuclear Division laboratories include a 10 KW pool-type research reactor, a neutron accelerator, a sub-critical assembly, a radiochemistry laboratory, a reactor heat transfer laboratory, an analog computer, and a machine shop.

In addition each Division maintains its own small library and reading room, and office space for a substantial number of graduate research students.

**PROGRAMS OF STUDY**

**BACHELOR OF SCIENCE**

Students desiring to specialize in mechanical engineering during their undergraduate period may do so by following the curriculum outlined earlier under School of Engineering. The University's basic requirements for the Bachelor's degree are discussed in the section "Degrees" in this bulletin.

A program for Product Design is offered by the Design Division and leads to the degree of Bachelor of Science in General Engineering. It is recommended, however, that this should not be considered a terminal degree and that all students who elect this program continue on through the Master's degree in this field.

**MASTER OF SCIENCE**

**Admission and Registration** — The basic University requirements for the Master's degree are discussed in the section "Degrees" in this bulletin.

To be eligible for registration as a graduate student in the Department a student must have received a B.S. degree in engineering, physics, or some comparable science program. His undergraduate record and personal recommendations must demonstrate that he is capable of handling graduate level work and will be able to complete the requirements for the M.S. degree. Students whose undergraduate backgrounds are entirely devoid of some of the major subject disciplines of engineering (for example, fluid mechanics, applied thermodynamics, applied mechanics, circuit theory) may find it desirable to take some undergraduate courses to fill in obvious gaps and prepare themselves to take graduate courses in these areas. Such students may require more than three quarters to fulfill the Master's degree requirements, as the make-up courses may not be used for other than the free electives (see item 4 below) in the M.S. degree program. However, it is not the policy to require fulfillment of mechanical engineering B.S. degree requirements in order to obtain an M.S. degree, and furthermore students who have already fulfilled certain categories of the M.S. degree requirements as a result of their undergraduate work may find they have sufficient time under item 3 below to obtain the M.S. degree in the normal three quarters.

**Graduate Program** — The Master's degree program requires 45 units of course work. No thesis is required, although many students include some research work in their course program. The program is designed to provide considerable breadth in applied mathematics and the engineering sciences which are used in the professional practice of engineering. Although considerable depth
may be attained in a few areas, a high degree of specialization can only be attained by continuing toward the degrees of Engineer or Doctor of Philosophy, or by including more than 45 units in the M.S. degree program.

The Departmental requirements which must be met for the degree of Master of Science are:

1. 6 units of mathematics from A.M. 250, 251, 252 (or Computer Science 137), Mathematics 106, 113, 131, 132. (Ordinary differential equations, e.g., Mathematics 130, may not be used to fulfill this requirement; it may be taken as a free elective, item 5 below.)

2. Two courses in each of two of the following three categories, or two courses in one category and one course in each of the other two categories (11 to 13 units total).
   a) Design and Solid Body Mechanics
      M.E. 214, 217A, 218, 219B, 222;
      A.M. 202A, 205, 208, 221.
   b) Nuclear Engineering and Physics
      M.E. 271A, 175, 282, 285; Physics 130, 140
   c) Thermosciences
      M.E. 211A, 231A (or 231B), 233A,
      237A, 238A, 251; A.M. 242

3. 21 units of approved electives (approved by adviser); these should ordinarily be in mathematics, physics, chemistry, or engineering, and may include any courses in the above lists not used to satisfy area minimum requirements. Courses in this category should be graduate level courses or, if in another department, they should be at least junior level courses with a minimum of introductory courses; specific exceptions to the graduate level rule are Engineering 104, 171, 172, 175; M.E. 116B, 116C, 123, 133, 134, 136, 161. Advisers will normally also approve a limited number of units in the Graduate School of Business or other areas in the University.

   A maximum of 9 units in M.E. 291, 292, and 3 units in credit seminars may be included in this category.

   Students who have already fulfilled in full, or in part, any of the area requirements as a result of their undergraduate work, or work elsewhere, may place the released units in the approved elective category.

4. Included in the above courses must be a minimum of work in Engineering Experimentation and in Engineering Synthesis. This requirement can be fulfilled as outlined below:

   a) In Experimental Engineering, a minimum of 3 units of M.E. 292 (Experimental Project Work) by arrangement with a member of the faculty, or by completion of any one of the following courses: M.E. 175, 219C, 242A, 242B, 249A, 273, 274, A.M. 205, A.A. 220, 260A,B,C, E.E. 171H. M.E. 123 may also be used if it was not taken as an undergraduate.

   b) In Engineering Synthesis, a minimum of 3 units of M.E. 291, 292 (Engineering Synthesis Work) by arrangement with a member of the faculty, or by completion of any one of the following courses: M.E. 201, 214, 217A, 219A,B, 222, 235A,B, 237A, 282. M.E. 114B can also be used if it was not taken as an undergraduate.

   5. 5 to 7 units of free electives, to make a total of 45 units.

   Although it is possible to fulfill most of the above requirements with courses taken outside of the Department, or transferred from elsewhere, it is the policy of the Department that a student must present for the degree at least 15 units of course work in courses presented in the Department.

   Candidates for the degree of Master of Science will be expected to have a minimum scholastic average of 2.75 in the 45 units presented to fulfill degree requirements, regardless of grades in other courses that might be taken as a graduate student. (Courses with + grades can be included in the 45 units, but will not be counted in grade point computation.)

   Students falling below an overall average of 2.50 at the end of 20 units may be disqualified from further registration. Students failing to meet the complete degree requirements at the end of 60 units of graduate registration will be disqualified from further registration. An exception to the 60-unit rule will be units used to fill deficiencies arising from inadequate undergraduate preparation for mechanical engineering graduate work.

   Product Design—A special Master's program is available to those interested in the field of Product Design and is intended pr
mainly for those students who have com- pleted the undergraduate program in this field and who are admissible to the graduate school. For these students, the 48 units of work specified below are all that is required. For students with other undergraduate backgrounds, one or two years may have to be spent in removing undergraduate deficiencies before starting the graduate program. A special program is available in cooperation with the Art Department of the School of Humanities and Sciences for students who have a Bachelor of Arts in Fine Arts. They will register with the Art Department and, while they will take many of the courses listed below, they will receive the degree of Master of Arts in Art.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.E. 214</td>
<td>Philosophy of Design</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 215A,B,C</td>
<td>Design Seminar</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 219A</td>
<td>Advanced Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 219C</td>
<td>Experimental Development Engineering</td>
<td>2</td>
</tr>
<tr>
<td>M.E. 299A,B,C</td>
<td>Master's Project</td>
<td>12</td>
</tr>
<tr>
<td>Art 261</td>
<td>Graphic and Product Design</td>
<td>4</td>
</tr>
<tr>
<td>IE 208</td>
<td>Biotechnology</td>
<td>3</td>
</tr>
<tr>
<td>GSB 240</td>
<td>Marketing</td>
<td>3</td>
</tr>
<tr>
<td>Free Electives</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>48</strong></td>
</tr>
</tbody>
</table>

The grade point average requirements for this program are the same as for the ordinary Mechanical Engineering Master's Degree.

**Degree of Engineer**

The basic University requirements for the degree of Engineer are discussed in the section "Degrees" in this bulletin. This degree represents nominally an additional year of study beyond the Master of Science degree, and includes a research thesis. This program is designed for students who desire to do professional engineering work upon graduation, and who desire an opportunity to engage in more specialized study than is afforded by the Master's degree alone.

The admission standards for this program are substantially the same as indicated under the Master's degree. However, since thesis supervision is required, and the availability of thesis supervisors is strictly limited, the Department cannot admit a student to candidacy until he has personally arranged with some member of the faculty to supervise a research project. This will frequently involve a paid research assistantship, and research assistantships are awarded by individual faculty members (usually from the funds of sponsored research projects under the direction of individual faculty members) and not by the Department, so again a personal arrangement is necessary. Students studying for their Master's degree at Stanford and desiring to continue to the Engineer degree ordinarily make such arrangements during their M.S. degree year. Students holding Master's degrees at other universities will be admitted and allowed to register if they are sufficiently well qualified. However, the Department cannot guarantee thesis supervision or financial assistance, and the student must make such arrangements himself during his first quarter or two of residence.

The Departmental requirements for the degree include an acceptable thesis; up to 15 units credit will be allowed for thesis work. In addition to the thesis, 30 units of approved advanced course work in mathematics, science, and engineering are expected beyond the requirements for the Master of Science degree; the choice of courses is subject to the approval of the adviser. Students who have not fulfilled the Stanford M.S. degree requirements will be required to do so (with due allowance for approximate equivalence of courses taken elsewhere).

All candidates for the degree of Engineer will be expected to have a minimum scholastic grade point average of 3.00 for all courses (exclusive of thesis credit) taken beyond those required for the Master's degree. It is the policy of the Department that students engaged in faculty supervised research and special study are obligated to provide the faculty supervisor with a minimum of 20 hours per quarter of reading and grading assistance in the faculty member's other courses, if the faculty member asks for this assistance. The student will be paid for this assistance, unless he holds a fellowship that precludes such payment.

**Product Design**—A special two-year program is offered in the field of Product Design which leads to the degree of Engineer in Mechanical Engineering. It is intended for students who wish to augment their engineering background with training in the
aesthetic and human qualities essential in new product development. University requirements for the degree of Engineer are satisfied. Admission to the program follows the same standards as for the Master’s degree. Course work requirements are divided into two components. Approximately 54 units are devoted to engineering and product design and about 21 units are devoted to course work in the Department of Art and Architecture. The program requires a design thesis of 12 units. The total of 90 units can normally be completed in two academic years. Students deficient in prerequisite areas will normally take more time. Students who fulfill requirements for this program are awarded the degrees M.S. in Mechanical Engineering (Product Design) and Engineer in Mechanical Engineering (Product Design) simultaneously at its completion.

**Doctor of Philosophy**

The basic University requirements are discussed in the section “Degrees” in this bulletin. The Doctor’s degree is intended primarily for students who desire to pursue a career in research, advanced development, or teaching; for this type of work a broad background in mathematics and the engineering sciences, together with intensive study and research experience in a specialized area, are the necessary requisites.

The Department will allow a minor field of study, but does not require one. However, if a minor is waived, the candidate must show breadth of training by taking a group of courses in one or more related fields or departments.

A student studying for the Ph.D. degree ordinarily will not take an Engineer degree, although this is not precluded. However, he must have a Master’s degree, and must fulfill in essence the requirements for the Stanford M.S. degree in Mechanical Engineering.

Admission to the program involves much the same consideration as described under the Engineer degree. A sufficiently well-qualified student from Stanford or elsewhere will be admitted and assigned to an adviser. If the student has not arranged with a faculty member for supervision of his research prior to admission, his adviser will assist him in making such an arrangement. However, the Department cannot guarantee research supervision, as this involves a personal arrangement between the student and the individual faculty member, and such an arrangement is entirely the responsibility of the student. Once a student has obtained a research supervisor, this supervisor becomes thereafter his academic adviser. Research supervisors may require that the student pass the Departmental Oral examination before starting on research work and before awarding a paid research assistantship. Note that research assistantships are awarded by the individual faculty research supervisors and not by the Department.

It is very strongly urged that students anticipating working for a Ph.D. degree arrange to do some research work under M.E. 291 or 292 prior to attempting to make a Ph.D. supervision arrangement. Faculty members supervising Ph.D. research will generally require some such proof that a student has research potential before committing themselves to Ph.D. supervision and a research assistantship. It is most efficient to carry out this preliminary research effort during the M.S. degree year.

Prior to being formally admitted to candidacy for the Ph.D. degree the student must demonstrate his knowledge of engineering fundamentals by passing the Departmental qualifying oral examination. The academic level and subject matter of this examination correspond approximately to the Master of Science degree program described above. The examination consists of five oral interviews, one of which must be in mathematics, and the other four are chosen from the areas of controls, mechanical engineering design, fluid mechanics, heat transfer, elastic body mechanics, solid body mechanics, physics, nuclear reactor theory, or thermodynamics. Additionally the student must complete certain minimum course requirements in a sixth optional area, but need not take an examination. A student must have the approval of his adviser, and at least a tentative arrangement for research supervision, in order to take the examination. The examination is offered during the winter quarter and may in addition be offered at other times as the need arises. Normally the examination will be taken during
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the first post-Master's year. Details may be obtained from the Department secretary.

The Ph.D. thesis normally represents one full year of research work and must be a substantial contribution to knowledge. Students may register for up to 45 units of course credit for thesis work (M.E. 301) to fulfill University residence requirements, but they are not required to do so if they would prefer to fulfill residence by formal course work, and there is no minimum limit on registered thesis units.

It is the policy of the Department that students engaged in faculty supervised research and special study are obligated to provide the faculty member with a minimum of 20 hours per quarter of reading and grading assistance in the faculty member's other courses, if the faculty member asks for this assistance. The student will be paid for this assistance unless he holds a fellowship that precludes such payment.

FINANCIAL ASSISTANCE

The Department annually awards a number of fellowships, teaching assistantships, and research assistantships to graduate students. The fellowships are usually awarded to first-year graduate students, with the assistantship used primarily for post-Master's degree students. Preference for the teaching assistantships is generally given to students who obtain their Master's degree at Stanford. Research assistantships are awarded by the individual faculty research supervisors and not by the Department as a whole.

Applicants for all three forms of assistance may obtain the necessary application forms from the University Admissions Office. However, post-Master's degree applicants for research assistantships are advised to contact directly the faculty member under whom they would like to work, because of the individual nature of these awards, and if they are successful they need not apply to the Department for assistance. Formal applications to the Department for research assistantships will be referred to the individual faculty research supervisors.

Research assistants can, and normally do, carry out their thesis research work and write their thesis as an integral part of the commitments of their assistantship.

UNDERGRADUATE COURSES

Note.—Laboratory sections in experimental engineering will be assigned in groups. Insofar as the laboratory schedule permits, students will be allowed, with due regard to priority of application, to arrange their own sections and laboratory periods. Enrollment with the instructor concerned, on registration day or the first day of University instruction, is essential in order that the laboratory schedule may be prepared. Enrollment later than the first week will not be permitted under any circumstances.


3 units, Win, Spr (Bulkeley, Staff) TTh 9;
lab. T, W, Th, or F 1:15-4:05

50. Mechanisms—Application of graphical and analytical techniques to the kinematic and dynamic analysis of machines. Design of mechanisms. Exercises in measurement of mechanical parameters of machines. Prerequisites: Engineering 9, 12, and Physics 51.

3 units, Spr (Waldron) WF 1:15;
lab. F 2:15-5:05


3 units, Aut (Cannon) MWF 11
Win (Waldron) MWF 11

112A. Rapid Visualization—Systematic development, through lecture and laboratory exercise, of visual thinking skills essential to the designer. Emphasis upon quickly exe-
cuted, freehand orthographic and perspective sketches of concepts which exist only in imagination. Rapid visualization utilized as catalyst for fluent idea production.

3 units, Aut (McKim) MW 1:15-4:05

112B. Introduction to Product Design—Active encounter with human values in design. Lectures survey central philosophy of product design program, with emphasis upon the relation between technical and human values, the creative process, and design methodology. Laboratory exercises include the development of simple product concepts visualized in rapidly executed three-dimensional mockups. Prerequisite: 112A.

3 units, Win (Staff) MW 1:15-4:05

112C. Environmental Design — Experience with design problems involving large numbers of people (e.g., mass transportation). Students work in teams; nature of group activity examined. Final presentation to professional jury. Prerequisite: 112B.

3 units, Spr (McKim) MW 1:15-4:05

114A. Mechanical Engineering Design — Analysis and design of machine elements and assemblies. Synthesis, practical workability, and ease of manufacture will be emphasized through several short projects. Prerequisites: 4, 50, Engineering 9, 15, and C.E. 114 concurrently.

3 units, Aut (Fuchs) TTh 10; lab. Tor Th 2:15-5:05

114B. Mechanical Engineering Design — During this course the emphasis will be placed on the actual process of design, and the lecture and laboratories will be devoted to the design and building of a complete machine. The project is so chosen that it will demand the application of knowledge learned in other courses and act as a synthesizing agent. Final presentation will be to a professional jury. Prerequisite: 114A.

4 units, Win (Manning) TTh 1:15-4:05

116A. Advanced Product Design — Small-scale projects carried to a high degree of refinement. Emphasis upon craftsmanship and aesthetics. Prerequisite: 112C.

3 units, Aut (Staff) TTh 12:00-2:05

116B. Advanced Product Design — New product innovation via need-finding. Prerequisite: 116A.

3 units, Win (McKim) TTh 12:00-2:05

116C. Advanced Product Design — Summary project utilizing knowledge, methodology, and skills obtained in 112A,B,C, 114A, and 116A,B. Final presentation to professional jury. Prerequisite: 116B.

3 units, Spr (Staff) TTh 12:00-2:05

122. Mechanical Engineering Laboratory—Laboratory experiments on hydraulic and thermal power apparatus: (1) to introduce student to experimental methods in field of mechanical engineering, (2) to demonstrate validity of principles, techniques described in Engr. 31, M.E. 132, (3) to give student experience of analyzing own experimental work, presenting results in acceptable engineering report, and (4) to provide experience in joint group effort. Prerequisites: Engineering 21, 31, and preferably M.E. 132.

4 units, Win (Staff) one afternoon by arrangement

123. Mechanical Engineering Laboratory—More advanced laboratory experiments in thermal and nuclear engineering, and in mechanics, in which students participate to an increasing degree in the design of experiments. Prerequisites: 122 and 132.

4 units, Spr (Staff) one afternoon by arrangement

126. Materials Engineering Design—(Enroll in Materials Science 126.) Properties of engineering materials. Fabrication problems, economic and design factors relating to the selection of materials for particular service conditions. Prerequisite: Materials Science 50 or equivalent.

2 units, Spr (Staff) TTh 9


3 units, Aut (Staff) MWF 10

133. Engineering Thermodynamics—Continuation of 132; further work on availability, minimum work in separation processes, chemical thermodynamics, thermodynamics of combustion, analysis of combustion engines. Prerequisite: 132.

3 units, Spr (-----) MWF 9

134. Introduction to Kinetic Theory and Statistical Mechanics—Equilibrium kinetic
theory and transport processes, velocity distribution. Statistical mechanics and energy distribution; entropy, energy, pressure in terms of partition function. (Available for graduate student credit, but graduate students intending to complete the M.E. 211 series should take M.E. 211A rather than this course.) Prerequisite: 132.

3 units, Aut (Staff) MWF 1:15

135. Heat, Mass, and Momentum Transfer — Introductory treatment of conduction, convection, and radiation heat transfer, mass diffusion, boundary layer theory including the velocity, temperature, and concentration boundary layers. Prerequisites: Engineering 31 and concurrent registration in Mathematics 130.

3 units, Aut (Staff) MWF 11


4 units, Aut (Staff) TTh 11-12:15; one lab. by arrangement

Spr (Staff) MWF 8; one lab. by arrangement


3 units, Spr (Bulkeley) MWF 11

191. Engineering Problems and Experimental Investigation — Directed study and research for the undergraduate student on a subject of mutual interest to student and staff member. Student must find faculty sponsor and have approval of his adviser.

1 to 5 units, any quarter (Staff) by arrangement

COURSES PRIMARILY FOR GRADUATES

ENGINEERING DESIGN

201. Case Work in Engineering Design—Design projects undertaken by local industry will be studied by examination of arti-
mechanical, electromechanical and electronic control components. Prerequisite: E.E. 163.

3 units, Win (J. Manning) MWF 8

219A. Advanced Engineering Design—Experience in the design of a machine. Technical requirements and interactions of various disciplines will be emphasized. The design will be carried through working drawings. Machine members will be fabricated from the drawings during Winter Quarter and the machine developed in 219C. This course and 219C constitute a series. The intent of the series is to involve the student in a major portion of the design-development process. Students should enroll for both courses. Grades will be deferred until the completion of 219C. Limited enrollment. Prerequisite: 114A or equivalent.

3 units, Aut (Adams) TTh 12:00-2:05

219B. Design Operations—Synopsis of operations common to many design projects followed by more detailed study of case histories of design projects from various environments. Planning the experimental development of a design produced in 219A or of an approved alternate. Prerequisite: consent of instructor.

3 units, Win (Fuchs) TTh 3:15-5:05

219C. Experimental Development Engineering—Testing and improvement of the design produced in 219A or approved alternate. Limited enrollment. Prerequisites: 219A or B, or consent of instructor.

2 units, Spr (Adams, Fuchs) lab. MW 1:15-4:05

220. Space Mechanisms—Constraints and pairing in three-dimensional mechanisms; spatial velocity and acceleration analysis. The spherical 4-bar. The spatial 4-bar. Synthesis of spatial mechanisms for path and function generation. Prerequisite: 50.

3 units, Aut (Waldron) MWF 12

221. Kinematic Analysis—The relative motion between links in a mechanism is studied in terms of rolling centroids. The kinematical forms of the Euler-Savary equation are derived and the path curvature of points on a moving link are rigorously determined. The properties of the coupler curves are analyzed in terms of the theory of higher plane curves. Prerequisite: 50.

3 units, Win (Roth) MWF 12, given 1969-70

222. Kinematic Synthesis—The problem of determining linkage proportions from prescribed input-output conditions is considered for both path and function generating mechanisms. Critical comparison of graphical, analytical, and computer oriented methods. The techniques are applied to the synthesis of various machines and computers. Prerequisite: 50.

3 units, Spr (Waldron) MWF 12


3 units, Spr (J. Manning) MWF 11

228. Fluidics—Introduction to fluidic components and systems. Behavior and modeling of bistable and proportional jet devices, vortex amplifiers and sensors, passive elements, transmission lines. System synthesis, coupling effects. Survey of current applications and research. Prerequisites: E.E. 163 (may be taken concurrently) and M.E. 136 or A.A. 210A.

3 units, Aut (J. Manning) MWF 1:15

235A,B. Space Systems Engineering—(Enroll in Engineering 235A,B.) 40 to 50 students, mostly from engineering, but also from business, political science, law and education, form a team to prepare a preliminary design study of a space system. In previous years, a Mars Exploration System, an International Weather System, and a Communications and Educational Satellite System for Underdeveloped Countries have been designed. About 20 invited speakers from government and industry give the class the necessary background information. At the end of the second quarter, the class gives a verbal briefing to government and industry representatives and publishes a final report on the system.

235A. 3 units, Win (Adams) TTh 1:15-3:05 and two hours by arrangement

235B. 3 units, Spr (Adams) TTh 1:15-3:05 and two hours by arrangement

299A,B,C. Master's Project—Three-quarter graduate design project guided by a diverse faculty team. In the first quarter, the student uses rational and intuitive problem-finding procedures to identify a design project with-
in an unexplored area of need, presents a project proposal, and performs research. In the second quarter, he prepares a design program, develops concepts, performs necessary experiments, and carries project to the stage of a working prototype. In the third quarter, he refines design from the standpoint of cost and production, builds demonstration model, and presents project to professional jury.

299A. 4 units, Aut (McKim, Adams, Kahn) by arrangement
299B. 4 units, Win (McKim, Adams, Kahn) by arrangement
299C. 4 units, Spr (McKim, Adams, Kahn) by arrangement

THERMOSCIENCES

211A. Physical Gas Dynamics—(Enroll in A.A. 211A.) The fundamentals of high-speed, high-temperature flow of a gas from the molecular point of view; molecular concepts and simple kinetic theory; equilibrium properties of gases and gas mixtures as obtained from kinetic theory, chemical thermodynamics, and statistical mechanics.

3 units, Win (Mitchner) MWF 2:15

211B. Physical Gas Dynamics—(Enroll in A.A. 211B.) High-speed, high-temperature flows of gas mixture in local thermodynamic and chemical equilibrium; physical and chemical basis of rate equations; flows with vibrational and chemical nonequilibrium. Prerequisites: 211A and A.A. 210B, or equivalent background.

3 units, Spr (Vincenti) MWF 2:15

211C. Physical Gas Dynamics—Kinetic theory of gases in translational nonequilibrium: concepts from statistical mechanics; Boltzmann equation; molecular encounters and related concepts; conservation equations; H-theorem; Maxwell distribution; Chapman-Enskog method; viscosity and thermal conductivity for different molecular force models; selected applications. Prerequisites: A.A. 192 and acquaintance with basic equations of viscous flow or consent of instructor.

3 units, Aut (Karamcheti) MWF 1:15

212. Kinetic Theory of Transport Processes — The Chapman-Enskog development of the Boltzmann equation, its relation to the macroscopic fluid mechanics equations, the transport coefficient. Emphasis will be on the calculation of transport properties (viscosity, thermal conductivity, diffusivity of pure gases, and gas mixtures) from molecular interactions and on the molecular interaction potentials. Ionized gases will also be treated. If time permits other topics such as the Grad and Wang Chang-Uhlenbeck solutions of the Boltzmann equation will be discussed. Prerequisites: 211A or consent of instructor.

3 units, Win (Ferziger) MWF 2:15

231A. Heat Transmission — Application of principles of heat transfer and thermodynamics to solution of steady-state, transient heat transfer problems with combined mechanisms. Classical heat conduction theory. Radiation heat transfer analysis. Prerequisites: graduate standing and at least concurrent registration in Mathematics 130.

3 units, Aut (Staff) MWF 9

231B. Heat Transmission—Boundary layer theory, including heat, mass, and momentum transfer, laminar and turbulent flows inside tubes and external boundary layers; the high velocity compressible boundary layer; design of heat and mass transfer systems. Prerequisites: 231A or consent of instructor.

3 units, Win (Staff) MWF 9

231C. Heat Transmission—Continuation of 231B. Prerequisite: 231B.

3 units, Spr (Staff) MWF 8

233A. Advanced Thermodynamics — Fundamentals of thermodynamics. Review of First Law, Second Law, relations among properties of systems. Different treatments of principles are studied, compared. Applications given to engineering problems, including development of availability concept.

2 units, Win (Staff) TTh 11

233B. Advanced Thermodynamics — Theory of equilibrium. From the law of stable equilibrium and the generalized inertial principle of Gibbs, the criteria of various kinds of equilibrium and degrees of stability are derived for nonfluctuating systems. Applications to heterogeneous systems, chemical reactions, and solutions. Force fields. Generalization to statistical thermodynamics of fluctuating systems — single-molecule and multimolecule bodies—by introducing information concepts.

3 units, Spr (Keenan) TTh 9:00–10:30
237A. Thermodynamics of Propulsion Systems—Analysis of the performance of propulsion prime movers from a thermodynamic and dynamic point of view, including rocket, ramjet, and turbojet systems as well as piston, gas turbine, and compound piston-turbine type engines. Thermodynamics and kinetics of combustion reaction as applied to internal combustion engine systems. Prerequisites: 132 and graduate standing.
4 units, Win (Staff) MWF10 and one hour by arrangement

238A. Continuum Fluid Mechanics—Development of the basic mathematical models for the kinematics and dynamics of the fluid continuum. Integral theorems for mass, momentum and energy. The Newtonian fluid and Navier-Stokes equations. Fractional analysis of basic equations and boundary conditions to obtain simplified models: one-dimensional flow, two-dimensional potential flow of an incompressible fluid, the boundary layer. Applications to engineering problems by exact and approximate methods. Prerequisite: graduate standing.
3 units, Aut (Staff) MWF 8

238B. Continuum Fluid Mechanics—Continuation of 238A. Exact solutions to Navier-Stokes equations. Low Reynolds number flows. Introduction to lubrication. The laminar boundary and free shear layers (wakes and jets). Concepts of stability of fluid flows and introduction to hydrodynamic stability theory. Prerequisite: 238A.
3 units, Win (Staff) MWF 11

3 units, Spr (Staff) MWF 9

239A. Fluid Dynamics of Turbomachinery—Analysis of the fluid dynamics and thermodynamics of flow in turbomachinery. Basic equations for flow in rotating coordinates. Effects of Coriolis and centrifugal forces on boundary layers. Flow in, and design problems of, the centrifugal compressor stage used as vehicle for discussions of concepts and general methods. Prerequisites: 238A (required), 238B,C (recommended).
3 units, Win (Johnston) MWF 11, alternate years, given 1968–69

239B. Hydrodynamic Stability—Linear and nonlinear theories of hydrodynamic stability by classical, variational and numerical methods. Applications to laminar shear layer stability, transition to turbulence and structure of turbulent shear flows. Prerequisites: 238A,B (required), 238C, 260A,B (recommended).
3 units, Spr (Reynolds) alternate years, given 1969–70

240. Current Topics in Fluid Mechanics—This course will consist of a series of lectures by invited experts from outside the University on a topic of current interest in the general area of fluid mechanics. The topic chosen will be announced in the Summer Quarter Bulletin.
2 or 3 units, Sum (——) by arrangement

242A. Experimental Methods in the Thermosciences—Planning experimental programs, uncertainty analysis and the selection of instrument systems. Steady state measurements of heat flux, temperature, pressure, and flow rate. Flow visualization and boundary layer techniques in air and water. Advanced laboratory problems in heat transfer and fluid dynamics. Prerequisites: graduate standing or consent of instructor.
4 units, Spr (Moffat) MWF 10 plus one 3-hour lab. by arrangement

242B. Experimental Methods in the Thermosciences—Measurements in dynamic systems. Overall system response. Transient temperature, pressure, velocity measurements. Hot wire anemometry in turbulence measurements. Spectral analyses and correlation measurements. Digital data acquisition and processing. Prerequisites: graduate standing or consent of instructor.
3 units, Sum (Moffat) MWF 10 plus one 2-hour lab. by arrangement

248. Plasma Physics Seminar—(Enroll in Engineering 214.) Discussion of research problems and current literature in plasma physics is offered by faculty, students and outside specialists.
1 unit, Aut, Win, Spr (Staff) by arrangement
249. Experimental Plasma Physics I—(Enroll in Engineering 212.) Lecture course which, together with 249A, is intended to introduce the student to selected basic plasma phenomena, with emphasis on the production and characteristics of d.c. and r.f. discharges, and plasma diagnostics using d.c., r.f. and optical methods. Prerequisite: 251 or Engineering 210 or permission of instructor.

2 units, Win (Staff)


2 units, Win (Staff) by arrangement

250. Experimental Plasma Physics II—(Enroll in Engineering 213.) Continuation of 249. Prerequisites: 249 and 249A.

2 units, Spr (Staff)

250A. Experimental Plasma Physics Laboratory II—(Enroll in Engineering 213A.) Continuation of 249A. Prerequisites: 249 and 249A. Concurrent registration in 250 required.

2 units, Spr (Staff) by arrangement


3 units, Win (Chang) MWF 10

252. Magnetofluidmechanics — Interaction of conducting fluids with electric and magnetic fields. MHD one-dimensional channel flow, boundary layers, power generation and fluid acceleration. Calculations of electrical conductivity of equilibrium and nonequilibrium partially ionized gases. Prerequisite: 251 or consent of instructor.

3 units, Spr (Staff) MWF 10

253. Kinetic Theory of Partially Ionized Gases—Collisions between charged particles, Debye shielding. The Fokker-Planck equation and its relation to the Boltzmann equation. Application of the spherical harmonic expansion to the calculation of electrical and thermal conductivities and thermal-diffusion coefficients of partially ionized gases in a magnetic field. The effect of strong electric fields on the electron velocity distribution and on the values of the transport coefficients; the electron energy equation. Rate equations for the population of excited atomic states and the degree of ionization. Nonequilibrium as a result of relaxation and radiation escape. Prerequisites: 251 and 211A, or permission of instructor.

3 units, Spr (C. Kruger) MWF 1:15, alternate years, given 1969–70

254. Physics of Atomic and Radiative Processes in Partially Ionized Gases — This course will be primarily concerned with providing an introduction to fundamental concepts of electromagnetic theory of radiation and in quantum mechanics. Topics to be covered will include radiation from an accelerated charge, bremsstrahlung, blackbody radiation, deficiencies of classical theory, de Broglie waves, the uncertainty principle, Schrödinger’s equation and its solutions, scattering theory, Ramsauer effect. Emphasis will be placed on atomic collision processes of interest in high temperature gasdynamics. Prerequisite: Mathematics 132 concurrently or equivalent.

3 units, Spr (Mitchner) MWF 3:15, alternate years, given 1968–69


3 units, Spr (Staff) MWF 11


3 units, Spr (Staff) MWF 11
260A. Mathematical Methods in the Thermosciences — Advanced topics in the solution of ordinary and partial differential equations with application in a variety of physical problems, including viscous flows, hydrodynamic stability, liquid sloshing, conduction, convection, and radiation heat transfer. Prerequisites: Mathematics 106 and 132, or equivalent.

3 units, Aut (Reynolds) MWF 11, given 1968–69

260B. Mathematical Methods in the Thermosciences—Continuation of 260A. Prerequisite: 260A.

3 units, Win (Reynolds) MWF 10

296. Seminar in Fluid Mechanics—(Enroll in A.M. 296.) Problems in all branches of fluid mechanics. All Ph.D. candidates in fluid mechanics are normally expected to attend. Registration for one unit of credit, without letter grade, is open to students having the Master's degree; a letter grade is given for those presenting talks.

1 unit, Aut, Win, Spr (Staff) T 4:15

NUCLEAR ENGINEERING

For a listing of the courses in Nuclear Engineering, see “Division of Nuclear Engineering” below.

DIRECTED STUDY

291. Engineering Problems—Directed study for graduate engineering students on subject of mutual interest to student and staff member. May be used to prepare for experimental research during a later quarter under 292. Student must find faculty sponsor.

1 to 15 units, any quarter (Staff) by arrangement

292. Experimental Investigation of Engineering Problems — Graduate engineering student may undertake experimental investigation under guidance of staff member. Previous work under 291 may be required to provide background for experimental program. Student must find a faculty sponsor.

1 to 15 units, any quarter (Staff) by arrangement


2 to 15 units, any quarter (Staff) by arrangement


2 to 15 units, any quarter (Staff) by arrangement

DIVISION OF NUCLEAR ENGINEERING

Professor: Thomas J. Connolly (Director)
Associate Professors: Joel H. Ferziger, Rudolph Sher
Assistant Professor: Anthony Leonard
Affiliated Faculty: Paul Kruger, George Leppert

OFFERINGS AND FACILITIES

The Division provides graduate instruction in nuclear reactor theory and experimentation, in nuclear reactor design and control, and in particle and radiation transport theory and experimentation. In addition, a wide range of courses in mathematics, physics, and various engineering sciences is available to the student. The program is intended for those students who plan a career of research, teaching, design, or management in the field of nuclear energy processes or systems. Each student works out a program of study with his adviser.

The Nuclear Engineering Laboratory has among its facilities a pool-type research reactor, an accelerator-type neutron generator with pulsing capability, a subcritical assembly, extensive nuclear counting and spectrometry equipment, and a radiochemistry laboratory. These facilities are used for instruction and graduate student research.

An active program of research is carried on in the Division of Nuclear Engineering under the sponsorship of various agencies. These projects include experimental and theoretical investigations relating to nuclear reactor theory, neutron transport and thermalization, and neutron cross sections. Research programs are also conducted in heat transfer, fluid mechanics, and radiochemistry. Qualified students participate in these projects as research assistants, engaged in thesis research, in close working association with a faculty research supervisor and fellow students.

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

The Division operates exclusively at the graduate level and requires the B.S. degree for admission.
MASTER OF SCIENCE

Admission and Registration — The basic University requirements for the Master's degree are discussed in the section “Degrees” in this bulletin. The Division of Nuclear Engineering is administered within the Department of Mechanical Engineering. A prospective student may apply for admission either in this Department (Nuclear Engineering — Mechanical Engineering) or in the Engineering Science program (Nuclear Engineering — Engineering Science). In either case, to be eligible for registration as a graduate student an applicant must have received a B.S. degree in engineering, physics, or some comparable science program. His undergraduate record and personal recommendations must demonstrate that he is capable of handling graduate level work and will complete the requirements for the M.S. degree. The graduate program leading to the M.S. degree under the rules of the Department of Mechanical Engineering is described in the preceding section. A student who wishes to follow a more specialized program of study in nuclear engineering than would conform with the requirements of the Department of Mechanical Engineering may do so under the Engineering Science program. This program is described under School of Engineering graduate programs in this bulletin.

Graduate Program — To secure the recommendation of the Division for the Master's degree, a candidate must complete 45 units of course work distributed as follows: 6 units of mathematics, 33 units of restricted electives which will include several of the courses described below as well as other engineering or science courses, and 6 units of free electives.

DEGREE OF ENGINEER

The basic University requirements for the degree of Engineer are discussed in the section “Degrees” in this bulletin.

This degree represents nominally an additional year of study beyond the Master of Science degree, and includes a research thesis. This program is designed for students who desire to do professional engineering work upon graduation, and who desire an opportunity to engage in more specialized study than is afforded by the Master’s degree alone.

DOCTOR OF PHILOSOPHY

The basic University requirements are discussed in the section “Degrees” in this bulletin. The Doctor's degree is intended primarily for students who desire to pursue a career in research, advanced development, or teaching, where a broad background in mathematics and the engineering sciences, together with intensive study and research experience in a specialized area, are the necessary requisites.

The Division of Nuclear Engineering is administered within the Department of Mechanical Engineering; a Ph.D. candidate is enrolled in this Department. A student may elect a minor field of study if he wishes, but it is not required that he do so. A Ph.D. program should, however, show some breadth of training outside of a student's research field.

A student studying for the Ph.D. degree ordinarily will not take an Engineer degree, although this is not precluded. Although a Master's degree is not technically required, a student will usually have fulfilled M.S. degree requirements before becoming a candidate for the Ph.D.

Prior to being formally admitted to candidacy for the Ph.D. degree the student must demonstrate his knowledge of the fundamentals of nuclear engineering by passing a qualifying oral examination. The examination covers the subjects of mathematics, physics, nuclear reactor theory, and two other engineering science subjects (e.g., control theory, heat transfer) selected from a list of seven. The academic level of this examination corresponds to the M.S. degree program. A student must have the approval of his adviser, and at least a tentative arrangement for research supervision, in order to take the examination. The examination is offered during the winter quarter and may in addition be offered at other times as the need arises. Normally the examination will be taken during the first post-Master's year.

FINANCIAL ASSISTANCE

A number of fellowships and research assistantships are awarded annually to graduate students. The fellowships are usually awarded to first-year graduate students, with the assistantship used primarily for post-Master's degree students. Research assistantships are awarded by the individual
faculty research supervisors and not by the Division as a whole.

Applicants for all forms of assistance may obtain the necessary application forms from the University Admissions Office. However, post-Master's degree applicants for research assistantships, because of the individual nature of these awards, are advised to contact directly the faculty member under whom they would like to work. Formal applications to the Division for research assistantships will be referred to the individual faculty research supervisors.

Research assistants can, and normally do, carry out their thesis work and write their thesis as an integral part of the commitments of their assistantship.

COURSES


3 units, Win (Staff) MWF 9

172. Nuclear Chemistry—(Enroll in Engineering 172.) Properties of nuclei and radioisotopes; nuclear reactions; fission, fusion, reactors and accelerators; radiation detection and measurement; radiation safety; radiation chemistry; radiotracer, activation analysis, and their applications. Prerequisites: Chemistry 3, Mathematics 23, and Physics 57.

3 units, Win (P. Kruger) TTh 11

175. Nuclear Measurements Laboratory — (Enroll in Engineering 175.) Principles and techniques of radiation detection and measurement: ionization chambers, proportional, Geiger-Muller, and scintillation detectors; solid state detectors; statistical analysis of counting; beta and gamma spectrum analysis; radiation safety. Prerequisite: Concurrent registration in 171 or 172, or consent of instructor.

3 units, Aut, Win (Staff) lab. one afternoon by arrangement

176. Radiochemistry Laboratory — (Enroll in Engineering 176.) Nuclear reactions, radiochemical separations, radioactivity genetics, radioisotope production, neutron activation analysis and flux measurements; nuclear fission, radiotracer in physical chemistry and engineering. Prerequisite: Engineering 172 or 175, or consent of instructor.

3 units, Spr (P. Kruger) Th 1:15 and one lab. by arrangement


3 units, Spr (Staff) MWF 11

271A. Nuclear Reactor Theory — Neutron cross sections, the fission process. Infinite medium criticality calculations; the four-factor formula. Neutron diffusion and slowing down theory. Age theory. Criticality calculations for the bare homogeneous reactor. Elementary reactor kinetics.

3 units, Aut (Staff) MWF 10


3 units, Win (Staff) MWF 10


3 units, Spr (Staff) MWF 10

273. Reactor Physics Laboratory — Measurements of: reactor criticality, periods, control rod worth, danger coefficients, reactor flux and power. Prerequisite: 271A.

3 units, Win (Staff) one afternoon by arrangement

274. Reactor Physics Laboratory — Measurements of: buckling and other parameters of subcritical assembly, void coefficients in pool reactor, neutron age and diffusion length in various media. Prerequisite: 271B.

3 units, Spr (Staff) one afternoon by arrangement

albedo problem, Milne problem, half-space Green's function; approximate solutions of other problems; applications to kinetic theory of gases and radiative transfer. Extensions to the energy-dependent case will be treated briefly. Prerequisites: 271B and Mathematics 106.

3 units, Spr (Leonard) MWF 9, alternate years, given 1969–70

277. Neutron Thermalization—Calculation of thermal neutron spectra; space-dependent spectra in reactors, time-dependent spectra in pulse systems. Calculation of scattering kernels from the dynamics of the scattering system: the Zemach-Glauber and Van Hove formalisms, application to scattering from an ideal gas, Einstein and Debye crystals, and molecules; approximate treatments of liquids, real gases and crystals. Prerequisites: 271C and Physics 132.

3 units, Spr (Ferziger) MWF 9, alternate years, given 1968–69

282. Nuclear Reactor Design —The development of a reactor design from a set of specifications. The synthesis of reactor theory, heat transfer, properties of materials, and economics, in reactor design. The use of digital computer codes in reactor design. Prerequisite: 271A or consent of instructor.

3 units, Spr (Staff) TTh 11:00–12:15


3 units, Spr (Sher) TTh 10, alternate years, given 1969–70


3 units, Win (Staff) MWF 1:15

OPERATIONS RESEARCH

Executive Head: Gerald J. Lieberman
Professor of Decision Science: Ronald A. Howard
Associate Professor: Frederick S. Hillier
Associate Professors of Management Science: Charles P. Bonini, Robert Wilson
Assistant Professor: Richard W. Cottle
Assistant Professor of Management Science: Alan J. Seelenfreund

Offerings and Facilities

Operations research is concerned with the science of decision making and its application. With the advent of the computer nearly every aspect of decision making in government, business, engineering, economics, and the natural and social sciences has been subject to mathematical modeling and solution. These applications are largely characterized by the need to allocate limited resources. In such situations, considerable insight can be obtained from the scientific analysis provided by operations research.

Stanford University early recognized the significance of the emergence of operations research and the importance of developing an outstanding faculty to conduct research and teach courses in this new field. Thus, extensive research and teaching activities were flourishing within several departments and schools in the University by the late 1950's. In order to coordinate and integrate these activities, the Graduate Division in 1962 established an ad hoc committee on Operations Research to supervise an interdepartmental program leading to the Doctor of Philosophy degree in Operations Research. In recognition of the great growth and importance of the field, the University then established a Department of Operations Research to carry on this doctoral program and to initiate a Master of Science degree program.

Programs of Study

MASTER OF SCIENCE

The program leading to the degree of Master of Science in Operations Research
is designed to prepare individuals for high-level professional work in applying operations research. Thus, the emphasis is on providing a solid foundation for a life-long professional career involving the formulation, solution, and implementation of operations research models for analyzing complex systems problems in business or government.

In addition to the University's basic requirement for the Master's degree discussed in the section "Degrees" in this bulletin, a candidate is expected to complete an approved course program of 45 units. This program normally can be completed in one academic year (three academic quarters) of full-time work. A number of operations research workers in local industry also attend part-time, taking one or two daytime classes per quarter, under the Honors Cooperative Program. Each student will normally fulfill the following requirements for the Master of Science degree:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math. 113</td>
<td>Linear Algebra and Matrix Theory</td>
<td>3</td>
</tr>
<tr>
<td>Math. 115</td>
<td>Fundamental Concepts of Analysis</td>
<td>3</td>
</tr>
<tr>
<td>Stat. 116</td>
<td>Theory of Probability</td>
<td>4</td>
</tr>
<tr>
<td>Stat. 219</td>
<td>Elementary Statistical Inference</td>
<td>3</td>
</tr>
<tr>
<td>Stat. 220</td>
<td>Statistical Inference</td>
<td>3</td>
</tr>
<tr>
<td>Stat. 217A</td>
<td>Introduction to Stochastic Processes</td>
<td>3</td>
</tr>
<tr>
<td>Stat. 217B</td>
<td>Introduction to Stochastic Processes</td>
<td>3</td>
</tr>
<tr>
<td>Comp. Sci. 136</td>
<td>Introduction to Algorithmic Processes</td>
<td>3</td>
</tr>
<tr>
<td>Op. Res. 240</td>
<td>Linear Programming</td>
<td>3</td>
</tr>
<tr>
<td>Electives from the offerings of the Department of Operations Research or from authorized courses in other departments</td>
<td>11</td>
<td></td>
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<tr>
<td>Total</td>
<td></td>
<td>45</td>
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**DOCTOR OF PHILOSOPHY**

The program leading to the degree of Doctor of Philosophy in Operations Research is directed to those primarily interested in a career of research and perhaps teaching in a university, business, or government position. Therefore, emphasis is given to the scientific foundations of operations research. In particular, the program is focused on:

(a) the study of the abstract mathematical structure of models derived from real life situations such as allocation models of an enterprise or an economy, network flow models of transportation and communication systems, reliability models of complex engineering systems, queueing models of congestion, modeling and control of dynamical systems arising in physical, economic, or management contexts, discrete selection models for routing and pattern cutting, policy decisions for production and inventory control, and models for conflict resolution, and

(b) the development of the mathematical theory, including the theory of optimization, necessary for the solution of these models.

Examples of the applied mathematical disciplines studied include mathematical programming, dynamic programming, optimal control theory, structure and identification of dynamical systems, stochastic processes, optimal prediction and filtering, network and combinatorial theory, reliability, queueing theory, inventory theory, and game theory.

Typical course requirements for the Ph.D. degree in Operations Research are shown below. The programs of individual students may be adjusted to satisfy previous course work deficiencies or the special interest of the student.

**Prerequisites**

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<tr>
<th>Units</th>
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<tr>
<td>Stat. 119. Elementary Statistical Inference</td>
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<tr>
<td>Stat. 120. Statistical Inference</td>
</tr>
<tr>
<td>Math. 44. Advanced Calculus I</td>
</tr>
<tr>
<td>Math. 45. Advanced Calculus II</td>
</tr>
<tr>
<td>Math. 46. Advanced Calculus III</td>
</tr>
<tr>
<td>Econ. Microeconomics, equivalent of any one of the following:</td>
</tr>
<tr>
<td>Econ. 202. Price and Allocation Theory I</td>
</tr>
<tr>
<td>Bus. 401. Microeconomics</td>
</tr>
<tr>
<td>E.E.S. 210. Introduction to Price Theory and Resource Allocation</td>
</tr>
<tr>
<td>E.E.S. 212A. Price and Income Theory</td>
</tr>
<tr>
<td>C.S. 136. Introduction to Algorithmic Processes, or equivalent</td>
</tr>
</tbody>
</table>

**Requirements**

<table>
<thead>
<tr>
<th>Units</th>
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<td>Math. 113. Linear Algebra and Matrix Theory</td>
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<td>Stat. 217A. Introduction to Stochastic Processes</td>
</tr>
<tr>
<td>Stat. 217B. Introduction to Stochastic Processes</td>
</tr>
<tr>
<td>Elective courses having an operations research label or from courses of similar level and content from the offerings of other departments</td>
</tr>
<tr>
<td>Integrated courses in one or more related subject fields</td>
</tr>
<tr>
<td>Total units of requirements</td>
</tr>
</tbody>
</table>
In addition to the course requirements, the doctoral candidate must fulfill several University requirements, as described in the section "Degrees" in this bulletin. These include a reading knowledge of at least one foreign language, passing a University oral examination, and completion of a dissertation which represents an original contribution to knowledge expressed in a satisfactory form. The Department of Operations Research also requires that the candidate successfully complete a set of written comprehensive examinations, which normally are taken in April of the second year in the program.

A student performing satisfactorily in the Ph.D. program normally would be eligible to receive a Master of Science degree in Operations Research, if he so desires, after completing 45 units of course work.

FELLOWSHIPS AND ASSISTANTSHIPS

Financial aid is available on a competitive basis for qualified doctoral candidates. This includes a number of fellowships as well as some research assistantships supported by departmental research grants and contracts. Although these research assistants work closely with the faculty on their research projects, they usually are able to take close to a full course load. A few additional research assistantships are awarded with duties assigned at the Stanford Research Institute. Supplementary financial aid can sometimes be obtained by grading, assisting in special projects, or University loans.

All applicants for financial assistance are required to take the Aptitude Test and the Advanced Test (in the field of the applicant's choosing) of the Graduate Record Examination.

Applications for fellowships and assistantships should be made to the Financial Aids Office by March 1.

COURSES

152. Introduction to Operations Research I — Introduction to deterministic models in operations research. Linear, nonlinear, and dynamic programming. Network analysis, inventory theory, simplex method, transportation problem, dual theorem, convex programming, integer programming, structure of deterministic dynamic programming problems, minimax theorem. Matrix notation will be introduced. Graduate students enroll in 252. Prerequisite: differential calculus.

3 units, Win (Lieberman) MW 4:15–5:30


3 units, Spr (Iglehart) MW 4:15–5:30

240. Linear Programming — This course will survey linear programming, emphasizing standard model formulation, fundamental theorems, variations of the simplex method and parametric programming. Students will solve a linear programming problem on the computer. Corequisite: Mathematics 113.

3 units, Aut (Manne) TTh 1:15–2:30

250. Deterministic Models in Operations Research — Formulation, solution, and analysis of mathematical programming models in operations research, including those of integer programming, nonlinear programming, network flow theory, dynamic programming, and game theory. Prerequisite: 240.

3 units, Win (——) TTh 4:15–5:30


3 units, Spr (——) MW 4:15–5:30

252. Operations Research — For graduate students who have not had the equivalent of 152 and 153. Prerequisites: Calculus and Statistics 27, or 110, or 116. (May be taken concurrently.)

4 units, Aut (Cottle) MW 3:15–5:05
Win (Iglehart) MW 4:15–6:05

257. Data Processing in Operations Re-
search—Seminar in selected topics in the application of electronic computers to operations research activities. Emphasis on the use of simulation techniques. Prerequisites: C.S. 136 or equivalent and at least two courses in operations research. (May be taken concurrently.)

3 units, Win (Bonini) MW 4:15-5:30

299. Independent Study — Intensive study of literature of special topics.

Any quarter (Staff) by arrangement

340. Mathematical Programming — Basic concepts and methods of the mathematical programming field. Serves as an introduction to nonlinear programming, integer programming and stochastic programming. The fundamental problem of minimization of a function of many variables subject to a system of linear and nonlinear inequality constraints. Separation theorems and other properties of convex sets. Duality theorems and extension of Lagrange multiplier concepts to inequality constrained systems, Kuhn-Tucker, Fritz John conditions for optimality. Complementary pivot theory: a constructive uniform theory of the solution of linear and quadratic programs and bimatrix games with extensions to nonlinear programs. Special topics include variants of the simplex method, upper bounding, parametric methods, lexicographic theory for handling degeneracy, economic interpretation of dual variables as prices, matrix games (zero and nonzero sum), applications and computational experience. Prerequisites: Mathematics 113 and 115.

3 units, Win (Dantzig) TTh 1:15-2:30

341. Large Scale Systems in Mathematical Programming — (Enroll in Computer Science 341.) Specializes the methods of 340. Development of efficient solution methods for optimizing special large-scale linear inequality systems such as those encountered in control theory, programming in a Markov chain, investment and economic planning, multi-commodity network flows, multi-item production and distribution models; and those that arise as a solution procedure for nonlinear, integer, and stochastic programming problems. The decomposition principle, partitioning proposals, compact inverse schemes will be developed and applied to various special structures. The role of flexible computer languages to assist in the experimental development will be discussed. Prerequisite: 340.

3 units, Aut (Dantzig) by arrangement


3 units, Win (Cottle) MWF 3:15


3 units, Win (Cottle) MWF 11


347A. 3 units, Aut (Kalman) TTh 11:00-12:15

347B. 3 units, Win (Kalman) TTh 11:00-12:15

348. Dynamic Optimization (Deterministic)—Mathematical theory of optimization problems with respect to dynamical systems: unified treatment of necessary conditions via convexity methods, Pontryagin’s theorem, theory of the second variation. Prerequisites: 347A, B or equivalent or consent of instructor.

3 units, Aut (Kalman) TTh 2:45-4:00, alternate years, given 1968-69

349. Dynamic Optimization (Stochastic)—Optimal prediction and filtering theory of linear systems; realization of theory of random processes, nonlinear prediction, plus some recent research results. Prerequisites: 347A, B or equivalent or consent of instructor.

3 units, Aut (Kalman) TTh 2:45-4:00, alternate years, given 1969-70

3 units, Aut (Seelenfreund) TTh 9–11


3 units, Spr (Lieberman) TTh 11:00–12:15

356. **Inventory Theory** — Characterization and computation of optimal inventory policies for single and multi-item dynamic inventory models with convex or concave cost functions and known or uncertain requirements. Myopic policies. Bayes and minimax policies. Multi-echelon models. Corequisite: Statistics 217B.

3 units, Spr (Iglehart) TTh 8–10


3 units, Aut (Hillier) TTh 4:15–5:30

370. **Seminar in Mathematical Programming** — Advanced topics. Prerequisite: 341.

3 units, Spr (Dantzig) by arrangement

371. **Seminar in Combinatorial Analysis and Integer Programming** — Advanced topics. Prerequisite: 341. (See 469A for 1968–69.)

3 units, given 1969–70

372. **Seminar in Nonlinear Programming** — Advanced topics. Prerequisite: 342.

3 units, Aut (Cottle) by arrangement

375. **Seminar in Network Theory** — Advanced topics. Prerequisite: 345.

3 units, given 1969–70

378. **Seminar on Mathematical System Theory** — Advanced topics. Prerequisite: 348.

3 units, given 1969–70

381. **Seminar in Dynamic Programming** — Advanced topics. Prerequisite: 351.

3 units, given 1969–70

385. **Seminar in Reliability Theory** — Advanced topics. Prerequisite: 355.

3 units, given 1969–70

386. **Seminar in Inventory Theory** — Advanced topics. Prerequisite: 356.

3 units, given 1969–70

388. **Seminar in Queueing Theory** — Advanced topics. Prerequisite: 358.

3 units, given 1969–70

389. **Seminar in Applied Probability** — Advanced topics. Prerequisite: 358 or consent of instructor.

3 units, Win (Iglehart) by arrangement


Any quarter (Staff) by arrangement

469A. **Management Science Workshop** — (Enroll in Business 469A.) The topic for this quarter will be integer programming.

4 units, Aut (Hillier) by arrangement

469B. **Management Science Workshop** — (Enroll in Business 469B.) Selected topics drawn from the literature.

4 units, Win (——) by arrangement
School of Humanities and Sciences

Dean: Robert R. Sears (on leave 1968-69)
Associate Dean: Lawrence V. Ryan
Assistant Dean: Donald R. Price

Organization

The School of Humanities and Sciences includes all members with the rank of instructor or above of the Departments of Aerospace Studies, Anthropology, Applied Physics, Art and Architecture, Asian Languages, Biological Sciences, Chemistry, Classics, Communication, Computer Science, Economics, English, French and Italian, German, History, Humanities Special Programs, Mathematics, Military Science, Music, Naval Science, Philosophy, Physics, Political Science, Psychology, Slavic Languages and Literatures, Sociology, Spanish and Portuguese, Speech and Drama, and Statistics, together with appointees to the Faculty at Large.

Members of the School of Humanities and Sciences are listed under their respective departments, or under the staff for Special Interdepartmental Programs.

Undergraduate Programs

A student wishing to take a departmental major leading to the degree of Bachelor of Arts should consult appropriate sections of the announcements following. Further information concerning requirements may be obtained from the department concerned.

A student desiring to fulfill the requirements for the degree of Bachelor of Arts or Bachelor of Science in one of the special interdepartmental programs (see Humanities Special Programs, Physical Sciences General Program, and Social Sciences Special Program in following sections of this bulletin) should consult the Director of Special Programs in the Humanities, the Chairman of the General Program in the Physical Sciences, or the chairman of the interdepartmental program in the Social Sciences. For general statements of the requirements for the degree of Bachelor of Arts or Bachelor of Science in these programs, students should see appropriate sections of the announcements following.

The School of Humanities and Sciences offers several survey courses in Geography which are listed separately in this publication. It is not possible, however, for a student to elect Geography as a major or minor field.

ROTC—Reserve Officers' Training Corps are maintained at Stanford by the Army, the Navy, and the Air Force (see Aerospace Studies, Military Science, and Naval Science in this bulletin). Students enrolled in Chemistry or Physics who are also enrolled in an ROTC program will usually require more than the usual four years (twelve quarters) in the University to obtain a baccalaureate degree. Because of the 36 units of credit required for the Aerospace Studies, Military Science, and Naval Science, the Chemistry or Physics courses require additional time for graduation which will vary from one to three quarters depending upon the circumstances in each case.

Graduate Programs

Candidates for the degree of Master of Arts, Master of Science, or Doctor of Philosophy should consult appropriate sections of the announcements following and should also consult the department in which they intend to specialize.

For regional, area studies, or other special graduate programs leading to the degree of Doctor of Philosophy, see listing under Graduate Division Special Programs.
AEROSPACE STUDIES

Executive Head: Leon C. Heinle (Major, USAF)
Professor: Leon C. Heinle (Major, USAF)
Assistant Professor: Carl R. Oliver (Captain, USAF)

GENERAL

The Department of Aerospace Studies offers a program of Air Force ROTC instruction and pre-commissioning training which, in conjunction with a baccalaureate degree, qualifies a student for a commission in the United States Air Force. This program can be completed in either a two- or a four-year configuration.

CURRICULUM

NEW TWO-YEAR PROGRAM (GRADUATE OR UNDERGRADUATE)

It is now possible for a student with two years remaining at Stanford University to participate in the AFROTC Program. Graduate students are especially invited to apply. The Professional Officer Course covers the development of aerospace power from man's early attempts to fly through our current space programs. Included is a detailed study of the military as a profession with particular emphasis on leadership and management training.

Throughout the AFROTC curriculum, major emphasis is placed on the development of the student's communicative skills. All classes are taught by the seminar method, with active student participation required. All cadets attend one hour of Leadership Laboratory each week on Thursday.

Students will attend a six-week Field Training Course during the summer preceding their enrollment. This Field Training Course replaces the General Military Course required in the four-year program and satisfies all Field Training requirements. Each student will experience living on an Air Force base and virtually become a part of the Air Force. He will learn about modern air and space weapons, participate in orientation flying, train in the use of weapons, and gain leadership experience and discipline through group drill.

FOUR-YEAR PROGRAM

This program consists of the General Military Course offered during the freshman and sophomore years and the Professional Officer Course during the junior and senior years.

The General Military Course includes an introductory course exploring the causes of the present world conflict as they affect the security of the United States, an introduction to the United States Air Force and a comparative study of the Free and Communist world military forces. The Professional Officer Course is the same as that described in the two-year program.

Students will attend a four-week Field Training Course on an Air Force base during the summer preceding their senior year.

ACTIVITIES

In addition to the academic curriculum the AFROTC program offers many activities which help the student develop the qualities of an Air Force officer. Leadership training is held once each week and enables the cadet to practice skills he studied in the seminar. Tours of Air Force installations acquaint cadets with the facilities and operations required to accomplish the Air Force missions. Orientation flights, often in jet aircraft, are offered to selected students. The Arnold Air Society, an honorary professional organization, sponsors social activities, service projects, and inter-ROTC competition.

DEFERMENT DELAY

Active participation in the AFROTC program authorizes deferment from selective service induction. This deferment can insure completion of undergraduate or graduate courses of study. Upon graduation and commissioning, education delays (postponement of active duty) may be granted to students pursuing graduate studies.

DISTINGUISHED GRADUATE PROGRAM

The Air Force ROTC Distinguished Graduate Program provides an opportunity for highly qualified cadets to be selected for appointment in the Regular Air Force.
The Professor of Aerospace Studies may designate as Distinguished Graduates those seniors who possess outstanding qualities of leadership and have demonstrated these qualities both in military classwork and other campus activities. They must also maintain high academic standings in their military and University studies.

Twenty per cent of Air Force ROTC graduates may be designated as Distinguished Graduates annually, and become eligible to compete for regular commissions.

**PAY AND BENEFITS**

All necessary military textbooks and uniforms are furnished without cost to the student. Cadets receive a retainer fee of $50 a month.

Students enrolled in the Two-Year Program receive approximately $135 while attending the six-week Field Training Course prior to entering the Two-Year Professional Officer Course. Students enrolled in the Four-Year Program receive approximately $150 while attending the four-week Field Training Course.

**FLIGHT INSTRUCTION PROGRAM**

A light plane pilot training program is offered during the final year to cadets who plan to enter the USAF pilot training program following commissioning. Cadets may obtain a private license through this program.

**COURSES**

Course numbers are assigned by the Air Force and do not correspond to the general University plan for numbering, i.e., none are graduate courses.

**FIRST YEAR**


101. 1 unit, Aut (___) TTh 10 or 1:15
102. 1 unit, Win (___) TTh 10 or 1:15
103. 1 unit, Spr (___) TTh 10 or 1:15
Leadership lab. Th 3:15

**SECOND YEAR**

201, 202, 203. World Military Systems—A study of world military forces (Air, Land, and Naval), to include trends in the development of military equipment and changing concepts of employment. International security organization and the rationale of contemporary peace proposals.

201. 1 unit, Aut (___) TTh 10 or 1:15
202. 1 unit, Win (___) TTh 10 or 1:15
203. 1 unit, Spr (___) TTh 10 or 1:15
Leadership lab. Th 3:15

**THIRD YEAR**


301. 3 units, Aut (Oliver) MW 11;
Leadership lab. Th 3:15
302. 3 units, Win (Oliver) MW 11;
Leadership lab. Th 3:15


3 units, Spr (Oliver) MW 11;
Leadership lab. Th 3:15

**FOURTH YEAR**

401. The Professional Officer—The foundations of the military profession. The channels of communications. Human relations as they apply to the leadership situation, and the theory of leadership.

3 units, Aut (Heinle) MW 3:15;
Leadership lab. Th 3:15


3 units, Win (Heinle) MW 3:15;
Leadership lab. Th 3:15

403. The Professional Officer—Air Force management, principles, and functions. The command and staff team. Data processing
and controls. Performance standards. The junior officer as an administrator.

3 units, Spr (Heinle) MW 3:15;
Leadership lab. Th 3:15

ADVANCED LABORATORY
199. Corps Training—Open to the AFROTC cadet staff and selected cadets. One hour each week.
1 unit, Aut, Win, Spr (Staff)
by arrangement

ANTHROPOLOGY

Executive Head: Benjamin D. Paul


Associate Professors: Clifford R. Barnett, Alan R. Beals, Roy G. D’Andrade, A. Richard Diebold, Charles O. Frake, Bert A. Gerow, James L. Gibbs, Robert B. Textor

Assistant Professors: Harumi Befu, John C. Hotchkiss

Lecturers: Peggy J. Golde, Louise Spindler

Research Associates: Peter Z. Snyder, Gene McN. Stirling

OFFERINGS AND FACILITIES

The courses offered by the Department of Anthropology are designed: (1) to provide undergraduate students who wish to add to their general education, or to supplement collaterally their major field, with instruction in this discipline which deals with man from the broadest viewpoints of biological heritage, culture, society, and personality; (2) to provide undergraduate majors in anthropology with a program of work leading to the Bachelor’s degree, and (3) to prepare candidates for advanced degrees in anthropology.

Students wishing to enroll as majors in anthropology should apply to the departmental adviser for undergraduate majors. Students wishing to change their majors to anthropology will be accepted if they have an average of C or higher in all previously completed courses which count toward a major in the field.

PROGRAMS OF STUDY

BACHELOR OF ARTS

For the Bachelor’s degree in Anthropology, 45 units of work in the Department are a requirement. The program of courses can be arranged in consultation with the adviser to meet the special needs and interests of the student. The following basic course requirements will be included in the 45 units, unless specifically excepted: Anthropology 1; Anthropology 5, Sociology 1 or other approved sociology course; Psychology 1 or other approved psychology course; Anthropology 191 (Senior Seminar). To be recommended for the Bachelor’s degree, the student must have an average grade of C or higher for work in the major field.

The Department offers an Honors Program in Anthropology to give department majors with superior scholastic records and outstanding ability in anthropology an opportunity to undertake more independent and creative work along the lines of their special interests. Honors work, when undertaken, is part of the student’s junior and senior year program, and culminates in the presentation of an honors thesis in the final quarter of the senior year. A student completing the program will graduate “With Departmental Honors.”

To qualify for admission to the Honors Program the student must have a grade point average of B or better (normally based on 15 units of work) in courses within the anthropology major sequence, and an overall grade average of B or better in general University work. Candidates for admission should apply to the departmental adviser for majors by the second quarter of the junior year. A student may be admitted in the third quarter of the junior year and, in exceptional cases, at the beginning of the first quarter of the senior year. The departmental adviser will assist the student with the selection of a faculty member to act as his honors adviser. Each student will prepare a proposed program of study, including his thesis topic, in consultation with his adviser and any other faculty member whose interests relate to his own. Topics for the honors thesis may consist of empirical field studies, where feasible; problems in the history of anthropological theory; or the manipulation of data from the literature bearing upon some problem of special interest to the student.
The honors student may apply 12 units of the 45 units required for the departmental major to a special study program. These 12 units will be distributed as appropriate between (a) courses in or outside the department which bear directly on the preparation of the honors thesis and (b) a special independent study course for honors. The honors thesis will be presented to his adviser at least two weeks before the end of the final quarter of the senior year.

Students majoring in other social science fields or in education, and interested in taking an undergraduate minor or coordinated program in anthropology, may wish to consider a choice from the following courses as being particularly relevant: 1 (General Anthropology), 126 (Culture Change), 131 (Comparative Social Systems), 158 (Culture and Personality), 159 (Cognitive Anthropology), 169 (General Linguistics and the Study of Language Behavior).

For majors in humanities fields the following anthropology courses are brought to special attention: 1 (General Anthropology), 5 (Development of Man), 121 (Cultural Evolution), 144 (Mythology and Folklore), 167 (Language and Culture).

For students in the biological sciences the most relevant courses are: 5 (Development of Man), 175 (Physical Anthropology: by permission of instructor).

It will also be noted that regional courses are given, especially in fields where Stanford has strong teaching and research commitments: Africa; Western Europe; India; China; Japan; the Pacific Islands; North, Central, and South America.

Interested students may take part in field work on local archaeological sites. They may also obtain training in museum methods by doing directed work relating to the Stanford anthropological collections. See courses 180 and 282.

ADVANCED DEGREES

Prospective graduate students should apply formally through the Graduate Admissions Office, which will submit their names to the Department for approval when application requirements are completed.

An applicant for admission to graduate work must file a report of his scores on the Aptitude Test of the Graduate Record Examination. This examination may be taken at most American universities (see your Registrar for further information). Applicants who do not have access to testing centers should write to the Educational Testing Service, Box 955, Princeton, New Jersey 08540, for possible arrangements, or notify the Department.

The Department of Anthropology offers the Master of Arts and the Doctor of Philosophy degrees. The Department will not admit students who wish to work only toward the Master of Arts degree unless they are enrolled in a Ph.D. or M.D. program in another division of the University.

MASTER OF ARTS

The requirements for the Master of Arts degree consist of residence at Stanford University as a graduate student for one year, with a minimum of 36 quarter units, plus a thesis, unless the thesis requirement is waived by action of the Department. Course requirements are to be determined by the Department, depending on the student's program.

DOCTOR OF PHILOSOPHY

The Doctor of Philosophy degree is earned by fulfilling the following requirements:

1. Have a reading knowledge of one foreign language in which there exists a substantial body of literature relevant to the student's program of study.

2. Pass a General Examination, given during the first year, based on a selection of any four of the following set of core courses offered during the autumn and winter quarters: 223, 233, 249, 255, 290.

3. Satisfactorily complete course 283 in the spring quarter of the first year.

4. Pass the following courses, by the end of the second year, at an acceptable graduate level:
   a) Introduction to Linguistics (265)
   b) Introduction to Mathematical Anthropology (285)
   c) Prehistoric Archaeology (170 or 172)
   d) Physical Anthropology (175 or 177)

Students who submit satisfactory evidence of having had previous training in any of these fields are urged to take more advanced courses in the same topic areas,
or to submit to the faculty a proposal to substitute courses in other fields.

5. Pass a Special Examination, normally given toward the end of the autumn quarter of the third year, covering the candidate’s major topic of specialization and one major ethnological area of the world.

6. Present a dissertation based upon independent research.

7. Pass the University Oral Examination, normally given in defense of the dissertation.

The Department of Anthropology maintains a graduate summer field training program in Oaxaca, Mexico. Normally graduate students will be given directed training in field research (course 288) during the summer after the first academic year, either at the Oaxaca field site or in another area where directed field training is available.

Students are expected to serve, and gain experience, as teaching assistants on a part-time basis for one or two quarters before or after doing field work for the dissertation.

**FELLOWSHIPS**

All first-year students in the doctoral program will be supported by fellowship or traineeship awards, and all graduate students whose progress is satisfactory will be similarly supported during successive years of doctoral training. Students with first-class records are encouraged to apply for outside awards such as National Science Foundation and National Institutes of Health fellowships.

**COURSES PRIMARILY FOR UNDERGRADUATES**

#1. General Anthropology—Anthropological approaches and perspectives relating to man, his culture, and his society. Emphasis on fields of cultural anthropology.

5 units, Aut (Spindler) MTWThF 1:15
Win (Beals) MTWThF 1:15
Spr (Gibbs) MTWThF 1:15

4 units, Sum (——) MTWThF 10

5. The Development of Man—Human evolution; early man; racial and other differences in modern man; early development and differentiation of culture. Introduction to physical anthropology and prehistory.

5 units, Win (Gerow) MTWThF 11

**ADVANCED UNDERGRADUATE AND GRADUATE COURSES**

(Except where prerequisites are specified, courses are open to all students. With consent of the instructor, one or more extra units may be added by undertaking special project work.)

102. Indians of North America — History, cultural background, and contemporary situation of major tribes in North America. Prerequisite: 1 or consent of instructor.

4 units, given 1969–70

103. Peoples of Middle America—Cultural development culminating in the high, pre-conquest civilizations and post-conquest changes in Indian peasant traditions are surveyed. Emphasis is given on the analysis of the institutions of contemporary small rural communities, using modern village studies as source materials. Prerequisite: 1 or consent of instructor.

4 units, Win (Hotchkiss) MWF 1:15

106. Indians of South America — Cultural and linguistic backgrounds of the aboriginal peoples of South America and the development of Andean civilization are reviewed. Emphasis is given on the analysis of institutions of the pre-conquest Indian societies. Prerequisite: 1 or consent of instructor.

4 units, Spr (Hotchkiss) MWF 11

108. Peoples of Europe — A review of anthropological materials on rural (peasant) societies in Europe, with emphasis on Ireland, France, Spain, Italy, and Greece. Prerequisite: 1 or consent of instructor.

4 units, Spr (Siegel) MWF 9

109. Peoples of Africa—Social organization and cultural institutions of traditional Sub-Saharan societies and their modification in response to changing conditions. Weekly lecture-laboratory employing tape recorded events and other African culture materials. Opportunity for special work on chosen topic. Prerequisite: 1 or consent of instructor.

5 units, Aut (Gibbs) MTWF 9

113. Peoples of South Asia — The social structure of the traditional community and its modification in response to changing conditions. Prerequisite: 1 or consent of instructor.

4 units, Spr (Beals) MWF 9
116. Peoples of Japan—Emphasis on Japan and relationship with other peoples of East Asia. Racial, linguistic, cultural backgrounds and characteristics; opportunities to read on special areas. Prerequisite: 1 or consent of instructor.

4 units, Aut (Befu) MWF 1:15

117. Traditional Chinese Society—(Graduate students enroll in 217.) The society, polity, economy, and religion of late traditional China analyzed as a total system. Secondary attention is given to the nature of premodern social change. Prerequisite: 1 or Sociology 1 or consent of instructor. Not open to freshmen or sophomores.

5 units, Win (Skinner) MTWTh 8

118. Communist Chinese Society—(Graduate students enroll in 218.) An examination of social and cultural change and political and economic development in the People's Republic of China in light of current social science theory. Secondary attention is given to a systemic analysis of contemporary Chinese society. Prerequisite: 117.

5 units, Spr (Skinner) MTWTh 8

119. Peoples of the Pacific—Ethnology of the Malayo-Polynesian speaking world focusing on linguistics, ecology, social structure, and cultural history. Emphasis on the importance of this area to a variety of general problems in anthropological theory. Prerequisite: 117.

4 units, Aut (Frake) MWF 11

121. Cultural Evolution—Examination of the nineteenth and twentieth century evolutionary theories. General and specific evolution. Cultural adaptation as an evolutionary process. Prerequisite: 1 or consent of instructor.

4 units, Win (Befu) MWF 10

126. Culture Change—Long and short range processes of sociocultural growth and change, including independent development, diffusion, culture contact, and technical aid programs. Prerequisite: 1 or consent of instructor.

4 units, Aut (Paul) MWF 10

131. Comparative Social Systems—Analysis of social structure, including kinship, community, other principles of organizing social life; comparison of non-Western with Western societies. Prerequisite: 1 or Sociology 1 or consent of instructor.

4 units, Aut (Siegel) MWF 1:15

132. Peasant Society and Culture—Analysis of peasantry as a concept, its community structure and personality, its interrelation with the outside world, processes of change in the modern world. Prerequisite: 1 or consent of instructor.

4 units, Spr (Befu) MWF 1:15

141. Belief Systems—Methods for the utilization of personal documents and questionnaires in the study of belief systems will be discussed. Students will be expected to carry out independent research and analysis of particular aspects of belief systems. Prerequisite: 1 or consent of instructor.

4 units (Beals) given 1969–70

143. Anthropological Approaches to Religion—This course will emphasize a behavioral, non-evaluative approach to religious belief and behavior. Selected theoretical approaches will be employed. Illustrative materials will be drawn primarily from mainland Southeast Asia. Prerequisite: 1 or consent of instructor.

4 units (Textor) given 1969–70

144. Mythology and Folklore—Anthropological contributions to understanding these fields of human activity; comparisons with Western literature.

4 units (Gerow) given 1969–70

145. Political Anthropology—This course will deal with the generation, allocation, and use of power in a variety of nonliterate and literate societies. Special emphasis will be placed on the politicization of populations in the new nations of the developing areas. Prerequisite: 1 or consent of instructor.

4 units, Win (Textor) MWF 11

158. Culture and Personality—Anthropological contributions to understanding the role of culture in personality development; comparative studies; present status of problem. Prerequisites: 1 and Psychology 1 or consent of instructor.

4 units, given 1969–70

159. Cognitive Anthropology—Investigation of the relation between cognitive process and cultural behavior. Selected topics from the fields of perception, language, and belief will be considered. Prerequisite: 1 or consent of instructor.

4 units, Win (D'Andrade) MWF 9

167. Language and Culture—The relevance of linguistic theory, semantic analysis, and
the study of speech as social behavior to problems of anthropology, sociology, and psychology. Prerequisite: 1 or consent of instructor.

4 units, Spr (Frake) MWF 10

169. General Linguistics and the Study of Language Behavior — An interdisciplinary introduction to linguistic, psychological, anthropological, and sociological approaches to the study of language and verbal behavior.

4 units, Win (——) MWF 1:15

170. Prehistoric Archaeology — Methods, findings in this field; correlations of prehistory of Europe and Near East with that of other zones over the world. (Graduate students enroll in 270.) Prerequisite: 5 or consent of instructor.

4 units (Gerow) given 1969–70

172. Prehistoric Archaeology of the New World — Current methods and findings in this field, with special emphasis in 1968–69 on the Cordilleran region of the Western United States and Mexico. Prerequisite: 5 or consent of instructor.

4 units, Spr (Gerow) MWF 11

175. Physical Anthropology — Methods, findings relating to human evolution, fossil man, and racial differences.

5 units, Win (——) MW 2:15–4:05

177. Primate Social Behavior — A Survey of the social behavior of monkeys and apes based on observation of natural, semi-natural, and captive colonies with emphasis on the implications of these observations for reconstructing the evolution of human behavior.

4 units (Shirek-Ellefson) given 1969–70

180. Archaeological Field Methods — Studies, excavations of local archaeological sites, and related work in the Department archaeological laboratory. Prerequisite: 5 or consent of instructor.

4 units, Spr (Gerow) by arrangement

190. Directed Individual Study — For undergraduate students with special needs, and showing capacity to do independent work. Prerequisite: 1 or consent of instructor.

Any quarter (Staff) by arrangement

191. Senior Seminar — For undergraduate majors, to give experience in seminar techniques and afford opportunity to undertake special project work. Prerequisite: 1.

2 units, Win (Textor) Th 2:15–4:05

195. Honors Program — Directed independent study and honors thesis work for students admitted to this program.

Any quarter (Staff) by arrangement

COURSES PRIMARILY FOR GRADUATE STUDENTS

203. Middle American Research — Problems on social organization in Middle America. Students may utilize materials from current staff research projects. This seminar may also serve as a follow-up of work done by summer field trainees. Prerequisite: graduate standing or consent of instructor.

5 units, Aut (Hotchkiss, Paul) M 2:15–5:05

207. Latin American Peasantry — Seminar treating selected topics in the study of agrarian based societies of Latin America. Emphasis in 1968–69 is on plantation systems and relations between local communities and larger political units. Prerequisite: consent of instructor.

5 units, Win (Siegel) T 2:15–5:05

209. African Law — Seminar analyzing the traditional legal systems of Sub-Saharan Africa, the relationship of legal beliefs and practices to other areas of culture and to other means of social control. Special attention to the changing role of law under colonialism and since independence. Prerequisite: graduate standing or consent of instructor.

5 units, Win (Gibbs) T 2:15–5:05

213. Selected Problems in South Asia — Selected topics in South Asian anthropology with an emphasis on community studies. Prerequisite: graduate standing or consent of instructor.

5 units (Beals) given 1969–70

217. Traditional Chinese Society — (See 117).

218. Communist Chinese Society — (See 118).

223. Advanced Cultural Systems — A survey of recent developments in the analysis of cultural systems with emphasis on belief systems, conflict and cultural change. Pre-
requisite: graduate standing or consent of instructor.

5 units, Aut (Beals) MW 2:15–4:05

224. Problems in the Study of Art and Culture—Consideration of concepts of art and aesthetics, the nature and development of art style; critical review of studies relating graphic art to social structure, values or personality; use of ethnographic materials for illustrative and research purposes. Prerequisite: graduate standing or consent of instructor.

5 units, Aut (Golde) given 1969–70

227. Selected Problems in Cultural and Social Change—Consideration of sources and characteristics of new alternatives, the reorganization of choice behavior in relation to prevailing social structure, technology and cultural orientations. Prerequisite: graduate standing or consent of instructor.

5 units, Aut (Siegel) T 2:15–5:05

228. Culture and Education in Developing Nations—(Same as Education 306A.) Concepts of culture and cultural relativism as analytical tools in defining and approaching problems of socio-economic development in Africa, Asia and Latin America. Relation of education to cultural and national development will be explored. Prerequisite: graduate standing or consent of instructor.

2 to 5 units, Aut (Textor) by arrangement

233. Social Organization — Examination of theories and findings in the area of culturally defined interpersonal relations, focusing on kinship and local group organization. Prerequisite: graduate standing or consent of the instructor.

5 units, Aut (D’Andrade) TTh 10:30–11:50

234. Comparative Peasant Societies—Seminar treating selected topics in the comparative analysis of traditional agrarian societies. The focus is on systems of governance and the political process. Cases may be drawn from any of the historical or contemporary peasant societies in Asia, the Middle East, Africa, Europe, or Latin America. Prerequisite: graduate standing or consent of instructor.

5 units, given 1969–70

235. Kinship and Social Behavior—Seminar in selected topics in the study of kinship and social interaction, emphasizing research applications. Prerequisite: graduate standing or consent of instructor.

5 units, given 1969–70

244. Advanced Mythology and Folklore—Anthropological contributions to understanding of these fields of human activity; comparisons with Western literature. Prerequisite: graduate standing or consent of instructor.

5 units, Aut (Gerow) T 2:15–5:05

245. Advanced Political Anthropology — (Same as Political Science 218.) Seminar treating the political process in traditional and modernizing societies, both simple and complex, and in their various subsystems. Analysis will proceed in connection with a rethinking of relevant theory from political science, anthropology, sociology, and related disciplines.

5 units, given 1969–70

249. Political and Economic Anthropology—An approach to the analysis of political and economic systems in the context of whole societies, the latter ranging in type from simple hunting and gathering societies to advanced agrarian societies. Prerequisite: Graduate standing or consent of instructor.

5 units, Aut (Skinner) TTh 9:00–10:20

254. Cultural Ecology—Seminar on problems of cultural adaptations of human societies to their environments. Prerequisite: graduate standing or consent of instructor.

5 units, Spr (Frake) W 2:15–5:05

255. Psychological Anthropology—Consideration of the role of cultural institutions in the shaping of personality, and conditioning of the form and function of cultural institutions by recurring personality dispositions. Treatment of methods characteristic of psychological anthropology. Special focus on socialization, deviance, therapies, revitalization movements. Prerequisite: graduate standing or consent of instructor.

5 units, Win (Gibbs) TTh 9:00–10:20

256. Cultural Transmission—(Same as Education 315.) The transmission of values, implicit cultural assumptions, and the patterning of education in cross-cultural perspective, with special attention to American culture. Prerequisite: graduate standing or consent of instructor.

3 units, Aut (Spindler) M 7–10 p.m.

4 units, Sum (——) MTWThF 9
258. Advanced Culture and Personality — Seminar on selected problems concerning the role of culture in personality development. Prerequisite: graduate standing or consent of the instructor.

5 units, Spr (Spindler) M 2:15–5:05

261. Linguistic Field Methods — Introduction to articulatory phonetics and intensive training in phonetic transcription; introduction to techniques of phonological, grammatical, and semantic analysis. Practice in elicitation procedures and the collection and collation of linguistic data. Emphasis will be placed on the contrastive analysis between English and the foreign target language spoken by the linguistic informants who will participate in the course. Prerequisite: graduate standing or consent of instructor.

5 units, Spr ( ) Th 9:00–11:50

263. Grammatical Theory — Field-oriented training in linguistic analysis as applied to grammatical systems. Lecture-discussion and laboratory. Prerequisite: elementary linguistic course or consent of instructor.

5 units, Spr (Greenberg) W 2:15–5:05

264. Typology and Universals of Language — The methodology of structural comparisons of languages; the connection between typological analyses and generalizations about language; universals of language in phonology, grammar and semantics; problems concerning deductive explanation of universals. Prerequisite: elementary linguistic course or consent of instructor.

5 units, Win (Greenberg) Th 2:15–5:05

265. Introduction to Linguistics — General theory of language including basic problems of descriptive and historical linguistics. Prerequisite: graduate standing or consent of instructor.

5 units, Aut (——) Th 2:15–5:05

267. Linguistic Anthropology — Seminar on the use of linguistic methods and linguistic data in anthropology. Students will receive training in eliciting and analyzing verbal material in languages other than their own. Intended primarily for graduate students in anthropology with prior training in descriptive linguistics.

5 units (Frake) given 1969–70

269. The Languages of Africa — A survey of the history of African linguistic investigation, characteristics of African languages, and sociolinguistics in Africa, including the formation of standard languages, language and educational policy, and language in connection with colonialism and national policy.

5 units (Greenberg) given 1969–70

276. Family Structure and Health — (Same as Pediatrics 276 and Preventive Medicine 12.) Arrangements are made through the Department of Pediatrics for students to observe children and their families in the Clinic and at home. The course is designed to help students understand interrelationships of patients, families and communities as they affect health and disease. Prerequisite: graduate students, other than medical students, must have consent of Dr. Barnett.

2 units, Aut, Win, Spr (Barnett, Staffs of Departments of Preventive Medicine, Pediatrics and Division of Clinical Social Work) by arrangement

277. Medical Anthropology — Seminar, analyzing theories of disease and therapy in selected societies, the relation of medical beliefs to other areas of culture, and similar problems of medical-anthropological interest. Prerequisite: graduate standing or consent of instructor.

5 units, Spr (Golde) TTh 4:15–6:05

278. Advanced Medical Anthropology — Seminar devoted to examination in depth of research problems requiring medical and behavioral science collaboration. Prerequisites: 277 and consent of instructor.

5 units, Win (Barnett) by arrangement

281. Research Methods in Anthropology — Consideration of methodological problems in anthropology such as models, typology, theory, etc. The 1968–69 seminar will focus particularly on models in anthropology. Prerequisite: graduate standing or consent of instructor.

5 units, Win (Befu) MW 4:15–6:05
282. Museum Methods—Directed work on anthropological collections in Stanford Museum. Prerequisite: graduate standing or consent of instructor.
   5 units (Gerow) given 1969-70

283. Seminar: Research Paper—Forum for guiding first-year graduate students in anthropology in preparation of their required research papers. Prerequisite: graduate standing in Department.
   5 units, Spr (Beals) T 9:00-11:50

285. Introduction to Mathematical Anthropology—Application of mathematics to social and cultural data. Examples will be taken from probability theory, statistics, algebra and logic. Prerequisite: graduate standing or consent of instructor.
   5 units (D'Andrade) given 1969-70

286. Computer Applications in Social Anthropology—Seminar in the use of digital computers in social anthropology, including both data manipulation and simulation techniques. Familiarity with Algol or a similar computer language is required.
   5 units, Spr (D'Andrade) TTh 2:15-4:05

288. Field Training in Cultural Anthropology—Instruction and practice in data gathering methods and analyses in native community settings at one of three field stations in the United States and Mexico. Required of all first-year students in the Department's Ph.D. program. Open to other graduate students with permission of instructor.
   15 units, Sum (Hotchkiss and Staff) by arrangement

290. History of Anthropological Theory—A historical treatment of the chief theoretical trends in anthropology. Prerequisite: 1 or graduate standing.
   5 units, Win (Greenberg) TTh 10:30-11:50

300. Directed Project Work—Special research projects undertaken for course credit.
   Any quarter (Staff) by arrangement

301. Department Colloquium—Meetings at two-week intervals throughout the school year for the presentation and discussion of current research interests of the faculty and of visiting specialists. Prerequisite: Open to all graduate students in anthropology; required of all first-year students.
   1 unit, Aut, Win, Spr (Paul, Staff) F 4:15-5:30

302. Directed Individual Study—Provides opportunities for advanced students to explore special areas of interest.
   Any quarter (Staff) by arrangement

   5 units, Win (Lau, Lewis, Skinner)
   by arrangement

   Any quarter (Staff) by arrangement

   Any quarter (Staff) by arrangement

Graduate courses offered in other departments, institutes and schools within the University may also be elected for graduate credit provided the course concerned is approved by the adviser as fitting into the student's program.

DIVISION of APPLIED PHYSICS

Executive Head: Marvin Chodorow

Professors: Marvin Chodorow, Theodore H. Geballe, Edward L. Ginzton (on leave), Walter A. Harrison, Hubert Heffner, Calvin F. Quate, Peter A. Sturrock (Space Science and Astrophysics)

Associate Professors: Arthur I. Bienenstock, Marshall S. Sparks, Mitchel Weissbluth

OFFERINGS AND FACILITIES

The program in Applied Physics offers to qualified students with backgrounds in physics or engineering the opportunity for graduate course work and research in those areas of physics which may be relevant to technical applications, and to natural phenomena. These areas include solid state, superconductivity, plasmas, quantum electronics, space science, astrophysics, and physics of macromolecules. Student research is supervised by the faculty members listed above and also by various members of other departments such as Materials Science and Electrical Engineering, who are engaged in related research fields. Research activities are carried out in the W. W. Hansen Labor...
A small number of students may by arrangement pursue a program of study of space science (see "Space Science and Related Opportunities") or astrophysics. Under the general provisions of the Graduate Division Special Programs, an approved program may lead to a Ph.D. degree in Space Science or Astrophysics.

FELLOWSHIPS AND ASSISTANTSHIPS

Besides the University fellowships open to all students, there are available in the Division several special fellowships and a number of assistantships involving research. Applications for fellowships, scholarships, and assistantships are made to the Office of Financial Aid and must be completed by January 15, 1969.
**Courses**


213. 3 units, Aut (——-) TTh 11:00–12:15
214. 3 units Win (——-) TTh 11:00–12:15
215. 3 units, Spr (——-) TTh 11:00–12:15

237. Quantum Mechanics of Atomic Systems—Directed toward application to solid state, magnetics, quantum electronics, etc. Includes the density matrix; quantization of the EM field; second quantization; interaction of EM radiation and matter; multiple-quantum effects. Prerequisite: E.E. 322B or Physics 231.

3 units, Spr (Heffner) MWF 9

238A. Applications of Quantum Theory — (Enroll in E.E. 324A.) A unified approach involving the density matrix; quantization of the EM field; second quantization; interaction of EM radiation and matter; multiple-quantum effects. Emphasis on the techniques for obtaining the appropriate equations of motion, rather than on detailed investigation of specific devices. Topics included are photocconductivity, rate equations, spontaneous emission, laser action, infrared absorption, superconductivity, and multiple photon absorption. Prerequisites: E.E. 322B or Physics 231.

3 units, Spr (Pantell)

238B. Applications of Quantum Theory — (Enroll in E.E. 324B.) Quantum mechanics applied to the analysis of systems of interest to the engineer and applied physicist. Topics include: multiple-photon processes, field quantization, Brillouin and Raman scattering, and electrons in crystals. Prerequisite: E.E. 324A.

3 units, Aut (Pantell)

250, 251. Wave Phenomena in Active Media —Theory of wave interactions in various active media. Space charge waves and cyclotron waves in electron beams and plasmas, coupled mode theory, traveling wave and parametric interactions. Applications to electron beam devices, solid state microwave devices, acoustic interactions in semiconductors and insulators, and negative resistance amplifiers such as masers and lasers. Prerequisites: Physics 111 and 122 or equivalents.

250. 3 units, Aut (Chodorow) TTh 9 and one hour by arrangement
251. 3 units, Win (Chodorow) TTh 9 and one hour by arrangement

252. Microwave Acoustics — Basic elasticity, plane wave propagation in isotropic and anisotropic media, dispersion relations, scattering at plane boundaries, guided wave propagation, piezoelectricity and magnetostriction, acoustic resonator theory, coupled wave systems (spin acoustic waves, carrier acoustic waves, opto-acoustic waves), radiation and diffraction. Prerequisite: permission of instructor.

3 units, Spr (Auld) alternate years, given 1969–70

290. Directed Studies in Applied Physics—Special studies under the direction of a faculty member for which academic credit may properly be allowed. Such studies may include laboratory work or directed reading.

Any quarter (Staff) by arrangement

300. Thesis Research.

Any quarter (Staff) by arrangement

302. Plasma Physics Seminar — (Enroll in Engineering 214.) Discussion of research problems and current literature in plasma physics is offered by faculty, students and outside specialists.

1 unit, Aut, Win, Spr (Staff)

323. Introduction to Plasma Physics—(Enroll in E.E. 354.) Plasma as a new medium; its significance in space and fusion research, individual and collective phenomena; ionization, charged particle orbits, collisions, plasma oscillations; Maxwell-Boltzmann distributions, Debye length, Landau damping, magnetionic propagation and dispersion, Sheath and probe theory, magnetic confinement, pinches, adiabatic motion, mirrors, pressures, stresses, magnetogasdynamics. Prerequisite: E.E. 243 or equivalent.

3 units, Spr (Buneman)
324. The Laboratory Plasma — (Enroll in Engineering 211.) Methods of forming laboratory plasmas and measurement of their properties. Collision processes, velocity distributions, the Boltzmann transfer equation, concepts of temperature and pressure, non-equilibrium velocity distributions. Macroscopic averages of the Boltzmann equation. D.C. and r.f. breakdown and avalanche phenomena, the effect of a magnetic field, the positive column at low pressure and medium pressure, ambipolar diffusion, the plasma sheath, wave propagation in infinite and in bounded plasmas. Prerequisite: E.E. 243 or equivalent.

3 units, Aut (Crawford) alternate years, given 1968-69


3 units, Win (Buneman)

326. Experimental Plasma Physics I—(Enroll in Engineering 212.) Lecture course which, together with 327, is intended to introduce the student to selected basic plasma phenomena, with emphasis on the production and characteristics of d.c. and r.f. discharges, and plasma diagnostics using d.c., r.f. and optical methods. Prerequisite: 324 or permission of instructor.

2 units, Win (Staff)


2 units, Win (Staff) by arrangement

328. Experimental Plasma Physics II—(Enroll in Engineering 213.) Continuation of 326. Prerequisites: 326 and 327.

2 units, Spr (Staff) by arrangement


2 units, Spr (Staff) by arrangement

333. Quantum Electronics—(Enroll in E.E. 431.) Topics in quantum theory relevant to lasers and quantum electronics: interaction of radiation and atoms; stimulated transitions; nonlinear atomic responses; density matrix formalism; inhomogeneously broadened transitions; spontaneous emission and quantum noise. This course fills in the quantum-mechanical background and details lying behind the simplified semi-classical models presented in E.E. 231, 232. Prerequisites: quantum theory to the level of E.E. 322B or Physics 231, and electromagnetic theory to the level of E.E. 142 or Physics 122. E.E. 231, 232 is not a prerequisite, but background reading in the material from this course may be necessary.

3 units, Aut (Siegman) alternate years, given 1968-69

335. Seminar in Quantum Electronics and Optics—(Enroll in E.E. 335.) Discussion by staff and students of selected topics, such as optical coherence theory; nonlinear optical effects; optical resonators; lasers; light modulation and demodulation.

1 unit, Aut, Win, Spr (Siegman, Staff) W 4:15

350. Electromagnetic Measurements I — Lecture course which, together with 351, is intended to introduce fundamental measurement methods, and instruments in microwave region. Measurements of frequency, wavelengths, electric fields; resonant cavity parameters and methods of detection. Prerequisite: concurrent registration in E.E. 243 or equivalent.

2 units, Aut (——) TTh 8

351. Electromagnetic Measurements Laboratory I—Experimental work to accompany 350. Concurrent registration in 350 required.

2 units, Aut (——) by arrangement

352. Electromagnetic Measurements II — Theory of the properties of waves at microwave and optical frequencies and the related laboratory techniques for measuring these properties: attenuation, impedance concepts, dispersion, phase and group velocity, periodic systems. Selected topics from the following: waveguides for electromagnetic waves, microwave circuit representation, space harmonics, acoustic waves in solids at microwave frequencies, the gaussian modes of optical waves confined between dielectric mirrors, properties of ma-
terials, propagation and dispersion of ultra short pulses, experimental study of active microwave devices. Prerequisites: 350 and 351.

2 units, Win (——) TTh 8

353. Electromagnetic Measurements Laboratory II—Laboratory course to accompany 352. Prerequisites: 350 and 351. Concurrent registration in 352 is required.

2 units, Win (——) by arrangement

354. Electromagnetic Measurements III — A continuation of 350 and 352. Electromagnetic theory as related to laboratory practice; measurement of dielectric constant, properties of ferrites, characteristics of microwave devices (BWO, TWT, tunnel diodes, solid state oscillators, parametric amplifiers). Study of generation and modulation of coherent optical waves. Also selected topics of current interest. Prerequisites: 352 and 353.

2 units, Spr (——) by arrangement

355. Electromagnetic Measurements Laboratory III — Laboratory course to accompany 354. Prerequisites: 352 and 353. Concurrent registration in 354 is requested.

2 units, Spr (——) by arrangement

360. Introduction to Astrophysics I: Solar-Terrestrial Relations—(Enroll in Engineering 207.) Origin and characteristics of the solar wind. Magnetosphere and bow wave; radiation belts; aurorae. Phenomena caused by solar flares: interplanetary shock waves; geomagnetic storms; Forbusch effect. Prerequisite: Physics 220, or E.E. 244, or A.A. 285A, or equivalent.

3 units, given 1969–70

361. Introduction to Astrophysics II: The Sun—(Enroll in Engineering 208.) Normal photosphere, chromosphere and corona. Fraunhofer spectrum. The solar cycle. Active phenomena: sunspots; prominences; flares; radio bursts. Prerequisite: Physics 220, or E.E. 244, or A.A. 285A, or equivalent.

3 units, given 1969–70


3 units, given 1969–70

363. Astrophysics Seminar—(Enroll in Engineering 210.) Discussion of research problems and current literature in astrophysics with contributions by faculty, students and outside specialists.

1 unit, Aut, Win, Spr (Staff)

375. Lattice Dynamics—A study of the vibrational properties of harmonic crystals, disordered alloys and anharmonic systems. While formalism, realistic interaction models and methods of observation will be of primary concern, thermodynamic parameters such as specific heat, thermal expansion and thermal conductivity will also be discussed. Prerequisite: introductory courses in solid-state physics and quantum mechanics.

3 units, Win (Bienenstock) alternate years, given 1969–70

376. Theory of Phase Transitions and Critical Phenomena—Modern statistical mechanical treatments of phase transitions and critical phenomena. After an introduction to statistical mechanics, the following topics will be treated: ferromagnetism, alloy order-disorder transitions, condensation and melting. Prerequisites: Physics 171 or Materials Science 222, plus an introduction to quantum mechanics.

3 units, Win (Bienenstock)

377, 378, 379. Theory of Solids — Basic methods and concepts of solid-state physics, including classical and quantum theories of the electron gas, crystal symmetry and group theory, the pseudopotential method, band theory, lattice vibrations, superconductivity, tunneling in solids, optical properties, magnetism, properties of crystal defects, and liquid metals. Prerequisite: Physics 231 or E.E. 322B.

377. 3 units, Aut (Harrison) MWF 10
378. 3 units, Win (Harrison) MWF 10
379. 3 units, Spr (Harrison) MWF 10

380. Group Theory with Applications to Atomic, Molecular, and Solid State Physics—A combination of lectures and problem-solving sessions designed to develop a working knowledge of group theory, and to show how a variety of problems can be solved (or at least elucidated) with the aid of group
theory. Current topics will be treated as well as the following traditional ones: elements of group theory; crystallographic point groups; presentation theory; compatibility relations and selection rules; projection operators; time reversal symmetry; double groups; space groups; multiplet structure of atoms; molecular vibrations; symmetry classification of lattice vibrational spectra and energy bands; crystal field theory; symmetry properties of magnetic crystals. Prerequisites: Either Physics 232 or Applied Physics 237, or Physics 130 series and Physics 172 or E.E. 328A.

3 units, Aut (Herman) by arrangement

384, 385. Physics and Chemistry of Solids—patterns in the properties of real solids. Both the periodic system of the elements and the concepts of modern microscopic theory will be used to discuss the properties of metals, semiconductors, and insulators. Superconductivity, magnetism, localized states in dilute alloys, and associated transport phenomena such as electrical and thermal conductivity will be considered. Prerequisites: 377, 378, and 379, or equivalents; 378 and 379 may be taken concurrently.

384. 3 units, Win (Geballe)
385. 3 units, Spr (Geballe)

ART and ARCHITECTURE

Emeriti: Edward McN. Farmer (Professor), Victor M. Arnautoff (Assistant Professor)

Executive Head: Lorenz Eitner

Professors: Lorenz Eitner, Albert Elsen, Ray N. Faulkner, Matthew S. Kahn, Daniel M. Mendelowitz, Michael Sullivan, Victor K. Thompson

Associate Professors: Keith Boyle, Elliot W. Eisner, Kurt W. Forster, Frank Lobdell, Dwight C. Miller, Nathan Oliveira

Assistant Professors: Gerald M. Ackerman, William Bowman, John-David P. LaPlante, Suzanne Lewis

Lecturers: Art History—Francoise Forster-Hahn, Isabelle Raubitschek. Architecture—Christopher Arnold, William H. Busse, Warren Callister, Birge M. Clark, Hervey P. Clark, Aaron Green, Robert C. Peterson, Eldridge T. Spencer, Goodwin B. Steinberg, Walter Stromquist, John C. Worsley, George J. Young; Kathryn I. Stedman (Landscape Architecture); Myron D. Alexander (Law); Dwight A. Coddingston (Mechanical Engineering); John T. Law, Bart Lytton, Harry L. Sanders (Planning); David J. Hammond, Isadore Thompson (Structural Engineering)

OFFERINGS AND FACILITIES

The Department offers courses of study in four areas: (1) in the history of art, (2) in the practice of drawing, painting, sculpture, design and printmaking, (3) in architecture, and (4) in art education. The undergraduate program of the Department is designed to introduce students to the humanistic study of the visual arts. The courses are intended to increase the students' understanding of the meaning and purpose of the arts, of their historical development, their role in society, and their relationship to such other humanistic disciplines as literature, music, and philosophy. The work in classroom and studio is designed to intensify the students' visual perception of the formal and expressive means of art and to encourage insight into a variety of technical processes. The collections of the Stanford Museum and the exhibitions program of the Stanford Gallery supplement the regular academic program of the Department.

PROGRAMS OF STUDY

Undergraduates may major in Art History, the Practice of Art (Studio), or in Architecture studies. A freshman or sophomore intending to major in one of these areas should consult with an adviser appointed by the Department in order to plan his course of study.

Graduate programs are offered in Art History, Studio (including Industrial Design), Architecture, and Art Education.

All graduate students are required to take an active part in the practical work of the Department, as teaching assistants, research assistants, or in other capacities, to be determined in consultation with their advisers.

During the first two years of their resident graduate work at Stanford, students are required to live in the immediate proximity of the University. Exceptions may be granted only on the basis of a petition formally submitted to the Executive Head of the Department.
HISTORY OF ART

BACHELOR OF ARTS

The major program in the history of art must include the following:

3 units—Art 1
39 units in courses in art history numbered over 100
3 units each—Art 40 and Art 50
Total units—48

Each undergraduate major in the history of art shall, in consultation with his adviser, select a coherent and substantial minor program in anthropology, classics, history, literature, philosophy, or some other area approved by the adviser. He shall, furthermore, take at least eight units of beginning German, French, or Italian, or present proof of reading ability in one of these languages.

MASTER OF ARTS

The University’s basic requirements for the Master’s degree are set forth in the section “Degrees” in this bulletin. The following are Departmental requirements:

Admission to Candidacy—Completion of the University’s requirements for a Bachelor of Arts degree in the history of art, or an approximately equivalent training, is required of students entering a program of study for the Master of Arts. Provisional enrollment may be permitted, however, in cases in which previous training has been deficient, with the understanding that the deficiency will be remedied in advance of Departmental approval of candidacy.

Recommendation for the Degree—To be recommended to the University Committee on the Graduate Division for the degree of Master of Arts in the history of art, the student must have satisfied the following requirements:

1. Completion of a minimum of three full quarters of graduate work in residence or its equivalent at this University.
2. Completion of a total of at least 51 units of graduate work, at least 36 of which must be in the history of art, including no fewer than 18 units in courses at the 200 level or above. At least 15 units must be taken in graduate courses in one or, at most, two supporting fields of study (such as history, literature, classics, anthropology or philosophy), determined in consultation with the Departmental adviser.
3. Reading knowledge of two foreign languages, preferably German and French or Italian. The student must pass a reading examination in one foreign language during his first quarter of enrollment.
4. Completion of two term papers of acceptable quality in courses in the history of art numbered 200 or above.
5. Completion of a comprehensive written examination covering the main periods in the history of art. The other requirements must be met before this examination can be taken. It can be taken in the middle of any quarter.

DOCTOR OF PHILOSOPHY

The University’s basic requirements for the degree of Doctor of Philosophy are set forth in the section “Degrees” in this bulletin.

Admission to Candidacy—The graduate student does not become a formal candidate for the Ph.D. degree until he has fully satisfied all the requirements which govern the A.M. program in the history of art (see above), and has been accepted as a candidate by the University Committee on the Graduate Division. Holders of the Master’s degree from other institutions must (1) pass Departmental examinations in two foreign languages, preferably German and French; (2) spend one year in residence at Stanford, carrying 36 units of graduate credit in courses selected in consultation with a Departmental adviser, and (3) take a comprehensive examination covering the main periods in the history of art.

Having satisfied all preliminary requirements, the candidate will submit a concise written statement of his dissertation topic to the Department. Departmental approval of the projected dissertation is necessary for admission to candidacy for the Ph.D. degree.

Residence—In order to be eligible for the doctoral degree, the student must have completed three years of graduate work in the history of art, and must have spent at least one of them in residence at Stanford.

Dissertation—A senior member of the Department will act as the student’s dissertation adviser and as chairman of his dissertation committee. The final draft of the dissertation must be in the adviser’s hands at least four weeks before the University deadline.
in the quarter during which the candidate expects to receive his degree. Dissertations may not be submitted during the summer quarter. The dissertation must be completed within five years from the date of the student's acceptance to candidacy for the Ph.D. degree. A candidate taking more than five years will be required to reinstate his candidacy.

Oral Examination—The oral examination is taken after completion of the dissertation. It serves primarily as a defense of the dissertation, but may range, at the committee's discretion, over a wider field.

PRACTICE OF ART (Studio)

Bachelor of Arts

The major program in the studio area must total 65 units and include the following:

3 units—Art 1
47 units in studio courses, including: Art 40, 50, 60; 9 units of drawing (140 or 141); 145; 6 units of 146; 148, 150, 151, 160, and at least nine units in art courses numbered 200 or above.
15 units of art history and architecture, 12 of which should be taken in courses numbered 100 or above.

Total units—65

Master of Arts

Programs for the Master of Arts degree are offered in the areas of painting, lithography, sculpture, and product or graphic design.

The Graduate Program in Painting, Sculpture, and Lithography provides an environment sympathetic to the needs of advanced students who are ready to involve themselves fully in these areas. Participants are chosen for the program on the basis of work which shows artistic individuality, motivated by the students' own goals and principles, and which indicates an ability to work without further need of close faculty supervision.

The Graduate Program in Design offers two alternatives, both of which have a major project as a nucleus: (1) a specialized program in industrial design, undertaken on a collaborative basis with the Department of Mechanical Engineering as described in the section, “Industrial Design”; (2) concentrated study in Graphic or Three-Dimensional Design within the framework of the studio program where students enroll in advanced courses oriented toward their professional objectives. Students in both programs are expected to participate in an advanced design seminar where critiques are based upon creative student work from varied design disciplines.

Admission to candidacy for the degree of Master of Arts is based on:

1. The equivalent of a Bachelor of Arts degree in art at this University.
2. A grade point average of B— in at least 65 units of undergraduate work in art.
3. Formal admission to candidacy granted by the University Committee on the Graduate Division.
4. Candidates for admission must submit six or more slides of paintings, lithographs or sculpture and six or more slides of drawings. Design candidates must submit a portfolio of twelve or more slides or photos of creative work, including original work when possible.
5. Applications and portfolios for the studio program must be submitted by February 1. They will be reviewed the first week of February. Students accepted are admitted for the beginning of the following Autumn quarter only; no applicants for mid year entrance will be considered.

The requirements for the degree of Master of Arts are:

1. Painting, sculpture and lithography students must participate in a weekly seminar in which their work is criticized and discussed in detail.
2. Completion of a minimum of three full quarters of graduate work in residence or its equivalent at this University.
3. Completion of the equivalent of 45 units of selected third- and fourth-year undergraduate and graduate courses. At least 30 units of this work must be in art with a grade of B or above and distributed as follows:
   a) 18 units in one of the four areas of concentration: (a) Drawing and Painting, (b) Sculpture, (c) Design, or (d) Printmaking.
   b) A total of 6 units in the remaining areas of concentration.
   c) 6 units of work on thesis or creative project.
The studio faculty reserves the right to make use of graduate painting, sculpture, and lithographs in exhibitions serving the interests of the Graduate Program, and shall retain for its permanent collection one work by each graduate at the time of his graduation.

INDUSTRIAL DESIGN

A Master of Arts in Art with emphasis in Industrial Design is offered jointly by the Department of Art and Architecture and the School of Engineering (Department of Mechanical Engineering). For information concerning the requirements for this program, please direct inquiries to the Chairman of the Design Committee of this Department.

ART EDUCATION

MASTER OF ARTS IN TEACHING

The degree of Master of Arts in Teaching is offered by this Department and the School of Education for teachers who wish further to strengthen their academic preparation. The candidate must have a teaching credential. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education. Detailed requirements are outlined in the section "School of Education" in this bulletin.

DOCTOR OF EDUCATION AND DOCTOR OF PHILOSOPHY IN EDUCATION

In cooperation with the School of Education the Department offers work leading to the Ed.D. and Ph.D. degrees with a concentration in Art Education. Consult the section on "Graduate Degrees" listed in the "School of Education" section in this bulletin. Complete information concerning these degrees may be secured from the Office of the Dean of the School of Education.

TEACHING CREDENTIAL (SECONDARY)

A program leading to a Master of Arts degree with a specialization in art education and/or including a California Teaching Credential in art is offered by the School of Education. This program is available to students who have majored in art at the undergraduate level, who have had no teaching experience, and who wish to become teachers of art at the elementary or secondary levels. For details with respect to this program consult the “Teaching Credential Program” listed in the “School of Education” section in this bulletin.

ARCHITECTURE

OFFERINGS AND FACILITIES

The Division of Architecture offers basic and advanced courses in architecture, and introductory courses in landscape architecture, interior design and environmental design. Facilities include a lecture room, drafting room and print room in the Art Gallery plus offices, a seminar room, and drafting rooms in Tower House. Workshop facilities in the Art Gallery are shared with the Art Studio program.

PROGRAMS OF STUDY

This Division offers two programs of study. A pre-professional program at the undergraduate level leading to the degree of Bachelor of Arts in architecture. The second program of study is professional in nature and is offered at the graduate level. It leads to the degree of Master of Architecture.

BACHELOR OF ARTS

The undergraduate curriculum provides the opportunity for a broad liberal education combined with a pre-professional course of studies. The student is introduced to the following four design disciplines which form a major part of environmental design: urban design, architecture, landscape architecture and interior design. The intent of the program is to provide the student with an awareness of the nature of these arts and their relationship. The program requires approximately two years of general education requirements and two years of pre-professional studies. The curriculum emphasizes basic and intermediate design, history, theory, basic technology and mathematics.

Required Courses

Architecture 171, 172, 173, 271, 272, 273, 291, 292, 293
Art 60, 160
Civil Engineering 20, 116, 170, Comp. Sci. 5, Engr. 9, 11, 15, Mathematics 10, 41, 42, 43
Mechanical Engineering 112A, Physics 51, 52

MASTER OF ARCHITECTURE

A two-year graduate program which prepares the student for the practice of architecture. In addition to the required professional courses, each student varies his program to suit individual needs by electing courses from the four areas of minor specialization: environmental design, construction engineering, structural engineering and product design.
Admission to Candidacy—Completion of the University’s requirements for a Bachelor of Arts degree in architecture or approximately equivalent training is required. Provisional enrollment may be granted to students deficient in these requirements provided that these deficiencies will be removed prior to approval of candidacy. Applicants shall have a grade point average of B-.

Recommendation for the Degree—To be recommended to the University Committee on the Graduate Division for the degree of Master of Architecture, the student shall have completed the following courses with a grade point average of B-.

**Required Courses**

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<th>Courses</th>
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Minor Specialization—15 units selected with approval of adviser from areas of environmental design, construction engineering, structural engineering and product design.

**COURSES IN HISTORY OF ART**

**BASIC COURSES**

- **#1. Introduction to Art**—A topical survey of problems in the interpretation of architecture, sculpture, and painting.
  - 3 units, Aut, Win, Spr (Ackerman, Elsen, Staff)
- **#5. Survey I**—Main currents in the history of art from prehistoric time to the end of the Middle Ages.
  - 3 units, Aut, Spr (Lewis, Staff)
- **#10. Survey II**—Main currents in the history of art from the Renaissance to the present.
  - 3 units, Win, Spr (Lewis, Staff)

**INTERMEDIATE COURSES**

- **100A. Ancient Art I**—The Pre-Hellenic Cultures: Egypt, Mesopotamia, Crete.
  - 3 units, Aut (Raubitschek)
- **100B. Ancient Art II**—Greece and Rome.
  - 3 units, Win (Raubitschek)
- **103B. Greek Architecture**—Origin to Hellenistic Age, with emphasis on Classical Period.
  - 3 units, Spr (Raubitschek)
- **105A. Medieval Art I**—Early Christian, Byzantine, and Early Medieval periods.
  - 3 units, Aut (Lewis)
- **105B. Medieval Art II**—Romanesque period.
  - 3 units, Win (Lewis)
- **105C. Medieval Art III**—Gothic period.
  - 3 units, Spr (Lewis)
- **110A. Renaissance Art I**—Italian architecture, sculpture and painting of the fourteenth and fifteenth centuries.
  - 3 units, Aut (Forster) given 1969-70
- **110B. Renaissance Art II**—Italian architecture, sculpture and painting of the sixteenth century.
  - 3 units, Win (Forster) given 1969-70
- **111A. Northern Renaissance Art I**—Art in German-speaking countries during the Reformation.
  - 3 units, Aut (Forster) given 1970-71
- **111B. Northern Renaissance Art II**—Art and architecture in France during the sixteenth century with emphasis on the First School of Fontainebleau.
  - 3 units, Win (Forster) given 1970-71
- **115A. Art in Italy During the Seventeenth Century**—Important developments in painting and sculpture with emphasis on Bologna and Rome; major trends of style and iconography.
  - 3 units, Win (Miller)
- **115B. Painting in the Low Countries and France During the Seventeenth Century**—Rubens and the Flemish Baroque; Dutch Painting; Poussin and French Classicism; the Art of the Court of Louis XIV.
  - 3 units, Spr (Miller)
  - 3 units (Miller) given 1969-70
- **120A. Modern Art I**—The movements of Classicism, Romanticism, and Naturalism (1770-1850) in France, England, Germany and Spain; with particular emphasis on painting; David and his School; Goya; Friedrich; Runge; the Nazarenes; Constable and Turner; Gericauld; Delacroix; and Ingres.
  - 3 units, Aut (Eitner)
120B. Modern Art II—European Art in the Second Half of the Nineteenth Century; the Painters of Barbizon; Courbet and the Realist Movement; Neo-Romantic and Neo-Classical Counter-Currents in France, England and Germany; Manet and Degas; the Impressionists and the Reaction against Impressionism; Seurat; Gauguin; Van Gogh; and Toulouse-Lautrec.

3 units, Win (Eitner)

120C. Modern Art III — Main currents of twentieth century art.

3 units, Spr (Ackerman)


3 units, Spr (Forster)

#125A. Oriental Art I—The arts of India, China and Japan from the Neolithic through the sixth century A.D.

3 units, Aut (LaPlante)

#125B. Oriental Art II—The arts of India, China and Japan from the seventh century A.D. to the Mongol Invasion (thirteenth century).

3 units, Win (LaPlante)

#125C. Oriental Art III—The arts of India, China and Japan after the thirteenth century.

3 units, Spr (LaPlante)

126A. Introduction to Chinese Art.

3 units, Aut (Sullivan)

126B. Chinese Painting—Prerequisite: History of Art 126A.

3 units, Win (Sullivan)

126C. The Art of Japan.

3 units, Spr (Sullivan) alternate years

126D. The Art of Southeast Asia.

3 units, Spr (Sullivan) alternate years

#130A. American Art I — Architecture, sculpture, painting and the household arts from pre-Columbian times to the Civil War (1860).

3 units (Mendelowitz) given 1969–70

#130B. American Art II — American art and architecture during the nineteenth century.

3 units, Win (Miller)

#130C. American Art III — Architecture, sculpture, painting and the household arts from 1914 to today.

3 units, Spr (Mendelowitz)

ADVANCED UNDERGRADUATE AND GRADUATE COURSES


3 units, any quarter (Staff)

201. Seminar in Ancient Art.

3 units, any quarter (Staff)

203B. Studies in Greek Architecture.

3 units, Win (Raubitschek)

205. Studies in Medieval Art.

3 units, any quarter (Lewis)

206. Seminar in Medieval Art.

3 units, any quarter (Lewis)


3 units, any quarter (Staff)

211. Seminar in Renaissance Art.

3 units, any quarter (Forster)


3 units, any quarter (Miller)

216. Seminar in Baroque Art.

3 units, any quarter (Miller)


3 units, any quarter (Ackerman, Eitner, Elsen)

221. Seminar in Nineteenth Century Art.

3 units, any quarter (Ackerman, Eitner, Elsen)


3 units, any quarter (Ackerman, Elsen, Forster)

223. Seminar in Twentieth Century Art.

3 units, any quarter (Ackerman, Elsen, Forster)


3 units, Aut, Win (LaPlante)


3 units, Aut, Win, Spr (Sullivan)

235. Methods of Art Historical Research.

3 units, any quarter (Eitner, Elsen, Forster)

236. Readings in the Literature of Art.

3 units, any quarter (Ackerman, Eitner, Elsen)
Methods of Museology.  
3 units, any quarter (LaPlante)

Seminar in Art for the Theater.  
3 units, Spr (Russell), given 1968–69

Individual Work: Art History.  
Any quarter (Staff) by arrangement

Research Project: Art History.  
Any quarter (Staff) by arrangement

Master's Thesis: Art History.  
Any quarter (Staff) by arrangement

Dissertation: Art History.  
Any quarter (Staff) by arrangement

RELATED COURSES
Philosophy of Art—See Philosophy 8.
For archaeological courses see "Classics" elsewhere in this bulletin.

INTERDEPARTMENTAL SEMINAR
Senior Seminar in Humanities — The Relationship Between the Arts—See Humanities 192.

COURSES IN PRACTICE OF ART (STUDIO)

BASIC COURSES
#40. Basic Drawing and Painting—Basic drawing and painting concepts introduced through charcoal, pencil, pen and ink, colored chalk, and opaque watercolor.  
2 units, Aut, Win, Spr (Staff)

#50. Basic Sculpture — Introduction to sculpture through the use of clay, wire, wood construction, and plastic materials.  
3 units, Aut, Win, Spr (Staff)

#60. Basic Design—Basic laboratory problems in two-dimensional design.  
3 units, Aut, Win, Spr (Faulkner, Kahn)

INTERMEDIATE COURSES

140. Drawing I—Life drawing and composition. Prerequisite: 40. May be repeated for credit.  
3 units, Aut, Win, Spr (Oliveira)

141. Drawing II — Life drawing and composition. Prerequisite: 40. May be repeated for credit.  
3 units, Aut, Win, Spr (Lobdell)

145. Painting I — Introduction to painting procedure. Still life, landscape, and figure studies in oil, watercolor, and varied media. Prerequisite: 40.  
3 units, Aut, Win, Spr (Boyle)

146. Painting II — Extended problems in pictorial organization and content, with stress on oil painting. Prerequisite: 145. May be repeated for credit.  
3 units, Aut, Win, Spr (Lobdell)

148. Lithography — Introduction to lithography. Prerequisite: 140. May be repeated for credit.  
3 units, Aut, Win, Spr (Oliveira)

150. Sculpture I — Introduction to figure modeling and human anatomy. Prerequisite: 50.  
3 units, Aut, Win, Spr (Staff)

151. Sculpture II—Introduction to carving, welding, and construction. Prerequisite: 50.  
3 units, Aut, Win, Spr (Staff)

160. Design I—Two- and three-dimensional laboratory problems basic to key areas of design practice (work in wood, paper, paint, metal, etc.). Prerequisite: 60.  
3 or more units, Aut, Win, Spr (Kahn)

161. Design II — Studio seminar in design and color. Individual projects with emphasis on the relation of theory to practice.  
4 units, Aut, Win (Faulkner)

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

241. Advanced Drawing and Painting Criticism I—Prerequisite: at least two quarters of 146.  
Aut, Win, Spr (Oliveira) by arrangement

242. Advanced Drawing and Painting Criticism II—Prerequisite: at least two quarters of 146.  
Aut, Win, Spr (Boyle) by arrangement

243. Advanced Drawing and Painting Criticism III—Prerequisite: at least two quarters of 146.  
Aut, Win, Spr (Lobdell) by arrangement

244. Individual Work: Drawing and Painting.  
Any quarter (Staff) by arrangement
245. **Watercolor Landscape Painting**—Prerequisite: 145.
   - 4 units, Spr (Mendelowitz)

248. **Advanced Lithography.**
   - Aut, Win, Spr (Oliveira) by arrangement

250. **Individual Work—Sculpture.**
   - Aut, Win, Spr (Staff) by arrangement

251. **Advanced Figure Modeling**—Prerequisite: 150.
   - 3 units, Aut, Win, Spr (Staff)

252. **Advanced Carving, Modeling, and Construction**—Prerequisites: 150 and 151.
   - 3 units, Aut, Win, Spr (Staff)

253. **Metal Casting**—By permission only.
   - 3 units, Aut, Spr (Staff)

255. **Individual Work: Design.**
   - Any quarter (Kahn, Staff) by arrangement

   - 3 to 6 units, Aut (Bowman)

261. **Graphic Design II: Communication**—Problems in visualizing ideas and information. Emphasis on technical idioms.
   - 3 to 6 units, Win (Bowman)

   - 3 to 6 units (Bowman) given 1969–70

266. **Three-Dimensional Design I: Media and Processes**—Three-dimensional problems providing experience with wood, clay, small metal constructions.
   - 6 units (Kahn) alternate years, given 1968–69

267. **Three-Dimensional Design II: Media and Processes**—Work with surface design in textiles, papers and plastics. Concentration on silk screen process.
   - 6 units, Aut (Kahn)

268. **Three-Dimensional Design III: Environment**—Problems in photography, exhibit and interior design.
   - 6 units (Kahn) alternate years, given 1969–70

340. **Master’s Thesis (Studio).**
   - Any quarter (Staff) by arrangement

341. **Master’s Project (Studio).**
   - Any quarter (Staff) by arrangement

341D. **Master’s Project: Industrial Design (Seminar).**
   - Any quarter (Kahn) by arrangement

342. **Advanced Creative Studies**—Intensive emphasis in areas of personal specialization, with comparative analysis.
   - Aut, Win, Spr (Kahn) by arrangement

**RELATED COURSES**

**Rapid Visualization**—See Mechanical Engineering 112A.

**Introduction to Product Design**—See Mechanical Engineering 112B.

**Philosophy of Design**—See Mechanical Engineering 214A.

**COURSES IN ARCHITECTURE**

**BASIC COURSES**

171. **Basic Design I**—Exploration into the form, function, structure and aesthetics of interior design through the case study process, with emphasis on basic architectural graphic media.
   - 3 units, Aut (Faulkner) TTh 1:15–3:05

172. **Basic Design II**—Introduction to problems in architecture and urban design. Projects prepared in graphic and model form.
   - 3 units, Win (Peterson) MW 1:15–3:05

173. **Basic Design III**—Introduction to problems of site selection, topography, grading, drainage, landscaping and plant materials.
   - 3 units, Spr (Faulkner) TTh 1:15–3:05

**INTERMEDIATE COURSES**

270. **Individual Work: Architecture**—Independent study with permission of instructor.
   - Any quarter (Staff) by arrangement

271. **Intermediate Design I**—Design and construction methods of educational and research buildings provide the opportunity for the analysis of complex building types and their solution.
   - 4 units, Aut (V. Thompson, Young) TTh 3:15–5:05

   - 4 units, Win (Callister, Staff) TTh 3:15–5:05

4 units, Spr (Peterson, Steinberg)  
MW 1:15–3:05


3 units, Aut (V. Thompson) TTh 9–11


3 units, Win (V. Thompson) TTh 9–11


3 units, Spr (V. Thompson) TTh 9–11

GRADUATE COURSES


5 units, Aut (Busse, Peterson) MW 1:15–3:05


5 units, Win (Green, V. Thompson) TTh 1:15–3:05

373. Advanced Design III — Development of the design of a single family residence based upon students' previously prepared preliminary drawing. Includes the preparation of architectural, structural, mechanical and electrical contract drawings and specifications.

5 units, Spr (Staff) MW 3:15–5:05

374. Systems Development — Building systems research, design and development based upon the solution of case study problems.

5 units, Aut (Arnold) F 1:15–3:05


2 units, Win (Alexander) M 7:30–9:30 p.m.


3 units, Aut (Hammond) MW 8

382. Structural Design II — Analysis, design and technology of steel building construction.

3 units, Win (Hammond) MW 8


3 units, Spr (Hammond) MW 8

384. Seminar: Lateral Forces — Theory, analysis and design of structures in respect to wind and earthquake conditions.

2 units, Spr (Hammond) M 7:30–9:30 p.m.

385. Building Materials — An investigation into the qualities and performance of basic building materials and components and their specification with assistance of the Producers' Council of America.

4 units, Aut (Staff) MW 10–12

386. Seminar: Building Materials — Discussions, lectures, field trips to study qualities, performance and specifications of building materials and components.

3 units, Win (B. Clark) M 11 and W 10–12

387. Environmental Technology I — Design and specification of building water supply and sanitation.

3 units, Aut (Coddington) Th 7:30–9:30 p.m.


3 units, Win (Coddington) Th 7:30–9:30 p.m.


3 units, Spr (Coddington) Th 7:30–9:30 p.m.

391. Internship: Professional Practice — Office internship in cooperating architectural firms. Weekly office visits are followed by a seminar.

2 units, Aut (Peterson) F 10–12
392. Internship: Business Administration—Continuation of Architecture 391.
2 units, Win (Peterson) F 1:15–3:05

393. Internship: Construction Administration—Continuation of Architecture 392.
2 units, Spr (Peterson) F 1:15–3:05

394. Community Planning Laboratory I—A case study project involving and serving an actual city or community. A multidisciplinary program open to graduate students in architecture, business, engineering, law and political science.
3 units, Aut (Law, Lytton, Staff)
T 7:30–9:30 p.m. and F 3:15–5:05

3 units, Win (Law, Lytton, Staff)
T 7:30–9:30 p.m. and F 3:15–5:05

3 units, Spr (Law, Lytton, Staff)
T 7:30–9:30 p.m. and F 3:15–5:05

401. Master’s Project I—Independent work evidencing the student’s ability to solve a significant architecture problem. Research, laboratory work and weekly seminars.
5 units, Win (Peterson, Stromquist)
MW 3:15–5:05

5 units, Spr (H. Clark, I. Thompson, V. Thompson) W 1:15–3:05 and alternate W 7:30–9:30 p.m.

COURSES IN ART EDUCATION
213. Foundations of Aesthetic Education—(Enroll in Education 213.)

219. Artistic Development of the Child—(Enroll in Education 219.)


380. Curriculum Theory in Art Education—(Enroll in Education 380.)

480. Directed Reading—(Enroll in Education 480.)

490. Directed Research—(Enroll in Education 490.)

ASIAN LANGUAGES
Emeritus: Frederic Spiegelberg (Professor)
Executive Head: William H. McCullough
Professors: S. Wing Chan, James J. Y. Liu, David S. Nivison
Associate Professors: William H. McCullough, Visiting: Toshihiko Kawasaki
Assistant Professors: Dana B. Young, Acting: Jerome T. Cavanaugh, Kung-yi Kao
Lecturers: Yin Chuang, Hiroyasu Kubota, Helen C. McCullough, Hiroshi Sakamoto

Chinese-Japanese Language and Area Center
Director: William H. McCullough
Associate Professors: William H. McCullough, Koji Taira, Visiting: Toshihiko Kawasaki
Assistant Professors: Harumi Befu, Lawrence J. Lau, Mark Mancell, Lyman W. Van Slyke, Dana B. Young, Acting: Jerome T. Cavanaugh, Kung-yi Kao, Michel C. Oksenberg
Lecturers: Yin Chuang, Hiroyasu Kubota, Helen C. McCullough, Hiroshi Sakamoto

Curator-Librarian, East Asian Collection Hoover Institution: John T. Ma

OFFERINGS
The Department of Asian Languages offers courses in the languages and literatures of China and Japan. The Department accepts candidates for the degrees of Bachelor of Arts, Master of Arts, and Doctor of Philosophy. It also gives a minor in Chinese or Japanese language and literature for the degree of Doctor of Philosophy.

PROGRAMS OF STUDY
BACHELOR OF ARTS
The degree of Bachelor of Arts is granted both in Chinese and in Japanese. The following courses must be completed:

1. Concentration in Chinese: 103, 151, 153, Philosophy 4 (Introduction to Chinese
ASIAN LANGUAGES

Philosophy) or 199 (Individual Reading in Chinese).

2. Concentration in Japanese: 103, 154, 155; 199 (Individual Reading in Japanese) or 4 units of course work in Japanese history as approved by the Department.

These requirements are in addition to the University’s basic requirements for the Bachelor's degree.

ADMISSION TO GRADUATE STUDY

All students contemplating application for admission to graduate study must have a creditable undergraduate record at Stanford or elsewhere. Undergraduate work need not necessarily have been in Chinese or Japanese, or in an East Asian area of specialization. For admission, an applicant must, however, satisfy the Department that he has an aptitude for language work, and that he has a command of English written style adequate for the pursuit of graduate study. While it is possible for an applicant to be admitted to graduate study in the Department with no previous knowledge of an East Asian language, such an applicant is warned that he will not be able to complete the requirements for the A.M. in the minimum time.

MASTER OF ARTS

The degree of Master of Arts is granted in Chinese and in Japanese. The normal length of study for the degree is two years.

Well-prepared students are encouraged, when appropriate, to spend their first graduate year at either the Taipei or the Tokyo center. (See below.) It is usually possible for them to do so without losing time in their progress toward the A.M., since advanced courses taken at the centers may exempt them from certain A.M. requirements. Thus, providing a graduate student’s preparation is the equal of the Department’s A.B. requirements, he should normally be able, after spending a year at the overseas center, to return to Stanford and complete his A.M. by the end of the following year. Students interested in doing this must consult the Graduate Adviser.

Candidates for the degree must be in residence at Stanford in California during the final quarter of registration.

A thesis is not required for the A.M. degree. Instead, the candidate must prepare, in Chinese 299 or Japanese 299, an annotated translation of a text of appropriate difficulty. Under special circumstances, a paper approved by the Graduate Adviser may be substituted.

The University’s basic requirements for the Master's degree are given in the section “Degrees” in this bulletin. Departmental requirements are set forth below. Graduate students registered at Stanford may obtain further information about the scope and nature of the A.M. written examination from the Graduate Adviser.

Master of Arts: Chinese

The candidate must:

1. Meet the Department’s requirements for the Bachelor of Arts in Chinese or their equivalent.

2. Complete the following course work: 201, 202; 211, 212, 213; 299; 16 units of Chinese course work in the Department numbered between 250 and 270, and 8 units numbered between 270 and 290; 16 units of course work, on the upper division or graduate level, in fields such as descriptive linguistics, Chinese history, Chinese philosophy and Chinese art, as approved by the Graduate Adviser.

3. Pass a written examination covering translation from Classical and Modern Chinese, Chinese literature; and one of the following fields: early Chinese history, later Chinese history, Chinese philosophy.

Master of Arts: Japanese

The candidate must:

1. Meet the Department’s requirements for the Bachelor of Arts in Japanese or their equivalent.

2. Complete the following course work: 201, 202; 211, 212, 213; 241, 242, 243; 251, 252; either 246 or 261; 299; 16 units of course work, on the upper division or graduate level, in fields such as descriptive linguistics, Japanese history and Chinese literature, as approved by the Graduate Adviser.

3. Pass a written examination covering translation from Classical and Modern Japanese, Japanese literature; and one of the following fields: Japanese history, Chinese literature, Chinese philosophy.
DOCTOR OF PHILOSOPHY

The Doctor of Philosophy degree is granted in Chinese and in Japanese. Candidates for the degree are expected to acquire a thorough familiarity with Chinese or Japanese language, an adequate command of both languages, and a comprehensive knowledge of East Asian history, social institutions, and thought. The University’s basic requirements for the doctorate are given in the section “Degrees” in this bulletin. Departmental requirements are set forth below.

Admission to candidacy—A student who has been admitted to graduate study in the Department must meet the following requirements before being certified for admission to candidacy.

1. He must complete all the requirements for the Master of Arts degree in this Department or the equivalent courses at another university.

2. He must demonstrate a reading knowledge of French or German by passing a written examination. Students must pass this examination before proceeding to the course work described below.

3. He must complete the following additional course work: 321, 361, plus at least 8 units above the level of 240.

4. He must pass an examination in the supporting East Asian language. If the candidate’s field is Chinese, he will be examined on his ability to read Modern Japanese (on the level of 103) and on his knowledge of and ability to use Japanese reference works of importance in Chinese studies. If his field is Japanese, he will be examined on his ability to read Classical Chinese (on the level of 103) and on his knowledge of and ability to use Chinese reference works of importance in Japanese studies.

5. He must pass a written examination in two fields other than the field chosen for the A.M. written examination. The candidate for the degree in Chinese must choose two of the following: early Chinese history, later Chinese history, Chinese philosophy, Chinese Buddhism, Japanese literature. The candidate for the degree in Japanese must choose two of the following: Japanese history, Japanese religion, early Chinese history, Chinese philosophy, Chinese literature.

6. He must also pass an examination demonstrating fluency in the modern spoken language of his field.

University oral examination—General regulations governing the oral examination will be found in the section “Degrees” in this bulletin. The candidate for the degree in Chinese must be prepared in the following fields, selected in consultation with the Graduate Adviser:

1. A field of Chinese literature.
2. A field of Chinese history.
3. Chinese philosophy or art or historical linguistics or some other appropriate subject that concerns China.
4. An outside field. For most candidates this will be a Western literary field and will give attention to modern methods of literary analysis and criticism. Under special circumstances, a candidate may be permitted to substitute a field of Western history, philosophy, comparative religion, or some other appropriate subject.

The candidate for the degree in Japanese must be prepared in the following fields, selected in consultation with the Graduate Adviser:

3. Japanese art or religion or historical linguistics or some other appropriate subject that concerns Japan.
4. An outside field, as described above.

Dissertation—The candidate will write a dissertation demonstrating his ability to undertake original research based on primary materials in Chinese or Japanese. He will not receive final approval of the dissertation topic until he has passed the University oral examination.

Minor for the Degree of Doctor of Philosophy—A student taking a minor in Asian languages shall complete at least 30 units of work within the Department to be chosen in consultation with a Departmental adviser. He must elect either Chinese 201–202 or Japanese 201–202 unless he satisfies the Department that work done elsewhere has given him similar training. He must also pass a written examination in the Chinese or Japanese language.
Special Programs for the Degree of Doctor of Philosophy—Properly qualified students may plan special interdepartmental programs in the Asian field for the degree of Doctor of Philosophy. See the section “Graduate Division Special Programs” in this bulletin.

Special Opportunities for Study Abroad—Attention is called to the programs of the Inter-University Program for Chinese Language Study in Taipei and the Inter-University Center for Japanese Studies in Tokyo (both of which are administered by Stanford University). They are described elsewhere in this bulletin.

Summer Program of Intensive Language Courses—A ten-week program, which begins at the same time as the University's general summer program and continues two weeks beyond it, is held each summer. Intensive instruction is offered, on four different levels, in both Chinese and Japanese. The intensive courses provide the equivalent in instruction to regular academic-year courses. (See courses Chinese 5, 25, 105, 215, Japanese 5, 25, 105, and 215 as described below.) For detailed information about these and other aspects of the summer program, apply directly to the Department of Asian Languages, preferably before the end of the preceding autumn quarter.

Courses Not Requiring a Knowledge of an Asian Language

#151. Chinese Poetry and Drama.
4 units, Aut (Liu) MWF 11

#152. Chinese Fiction.
4 units, Win (Chan) MWF 11

4 units, Aut (Kawasaki) MWF 11

4 units, Win (Young) MWF 11

3 to 5 units, Spr (McCullough) by arrangement, given 1969-70

See also History 91 and 92, East Asian Civilizations.

I. Courses in Chinese

#1, 2, 3. First-Year Modern Chinese—Conversation, grammar, reading, elementary composition.
1. 5 units, Aut (Kao) MTWThF 9
2. 5 units, Win (Kao) MTWThF 9
3. 5 units, Spr (Kao) MTWThF 9

5. Intensive First-Year Modern Chinese—Equivalent to 1, 2, 3 combined. Prerequisite: consent of instructor.
15 units, Sum (———) MTWThF 8–12

#21, 22, 23. Second-Year Modern Chinese—Further study in grammar, reading, conversation, composition. Prerequisite: 3 or equivalent.
21. 5 units, Aut (Chuang) MTWThF 9
22. 5 units, Win (Chuang) MTWThF 9
23. 5 units, Spr (Chuang) MTWThF 9

25. Intensive Second-Year Modern Chinese—Equivalent to 21, 22, 23 combined. Prerequisites: 3 or equivalent and consent of instructor.
15 units, Sum (———) MTWThF 8–12

31, 32, 33. Intermediate Conversation—Prerequisite: 3 or equivalent.
31. 2 units, Aut (Chuang) TTh 11
32. 2 units, Win (Chuang) TTh 11
33. 2 units, Spr (Chuang) TTh 11

41, 42, 43. Intensive Modern Chinese—Intensive study in grammar, reading, conversation, and composition, the equivalent of first-year and second-year Modern Chinese combined. The successful completion of this course will qualify the student to take 101.
41. 10 units, Aut (Cavanaugh, Kao) MTWThF 9 and 1:15
42. 10 units, Win (Cavanaugh, Kao) MTWThF 8 and 1:15
43. 10 units, Spr (Cavanaugh, Kao) MTWThF 8 and 1:15

Advanced

101, 102, 103. Introduction to Classical Chinese—Reading, syntax, composition. Prerequisite: 23 or equivalent.
101. 5 units, Aut (Nivison) MTWThF 9
102. 5 units, Win (Cavanaugh) MTWThF 9
103. 5 units, Spr (Cavanaugh) MTWThF 9
105. Intensive Introduction to Classical Chinese—Equivalent to 101, 102, 103 combined. Prerequisite: 23 or equivalent. Consent of instructor necessary.

15 units, Sum (—) MTWThF 9–12

121, 122, 123. Advanced Conversation — Prerequisite: 33 or equivalent.

121. 2 units, Aut (Chuang) TTh 1:15
122. 2 units, Win (Chuang) TTh 1:15
123. 2 units, Spr (Chuang) TTh 1:15

199. Individual Reading in Chinese — (Asian Language majors only.) Prerequisite: 101 or equivalent.

4 units, Win, Spr (Staff) by arrangement

GRADUATE

200. Directed Reading in Chinese—Prerequisite: 103 or equivalent.

1 to 3 units, any quarter (Staff) by arrangement


201. 3 units, Aut (Cavanaugh) M 2:15–4:05
202. 3 units, Win (Cavanaugh) M 2:15–4:05

211, 212, 213. Modern Expository Chinese — Scholarly and journalistic writings in Chinese. The materials read in these courses cover two years. By permission of the instructor, the courses may be repeated for credit in a consecutive year. Prerequisite: 103 or consent of instructor.

211. 4 units, Aut (Chan) MWF 1:15
212. 4 units, Win (Chan) MWF 1:15
213. 4 units, Spr (Chan) MWF 1:15

215. Modern Expository Chinese — Scholarly and journalistic writings in Chinese. Equivalent to 211, 212, 213, combined. Prerequisite: 23 or equivalent.

15 units, Sum (—) MTWThF 9–12

251, 252. Chinese Philosophical Texts.

251. 4 units, Win (Nivison) WF 2:15–4:05
252. 4 units, Spr (—) by arrangement

254. Chinese Historical Texts.

4 units, Spr (Chan) by arrangement

256, 257. Tang and Sung Prose Literature.

256. 4 units, Win (Liu) by arrangement
257. 4 units, Spr (Liu) by arrangement

261, 262. Chinese Poetry — Prerequisite: 251, 254, or equivalent.

261. 4 units, Aut (Liu) WF 2:15–4:05
262. 4 units, Win (Liu) by arrangement


271. 4 units, Aut (—) TTh 2:15–4:05
272. 4 units, Win (—) by arrangement

281, 282. Modern Chinese Literature—Prerequisite: 213 or equivalent.

281. 4 units, Aut (Chan) TTh 2:15–4:05
282. 4 units, Spr (Chan) TTh 2:15–4:05

299. Translation.

A total of 5 units, which may be taken in one or more quarters, Aut, Win, Spr (Staff) by arrangement

303. Bibliography and Research on Chinese Society—(Same as Anthropology, Economics, History, Political Science 303.) Recommended to all students planning to undertake advanced research on modern China, to obtain bibliographical control over source materials from mid-Ch'ing to the present, with an emphasis on the contemporary period. Prerequisite: Chinese 103, or 213, or an equivalent.

5 units, Win (Lau, Oksenberg, Skinner, Van Slyke) by arrangement

321. Seminar—May be repeated for credit.

5 units, Spr (Nivison) M 2:15–4:05

361. Seminar in Chinese Literary Criticism — May be repeated for credit.

5 units, Win, Spr (Liu) by arrangement

399. Dissertation.

By arrangement (Staff)

II. COURSES IN JAPANESE

#1, 2, 3. First-Year Modern Japanese — Conversation, grammar, reading, elementary composition.

1. 5 units, Aut (Sakamoto) MTWThF 9
2. 5 units, Win (Sakamoto) MTWThF 9
3. 5 units, Spr (Sakamoto) MTWThF 9

5. Intensive First-Year Modern Japanese — Equivalent to 1, 2, 3 combined. Prerequisite: consent of instructor.

15 units, Sum (—) MTWThF 8–12
#21, 22, 23. Second-Year Modern Japanese—Further instruction and practice in conversation, grammar, reading, and composition. Prerequisite: 3 or equivalent.

21. 5 units, Aut (Kubota) MTWThF 9
22. 5 units, Win (Kubota) MTWThF 9
23. 5 units, Spr (Kubota) MTWThF 9

25. Intensive Second-Year Modern Japanese—Equivalent to 21, 22, 23 combined. Prerequisite: 3 or equivalent. Consent of instructor necessary.

15 units, Sum (—— ) MTWThF 8–12

31, 32, 33. Intermediate Conversation—Prerequisite: 3 or equivalent.

31. 2 units, Aut (Sakamoto) TTh 11
32. 2 units, Win (Sakamoto) TTh 11
33. 2 units, Spr (Sakamoto) TTh 11

41, 42, 43. Intensive Modern Japanese—Intensive study in grammar, reading, conversation, and composition, the equivalent of first-year and second-year Modern Japanese combined. The successful completion of this course will qualify the student to take 101.

41. 10 units, Aut (Kubota, Sakamoto) MTWThF 8 and 1:15
42. 10 units, Win (Kubota, Sakamoto) MTWThF 8 and 1:15
43. 10 units, Spr (Kubota, Sakamoto) MTWThF 8 and 1:15

ADVANCED

101, 102, 103. Modern Written Japanese—Reading texts representative of various modern written styles. Prerequisite: 23 or equivalent.

101. 5 units, Aut (Young) MTWThF 9
102. 5 units, Win (W. McCullough) MTWThF 9
103. 5 units, Spr (W. McCullough) MTWThF 9

105. Intensive Modern Written Japanese—Equivalent to 101, 102, 103 combined. Prerequisite: 23 or equivalent. Consent of instructor necessary.

15 units, Sum (—— ) MTWThF 9–12

121, 122, 123. Advanced Conversation—Prerequisite: 33 or equivalent.

121. 2 units, Aut (Kubota) TTh 1:15
122. 2 units, Win (Kubota) TTh 1:15
123. 2 units, Spr (Kubota) TTh 1:15

199. Individual Reading in Japanese—(Asian Languages majors only.) Prerequisite: 101 or equivalent.

4 units, Win, Spr (Staff) by arrangement

GRADUATE

200. Directed Reading in Japanese—Prerequisite: 103 or equivalent.

1 to 3 units, any quarter (Staff) by arrangement

201, 202, Proseminar—Research methods in Japanese Studies. Prerequisite: 103 or equivalent.

201. 3 units, Aut (W. McCullough) M 2:15–4:05
202. 3 units, Win (W. McCullough) M 2:15–4:05

211, 212, 213. Modern Expository Japanese—Scholarly and journalistic writings in Japanese. The materials read in these courses cover two years. By permission of the instructor, the courses may be repeated for credit in a consecutive year. Prerequisite: 103 or equivalent.

211. 4 units, Aut (Young) MWF 1:15
212. 4 units, Win (H. McCullough) MWF 1:15
213. 4 units, Spr (Young) MWF 1:15

215. Modern Expository Japanese—Equivalent to 211, 212, 213 combined. Prerequisite: 103 or equivalent.

15 units, Sum (—— ) MTWThF 9–12


241. 4 units, Aut (H. McCullough) TTh 2:15–4:05
242. 4 units, Win (Young) TTh 2:15–4:05
243. 4 units, Spr (Young) TTh 2:15–4:05

246. Medieval Japanese Prose—Prerequisite: 243 or equivalent.

4 units, Spr (H. McCullough) by arrangement

251, 252, 253. Modern Japanese Literature—Poetry, prose, and drama after 1868. Prerequisite: 243 or equivalent.

251. 4 units, Aut (Kawasaki) WF 2:15–4:05
252. 4 units, Win (Kawasaki) WF 2:15–4:05
253. 4 units, Spr (Kawasaki) by arrangement
261, 262. Classical Japanese Poetry — Pre-
requisite: 243 or equivalent.

261. 4 units, Win (Kawasaki)
by arrangement
262. 4 units, Spr (Kawasaki)
by arrangement

299. Translation.
A total of 5 units, which may be taken in
one or more quarters, Aut, Win, Spr
(Staff) by arrangement

321. Seminar—May be repeated for credit.
5 units, Aut (Staff) by arrangement

321. Seminar in Japanese Literary Criticism
—May be repeated for credit.
5 units, Win, Spr (Staff) M 2:15–4:05

399. Dissertation.
(Staff) by arrangement

ADDITIONAL INFORMATION
For information concerning other oppor-
tunities for study in the Asian field, see list-
ings under the following departmental head-
ings: Anthropology, Art and Architecture,
Economics, Geography, Graduate Division
Special Programs, History, Humanities Spe-
cial Programs, Philosophy, Political Science,
Senior Colloquia, Social Sciences (Special
Program).

BIOLOGICAL SCIENCES
Emeriti: Lawrence R. Blinks, Rolf L. Bolin,
Executive Head: Donald Kennedy
Professors: Donald P. Abbott, Allan McC.
Campbell, Paul R. Ehrlich (Director of
Graduate Studies), Arthur C. Giese, Mal-
vern Gilmartin, Richard W. Holm, Donald
Kennedy, Joshua Lederberg, George
S. Myers, Joseph F. Oliphant, Robert M.
Page, David D. Perkins (on leave 1968–69), John H. Phillips, Jr., Peter M. Ray,
David C. Regnery, Donald M. Wilson,
Charles Yanofsky. By Courtesy: Jens C.
Clausen, Charles S. French, William M.
Hiesey
Associate Professors: Philip C. Hanawalt (on
leave winter, spring quarters), Peter H.
Raven, Robert T. Schimke, Norman K.
Wessells (on leave 1968–69), Dow O.
Woodward (on leave spring quarter)
Assistant Professors: David Epel, Welton L.
Lee, Ward B. Watt (on leave 1968–69)
Instructors: Marcia K. Allen, Charles H.
Baxter
Lecturers: Walter C. Brown, Warren C.
Freihofer, Laurence M. Klauber, Alan E.
Leviton, Oscar E. Sette, John H. Thomas.
Research Biologists: Isabella A. Abbott,
Dorothy Newmeyer, Virginia M. Page

ORGANIZATION
The Department of Biological Sciences
comprises facilities and personnel housed in
the new Herrin Laboratories and Herrin
Hall, the Museum Building on the campus,
and in the Hopkins Marine Station in Pacific
Grove on Monterey Bay.

The Department provides: (1) courses de-
dsigned for the general student, (2) a major
program leading to the degree of Bachelor
of Arts, and (3) programs of graduate study
and research leading to the degrees of Mas-
ter of Arts and Doctor of Philosophy.

A brochure of special interest to prospec-
tive candidates for advanced degrees, Grad-
uate Study in the Biological Sciences at Stan-
ford University, is available upon request to
the Department. The brochure describes the
areas of specialization represented in the
Department, facilities for study and re-
search, and the opportunities for financial
aid available to graduate students. Interest-
ed students may also wish to consult the de-
partments of Genetics, Medical Microbiol-
yogy, Anatomy, Physiology, Biochemistry,
Pharmacology, Psychology, the Neurological
Sciences program and the Biophysics labora-
tory, all of which also conduct graduate
programs.

PROGRAMS OF STUDY
BACHELOR OF ARTS
Candidates for the degree of Bachelor of
Arts must complete: (1) a group of specified
core courses in biology or their equivalents
and (2) sufficient units of elective courses in
the biological sciences or closely related
fields to make, when added to the units taken
in the core curriculum, a total of 40 units.
Elective courses may be selected from the
offerings in the Department of Biological Sciences or from a list of courses in other departments (see Note 1 below). These elective courses may be chosen with a view to obtaining either depth of training through advanced work in a particular field of specialization or breadth of training through exploration of various fields of biology. Courses included under “1” and “2” must be completed with an average grade of not less than C.

**Required Core Courses in Biology**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>Fundamentals of Biology</td>
<td>5</td>
</tr>
<tr>
<td>11.</td>
<td>Plants as Organisms</td>
<td>5</td>
</tr>
<tr>
<td>12.</td>
<td>Animals as Organisms</td>
<td>5</td>
</tr>
<tr>
<td>13.</td>
<td>Molecular Biology</td>
<td>3 or 6</td>
</tr>
<tr>
<td>14.</td>
<td>Cell Physiology</td>
<td>5</td>
</tr>
<tr>
<td>15.</td>
<td>Population Biology</td>
<td>4 or 5</td>
</tr>
</tbody>
</table>

Students majoring in Biological Sciences will ordinarily take Biology 10 during their sophomore year after having completed Chemistry 1, 2, and 3 during their freshman year.

**Required Courses in Cognate Fields**

A year (three quarters) of General Chemistry

A half year (two quarters) of Organic Chemistry

A year (three quarters) of General Physics Mathematics through Calculus

It is expected that many students will meet a portion of these requirements by advanced placement on the basis of their high school education. The following Stanford courses fulfill these requirements: Chemistry 1, 2, and 3, or 4 and 5; Chemistry 121 and 123, or 120; Physics 21, 23, and 29; and Mathematics 10, 11, 21, 22, and 23, or 41, 42, and 43. It is strongly recommended that students majoring in the Department of Biological Sciences complete one year of a modern European language, preferably German.

**Typical Schedule for a Four-Year Minimum Program**

### First Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 1, 2, 3.</td>
<td>General Chemistry</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>English 1, 2, 3.</td>
<td>Freshman English</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>History 1, 2, 3.</td>
<td>Western Civilization</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Math. 10, 11, 21.</td>
<td>Analytic Geometry and Calculus</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Group Activities</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>14</td>
<td>14</td>
<td>15</td>
</tr>
</tbody>
</table>

**Second Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology 10.</td>
<td>Fundamentals of Biology</td>
<td>5</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Biology 11.</td>
<td>Plants as Organisms</td>
<td>—</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>Biology 12.</td>
<td>Animals as Organisms</td>
<td>—</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>Chem. 121, 123.</td>
<td>Organic Chemistry</td>
<td>3</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Math. 22, 23.</td>
<td>Analytic Geometry and Calculus</td>
<td>3</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>German 1, 2, 3.</td>
<td>Introductory German</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Social Science</td>
<td>—</td>
<td>—</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Electives (See Note 1)</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Group Activities</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>15</td>
<td>15</td>
<td>17</td>
</tr>
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</table>

**Third Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology 113.</td>
<td>Molecular Biology</td>
<td>—</td>
<td>—</td>
<td>6(3)</td>
</tr>
<tr>
<td>Biology 114.</td>
<td>Cell Physiology</td>
<td>—</td>
<td>—</td>
<td>5</td>
</tr>
<tr>
<td>Biology 115.</td>
<td>Population Biology</td>
<td>5(4)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Physics 21, 23, 29.</td>
<td>Introductory Physics</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Humanities</td>
<td>4</td>
<td>4</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Social Science</td>
<td>—</td>
<td>—</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Electives (See Note 1)</td>
<td>3</td>
<td>3</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>16</td>
<td>16</td>
<td>15</td>
</tr>
</tbody>
</table>

**Fourth Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electives (See Note 1)</td>
<td></td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

**Pre-Health Students**

It is recommended that premedical students who are not biology majors take at
least the following courses in biology: 10, 11, 12, and 116. For specific requirements of various medical schools, consult departmental advisers.

**Predental Students**

The Council on Dental Education has fixed as the minimum basis for admission to an approved dental school the successful completion of two full academic years of work in an accredited college of liberal arts and science. The college course must include at least a year's credit in English, in biology, in physics, and in inorganic chemistry, and a half-year's credit in organic chemistry. All courses in science should include both class and laboratory instruction.

The predental requirement in biology may be fulfilled by taking either Biology 4 and 5, or Biology 10, 11, and 12.

**The Teacher's Recommendation**

Programs are provided for candidates seeking either (a) the Standard Teaching Credential (Secondary) with a teaching major or a teaching minor in biology, or (b) the Junior College Credential. Candidates holding the A.B. degree may satisfy the requirements for a Standard Secondary Credential by completing approved courses of study in biology and education in a minimum of four quarters of graduate study. Candidates who hold the degree of Master of Arts or Doctor of Philosophy may qualify for a Junior College Credential in Biological Sciences with a teaching major or minor in biological sciences, botany, or zoology. In satisfying the requirements for a teaching credential the candidate may offer units transferred from other institutions, but at least one course of advanced character should be taken in this Department. For the details of these programs the prospective candidate should consult the statement on credentials in the section “School of Education” in this bulletin, his adviser in the Department of Biological Sciences, and the Credential Secretary in the School of Education.

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and who wish further to strengthen their academic preparation. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education. Detailed requirements for the course are outlined in the School of Education section.

**ADVANCED STUDY AND RESEARCH**

Advanced courses and research are offered to qualified students in the various biological disciplines represented on the campus and at the Hopkins Marine Station by members of the Departmental faculty. Information concerning these research areas, and facilities and financial aid available to graduate students, will be found in the brochure, *Graduate Study in the Biological Sciences at Stanford University* (available upon request to the Department).

It should be noted that graduate programs in specialized areas of biology are offered in other departments on the campus, e.g., Genetics, Physiology, Psychology, Medical Microbiology, Pharmacology, Anatomy, Biochemistry, Neurological Sciences, Biophysics Laboratory. Students interested in these areas should contact the appropriate department, or should specify that their inquiries or applications to this Department may be routed to others if desirable.

All applications for admission to graduate status in Biological Sciences will be acted upon at one time each year, during March, for admission in September (or June). Applications and supporting materials are due in the Admissions Office not later than March 1.

**ADVANCED DEGREES**

A student who has fulfilled the requirements for the degree of Bachelor of Arts, or their approximate equivalent as determined by the Department, may apply for admission to the Graduate Division. An applicant must file a report of his scores (aptitude and advanced biology) on the *Graduate Record Examination* as part of his application. This examination may be taken at most American colleges (see your Registrar for further information).

Before admission to candidacy for an advanced degree a prospective candidate must conform to the regulations of the Department as stated below and of the University as outlined in the section “Degrees” in this bulletin.

Students who have had their undergraduate training in biology at Stanford are ordi-
narily encouraged to undertake graduate study elsewhere to insure breadth of experience. Printed information regarding choice of a graduate school can be obtained from the Departmental secretary.

**DOCTOR OF PHILOSOPHY**

*Preparation for graduate study*—It is expected that students seeking entrance to graduate study in biology ordinarily will have the equivalent of an undergraduate major in biology at Stanford (see above). It is recognized, however, that students trained in zoology or botany departments, or who may wish to concentrate on biological problems after undergraduate training in another science, may require special consideration. Such students will be advised at the time of initial registration as to how they should complete their background training during the first year of graduate study. In addition to the usual basic undergraduate courses in biology, it is recommended that wherever possible preparation for graduate work include courses in chemistry through organic chemistry, general physics, mathematics through calculus, and foreign languages (preferably German and French, at least 2 years).

The Master's degree is not required in order to proceed for a doctorate, although it may be recommended in specific cases.

*Courses required of all Ph.D. candidates*—Each student must take at least three units of work as a graduate under each of four or more Stanford faculty members. Course work to be taken in preparation for the qualifying examination will be determined in consultation with the graduate adviser or the Director of Graduate Studies.

Additional course requirements: As soon as possible after successful completion of the qualifying examination the student should meet with his major professor and dissertation reading committee to determine what (if any) further course requirements are to be met. Additional requirements may be specified by the major professor or the committee at any time during the student's dissertation work. A requirement may be removed only by action of the committee.

The *Ph.D. Qualifying Examination*—Before being recommended for admission to candidacy for the degree of Doctor of Philosophy, the prospective candidate will be required to pass a qualifying examination, normally during the fourth quarter of registration as a graduate student. The qualifying examination is given once a year near the beginning of the autumn quarter. The status of the student remains probationary until this examination is completed, at which time his eligibility to continue work toward the Ph.D. degree is determined on the basis of his total academic performance during the first four quarters of graduate study.

*Graduate Seminars*, devoted to the discussion of current literature and research in particular fields of biology, are an important means of attaining professional perspective and competence.

*Language Examinations*—Proficiency in reading scientific literature in one foreign language, normally German, is required of all students. Substitution of another language for German or prescription of additional language requirements (if any) is to be made in consultation with the major professor (or committee).

*Dissertation*—“A contribution to knowledge and the result of independent work, expressed in satisfactory form.” Abstracts of Ph.D. theses are published in *Dissertation Abstracts*.

*The Oral Examination*—Normally a three-hour examination, taken when the dissertation is at or near completion, the oral examination is conducted by a committee composed of members of the Department and others appointed by the Chairman of the University Committee on the Graduate Division. A candidate is expected to demonstrate a knowledge of the factual basis and theoretical implications of his thesis and an adequate mastery of his field of research. He must also show a grasp of the fundamental principles of biology and be able to show how these apply to his field of specialization. More detailed information concerning the oral examination and thesis will be found in the section "Degrees" in this bulletin. Additional information and a suggested schedule for completion of requirements may be obtained from the secretary of the Department.

*Minor for the Degree of Doctor of Philosophy*—The minor requirement in Biology is fulfilled by the successful passing of the Departmental Qualifying Examination.
MASTER OF ARTS

Students are not normally admitted to the Department for a terminal Master of Arts degree in the Biological Sciences. Students who wish to qualify for this degree will be informed of the requirements on request to the Director of Graduate Studies of the Department.

FINANCIAL SUPPORT FOR GRADUATE STUDY

Successful candidates for graduate admission are assured of support at the national fellowship level for four years, as long as their progress toward the Ph.D. degree is satisfactory.

All prospective Ph.D. candidates, regardless of the source of the financial support, will be expected to gain teaching experience as an integral part of their graduate training. Before completing his degree, each student will be called upon to assist in laboratory instruction for the equivalent of three half-time quarters.

The Department of Biological Sciences notifies successful applicants on or before April 1 for the coming year. Application forms for financial support should be submitted to the Office of Admissions not later than March 1. Forms may be obtained by writing to the Director of Graduate Studies of the Department.

Predoctoral Fellowships — Qualified applicants are asked to take the initiative in applying for predoctoral fellowships from the National Science Foundation and the U.S. Public Health Service (Forms and information: National Science Foundation Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. Deadline: Early January. Research Fellowships Branch, Division of Research Grants, National Institutes of Health, Bethesda, Maryland 20014. No deadline, but 3 to 4 months required between application and decision). These attractive awards provide full tuition and generous stipends. Application may be made by college seniors planning to work for a higher degree after graduation, as well as by students at any level of graduate work. Competition is with other applicants at the same level of advancement.

BIOLOGY SEMINAR

The Biology Seminar meets on Monday afternoons at 4:15. Topics of current biological interest are presented by speakers from Stanford and from other institutions, and are announced in the weekly University calendar. Students are urged to attend.

COURSES

The letter “H” following a number indicates that the course is given at the Hopkins Marine Station.

#4, 5. General Biology — Functional mechanisms in microorganisms, plants, and animals; major biological concepts, including historical development, logical or experimental bases.

Primarily for students who do not intend to major in biology, but may serve as a prerequisite to Biology 11 and subsequent courses leading to fulfillment of degree or premedical requirements. Lectures, laboratory, demonstrations. Enrollment only by signing class lists.

4. 4 units, Aut (Regnery, Baxter) MWF 8; lab. (I) T 9-12, (II) T 2:15-5:05, (III) W 2:15-5:05, (IV) Th 9-12, (V) Th 2:15-5:05

5. 4 units, Win (Regnery, Baxter) MWF 8; lab. (I) T 9-12, (II) T 2:15-5:05, (III) W 2:15-5:05, (IV) Th 9-12, (V) Th 2:15-5:05

10. Fundamentals of Biology — A concentrated introduction to biology for those intending to major in the subject and to take Biology 11-115. Emphasis on fundamental facts, concepts and questions which underlie later, more detailed, consideration in the core curriculum. Readings, lectures, and discussion-demonstrations. Prerequisites: Chemistry 1, 2, and 3.


11. Plants as Organisms — Structure and functions of plants at the organism level. Prerequisite: 10.

5 units, Win (Page) MWF 8; lab. (I) TTh 9-12, (II) TTh 2:15-5:05, (III) WF 2:15-5:05
12. Animals as Organisms—Basic functions of organisms as carried on by animals. Prerequisite: 11.

5 units, Spr (Oliphant, Wessells, Kennedy) MWF 9; lab. (I) TTh 1:15–4:05, (II) WF 1:15–4:05

100H. Marine Algae—Lectures, laboratory, field work on various classes of algae. Prerequisite: one year of biological science at college level.

5 units, Sum (second term) (I. Abbott) TThS

102. Invertebrate Biology—The phylogeny, classification, morphology, physiology, and ecology of invertebrates. Lectures, laboratory, and field trips. Prerequisite: an elementary biology course.

5 units, Spr (Baxter) MWF 8; lab. TTh 1:15–4:05

103. Comparative Histology—Microscopic structure of animal tissues; special reference to vertebrates.

3 units, Aut (Oliphant) TTh 10; lab. Th 1:15–4:05

105. Immunobiology—Principles of immunology as related to certain problems in biology.

2 units, Win (Feigen) TTh 10

111H. Marine Invertebrates — Structure, classification, biology, phylogeny of lower marine invertebrates, echinoderms, protochordates. Prerequisite: an elementary zoology course.

5 units, Sum (first term) (D. Abbott) TThS

112H. Marine Invertebrates—Continuation of 111H, covering molluscs, annelids, arthropods, allied minor phyla. While the two courses form a continuous sequence, either half may be taken separately. Prerequisite: elementary zoology, preferably also 111H.

5 units, Sum (second term) (D. Abbott) TThS

113A. Molecular Biology — The synthesis, function, interactions of the various macromolecular components of cells, with emphasis on molecular genetics. Prerequisites: 114 and Organic Chemistry.

3 units, Spr (Woodward) MWF 11

113B. Molecular Biology Laboratory — By permission.

3 units, Spr (Woodward) by arrangement

114. Cell Physiology—Fundamental activities of life as exemplified in plant and animal cells. Prerequisite: 12.

5 units, Win (Giese) MWF 9; lab. (I) TTh 1:15–4:05, (II) W 1:15–4:05, (III) Th 1:15–4:05, (IV) F 1:15–4:05

115A. Population Biology—Introduction to the properties of aggregations of organisms. Prerequisite: 10, 11, and 12.

4 units, Aut (Holm, Ehrlich, Raven) TThS

115B. Population Biology Laboratory—By permission.

1 unit, Aut (Holm, Ehrlich, Raven) by arrangement

116. Biology of Vertebrates — Structure, function, development, evolution of vertebrates. Prerequisites: 10, 11, and 12.

3 or 5 units, Aut (——) MWF 9; lab. (I) TTh 8–11, (II) TTh 1:15–4:05

118H. Phytoplankton — Lectures, laboratory, and field work on inshore and some open sea phytoplankton, morphology and systematics, ecology and sampling techniques. Prerequisite: one year of biological science at the college level.

5 units, Sum (first term) (Doty) MWF

119H. Marine Ecology—Ecological studies of selected marine associations and habitats. Emphasis will be on intertidal ecology. Prerequisites: At least two courses in general biology or zoology. Chemistry and invertebrate zoology are recommended. Preference will be given to students registering for both 119H and 120H. The class will meet daily during periods of low tides. Further meetings will be announced, to make a total of 15 meetings.

5 units, Sum (first term) (Lee)

120H. Marine Ecology — Continuation of 119H. Prerequisite: 119H. The class will meet daily during periods of low tides. Further meetings will be announced, to make a total of 15 meetings.

5 units, Sum (second term) (Lee)

124. Comparative Parasitology: Protozoa, Helminths — Principal attention to forms parasitic in man, animals, plants of importance in human economy.

4 units, Win (Oliphant) TTh 10; lab. TTh 1:15–4:05
128. Classification of Vascular Plants —
Lectures, laboratory, field studies. Prerequisite: 11.

4 or 5 units, Spr (Thomas) WF 1:15;
lab. WF 2:15–5:05; field trips
by arrangement

129. Fungi — Introduction to morphology and physiology of fungi. Prerequisite: 11.

4 units, Spr (Page) TTh 9;
lab. TTh 10–12
and two hours by arrangement

130. The Plant Kingdom: Algae and Arche-goniates — Structure, development, evolutionary relationships of algae, bryophytes, and lower vascular plants. Lectures, laboratory, field trips. Prerequisite: 11.

4 units, Aut (Page) TTh 1;
lab. TTh 2:15–5:05

132. The Plant Kingdom: Seed Plants — Structure, development, evolutionary relationships of seed plants. Lectures, laboratory, field trips. Prerequisite: 11.

5 units, Spr (Holm, Raven) MWF 1:15;
lab. WF 2:15–5:05

139. Herpetology I — Lecture, laboratory, field survey of living amphibians, with a synoptic history of herpetology. By permission.

3 units, Win (Leviton, Myers)
by arrangement

140. Herpetology II — Lecture, laboratory, field survey of living reptiles. By permission.

3 units, Spr (Leviton) by arrangement

145. Laboratory Techniques in Embryology—Application of microsurgical, chemical, tissue culture procedures to developmental problems. Prerequisites: 116 and permission of instructor.

3 units, Win (Wessells) TTh 1:15–5:05,
given 1969–70

147H. Comparative and Experimental Embryology—A lecture and laboratory course surveying developmental patterns, and their experimental modifications, in marine invertebrates, fishes, and algae. Prerequisite: a firm foundation in biology.

5 units, Sum (first term) (Epel) MWF

148H. Comparative and Experimental Embryology—Continuation of 147H. Prerequisite: 147H.

5 units, Sum (second term) (Epel) MWF

150. Evolution and Human Affairs—A synthesis of evolutionary thought with emphasis on the implications for man. Prerequisite:
a course in general biology. No credit will be given for 150 following 115A.

3 units, Win (Ehrlich, Holm) MWF 11

151. Evolutionary Genetics—Application of genetics to study of evolution.

2 units, Spr (Regnery) TTh 10, alternate years, given 1969–70

153. The Physiological Basis of Behavior—Properties of neurons and synapses and their relation to integrative processes; sense organs as transducers; information processing in sensory systems; organization of reflexes and the neural analysis of more complex behavior. Prerequisite: 12.

3 units, Win (Kennedy, Wilson)
MWF 1:15

156. Introductory Plant Physiology—Principal functions of organs of higher plants; growth, mineral nutrition, water relations, movement of materials, respiration, nitrogen relations, photosynthesis. Prerequisite: 114.

5 units, Spr (Ray) MWF 1:15

160. Topics in Population Biology — Interactions of individuals and populations. Prerequisite: 115A.

3 units, Spr (Raven, Ehrlich, Holm)
MWF 9

170. Readings in Paleobotany—Structure, evolutionary relationships of fossil plants. Prerequisites: 11, 131, 132, and permission of instructor.

(Holm) by arrangement


2 units, Spr (Leviton, Myers)

175H. Problems in Marine Biology — Field studies, laboratory, lectures, individual problems in marine biology. Designed primarily for undergraduates. Students will be in residence at the Hopkins Marine Station during the entire quarter. Prerequisites: 11 and 12; and Chemistry 1, 2, and 3; and permission of the instructors.

15 units, Spr (D. Abbott, Epel, Lee, Phillips) MTWThF


4 units (Ehrlich) by arrangement
198. Senior Honors Program—Readings or research in some phase of biology of especial interest to the individual. Satisfactory completion leads to Departmental recommendation for graduation with honors in biology. Open only to seniors (or students in the last quarter of their junior year) who have maintained an overall average grade of B or better. Not more than six units of honors work may be applied toward the units of electives required for graduation in biology.

(Staff) by arrangement

199. Special Problems.
(Staff) by arrangement

199H. Special Problems.
(Hopkins Marine Station Staff) by arrangement

212. Evolution of the Flowering Plants — Phylogenetic relationships of angiosperms. Prerequisite: 11.

3 units, Win (Raven) MWF10, alternate years, given 1969–70

215. Biosystematics — Current methods of approach to systematic problems in higher plants. Prerequisites: 11, and permission of the instructor.

4 units, Win (Raven) by arrangement, given 1968–69

222H. Biological Oceanography—Intensive lecture, field, and laboratory course dealing with marine organisms and their environment. The work is done on board ship in oceanic regions that vary from quarter to quarter. Open only to graduate students by arrangement with the Program Director through correspondence.

15 units, Aut, Win, Spr, Sum (Gilmartin) by arrangement

230. Advanced Systematic Ichthyology I—Intensive lecture, laboratory course extending through two quarters. Open only to especially qualified advanced students upon permission of instructor.

4 units, Aut (Myers) by arrangement

231. Advanced Systematic Ichthyology II—Continuation of 230.

4 units, Win (Myers) by arrangement

247. Advanced Cell Physiology — Discussion of a selected topic. Prerequisite: 114. By permission. May be repeated for credit.

3 units, Aut (Giese) M 1:15–3:30

249. Cytogenetics—(Same as Genetics 249.) Principles and modern methods of analysis of major cellular components. The structure and design of chromosomes from bacteriophages to higher organisms. The influence of chromosomal changes in development and evolution. Prerequisites: 4 and 5, or 10, 11 and 12, a knowledge of genetics, and permission of instructor.

3 units, Aut (Ganesan) MWF 10

250. Molecular Biophysics — A survey of physical approaches to biological problems at the molecular level. Lectures include discussion of intra- and intermolecular forces and their relation to biological structure, physical methods for characterizing macromolecules, the interaction of electromagnetic radiation with biological molecules, isotopic tracer techniques, and classical physics of cellular processes. Assigned readings and problems. Prerequisites: Biology 10, Chemistry 121, and Physics 57, or permission of instructor.

3 units, Aut (Hanawalt) TTh 10 and T 7:15 p.m.


3 units, Spr (Yanofsky) TTh 9

260. Seminar in Population Biology—Readings and discussions on research of current or special interest. Prerequisites: 115A and permission of instructors. May be repeated for credit.

1 unit (Ehrlich, Holm, Raven)
by arrangement

261H. Comparative Biochemistry of Marine Organisms—Prerequisites: elementary biology and organic chemistry.

5 units, Sum (first term) (Phillips) MWF

264H. Physiology of Algae—Lectures and experiments on the physiology of fresh-water, epiphytic, marine and brine algae. Osmotic and salt effects, permeability, respiration, pigments, photosynthesis and tropisms are among the topics studied. Prerequisites: elementary chemistry and biology.

5 units, Sum (second term) (Blinks) TThS

269H. Ecological Physiology — Physiological responses of animals to variations in environmental factors and to organisms. Most of the work will deal with marine inverte-
brates. Prerequisites: general zoology and elementary chemistry.

5 units, Sum (second term) (Giese) TThS


3 units (Ehrlich) by arrangement

300. Research.
(Staff) by arrangement

300H. Research.
(Hopkins Marine Station Staff) by arrangement

350. Graduate Seminars.
(Staff) by arrangement

See also Senior Colloquia.

**DIVISION OF MARINE BIOLOGY AND OCEANOGRAPHY, HOPKINS MARINE STATION**

Emeriti: Lawrence R. Blinks, Rolf L. Bolin, Cornelis B. vanNiel (Professors)

Director: John H. Phillips, Jr.

Associate Director: Donald P. Abbott


Assistant Professors: David Epel, Welton Lee

Research Biologist: Isabella A. Abbott

The Hopkins Marine Station is situated at Pacific Grove, on the south side of Monterey Bay, 90 miles from the main University campus at Palo Alto. The ground area comprises seven and a half acres, consisting of the main portion of Cabrillo Point, with complete control of the coast line of the Point and including a sheltered landing place and storage for small boats. Buildings include the “Marinostat,” the Alexander Agassiz Laboratory and the Jacques Loeb Laboratory. The library is especially endowed, and subscribes to about 300 journals. Its collections are particularly good in marine biology, oceanography, microbiology, and embryology.

The Station is open during the entire year and maintains a permanent staff of resident investigators and technical assistants; this staff is increased by visiting faculty members, especially during the summer. There are facilities for visiting investigators and for elementary and advanced instruction in biology. For further information, see the Hopkins Marine Station Bulletin issued in March.

Candidates for admission should make application to the Director, Hopkins Marine Station, Pacific Grove, California 93950. The application should state whether admission to the advanced undergraduate or graduate level as a matriculated student is desired; or whether the student wishes to register on the nonmatriculated basis (available in summer quarter only, except for course 222H). Applications from students wishing to register for summer classes should be sent in not later than March. Later applicants may find some classes filled.

**AUTUMN, WINTER, AND SPRING QUARTER COURSES**

Although few formal courses will be offered, the staff will welcome the opportunity to direct work of graduate and undergraduate students in the fields indicated. Owing to superior conditions of tides and weather, the autumn and spring quarters are especially recommended for research involving marine organisms.

175H. Problems in Marine Biology.

15 units, Spr (D. Abbott, Phillips, Epel, Lee) MTWThF

199H. Special Problems — Properly qualified undergraduate students may undertake individual work in fields indicated under 300H. Such studies are intended to introduce the serious student to methods of research. Arrangements must be made by consultation or correspondence.

(Staff) by arrangement

222H. Biological Oceanography—An intensive introduction to biological oceanography given at sea aboard the R/V TE VEGA in oceanic regions which vary from quarter to quarter.

15 units, Aut, Win, Spr (Gilmartin, , ) by advance arrangement only

300H. Research—Problems involving original work may be undertaken with members of the staff in the following fields:

Marine Zoology — Problems on the fun-
tional anatomy, taxonomy, development, and ecology of marine animals.  
(ABBOTT)

Physiology — Problems on physiology of invertebrate animals; photobiology, especially effects of ultraviolet light.  
(GIESE)

Comparative Biochemistry and Immunology—As exemplified in marine animals.  
(PHILLIPS)

Developmental Biology.  
(EPEL)

Marine Ecology.  
(LEE)

SUMMER QUARTER COURSES

The summer quarter is divided into two terms of five weeks each. Those courses requiring the lower tides of early summer are scheduled in the first term. It is possible to register for either term, or for the full quarter.

The regular five-unit laboratory courses are scheduled for three alternate days per week, an average of 20 hours per week being required. It is possible to obtain ten units in each term, but registration for more than fifteen units in the full quarter is not ordinarily advisable, owing to the intensive schedule.

For detailed descriptions of courses, see listings above under Biological Sciences; also the Hopkins Marine Station Bulletin (issued in March).

First Term

111H. Marine Invertebrates.  
5 units (D. ABBOTT) TThS

118H. Phytoplankton.  
5 units (DOTY) MWF

119H. Marine Ecology.  
5 units (LEE) meetings scheduled according to tides

147H. Comparative and Experimental Embryology.  
5 units (EPEL) MWF

199H. Special Problems—(See autumn, winter, spring quarters, above.)  
(Staff) by arrangement

222H. Biological Oceanography — (See above.)

261H. Comparative Biochemistry of Marine Organisms.  
5 units (PHILLIPS) MWF

300H. Research — (See autumn, winter, spring quarters, above.)  
(Staff) by arrangement

Second Term

100H. Marine Algae.  
5 units (I. ABBOTT) TThS

112H. Marine Invertebrates—Continuation of 111H.  
5 units (D. ABBOTT) TThS

120H. Marine Ecology.  
5 units (LEE) meetings scheduled according to tides

148H. Comparative and Experimental Embryology.  
5 units (EPEL) MWF

199H. Special Problems—(See under First Term.)  
(Staff) by arrangement

222H. Biological Oceanography — (See above.)

264H. Physiology of Algae.  
5 units (BLINKS) TThS

269H. Ecological Physiology.  
5 units (GIESE) TThS

300H. Research — (See under First Term.)  
(Staff) by arrangement

DIVISION OF SYSTEMATIC BIOLOGY

Emeriti: Roxana S. Ferris (Curator), Willis H. Rich, Ira L. Wiggins (Professors)

Director: Richard W. Holm

Professors: Paul R. Ehrlich, Richard W. Holm, George S. Myers

Associate Professor: Peter H. Raven


Curators: Paul R. Ehrlich (Entomological Collections), George S. Myers (Zoological Collections), John H. Thomas (Dudley Herbarium)
Assistant Curator: Warren C. Freihofler (Zoological Collections)

Research Associates: S. Stillman Berry (Malacology), Walter C. Brown (Herpetology), E. H. Neil (Ichthyology)

The Division of Systematic Biology has for its general purpose the maintenance of provisions (1) for proper housing and care of the systematic collections of animals and plants, and (2) for instruction, investigation, and research in systematics, geographical distribution, and ecology. It is housed in the west wing of the Museum Building, where instruction and research utilizing the collections are conducted. Facilities are available for a limited number of graduate students and qualified investigators.

Advanced courses and research leading to the degree of Doctor of Philosophy, in compliance with University and Department of Biological Sciences requirements, are offered in the following fields: (a) botany (morphology, distribution, and taxonomy of vascular plants); (b) zoology (ichthyology and herpetology, including taxonomy, morphology, ecology, and distribution); and (c) population biology.

DUDLEY HERBARIUM

The Dudley Herbarium, named in honor of Professor William Russel Dudley, is especially rich in material from western North America and offers unusual facilities for critical systematic and distributional studies of the floras of that region. The Harvey Herbarium, comprising about 65,000 sheets, and the herbarium of the late Dr. Herman Knoche, containing over 125,000 sheets, furnish authentic material from Europe and the Mediterranean region. They contain many historical, frequently cited specimens and are of great value to investigators studying plants recently introduced into North America or those closely related to Old World species. The collections of the Dudley Herbarium now number about 700,000 sheets.

ENTOMOLOGICAL COLLECTIONS

The entomological collections are restricted to those being used in particular research projects. No general collections are maintained except for teaching purposes.

ZOOLOGICAL COLLECTIONS

The collection of fishes is one of the largest and most important in the world, its basis being the material collected by Dr. David Starr Jordan, his associates, and his students. The marine and fresh water fishes of both eastern and western North America, the West Indies, Central America, Japan, eastern China, the Philippines, the Malay Peninsula, Hawaii, and Polynesia are well represented. In addition, there are large bathyal collections from the North Pacific and other parts of the world, as well as extensive series of fishes of Peru, Colombia, the Galapagos Islands, Venezuela, British Guiana, the Amazon, Cameroon, South and East Africa, India, the Malay Archipelago, and Australia.

The herpetological collections contain an extensive representation of the amphibians and reptiles of the West and considerable material from southeastern Asia and tropical America.

CHEMISTRY*

Emeriti: Frederick O. Koenig, Philip A. Leighton, J. Murray Luck, J. Pearce Mitchell, Carl R. Noller (Professors)

Executive Head: William S. Johnson
Associate Executive Head: Douglas A. Skoog


Associate Professor: Frank E. Harris
Assistant Professors: Lawrence J. Altman, Hans C. Andersen, John I. Brauman, Robert Pecora, Paul C. Simpson, Leonard M. Stephenson

Lecturer: Pierre Van Rysselberghe

Affiliated Faculty: Paul Kruger (Civil Engineering), Lubert Stryer (Biochemistry, School of Medicine)

* The curriculum leading to the B.S. degree in Chemical Engineering is described elsewhere in this bulletin.
ENTRANCE PREPARATION

Students who intend to major in chemistry are expected to offer entrance credit in the preparatory subjects of chemistry, physics, and mathematics (including algebra and plane trigonometry). Those who do not have entrance credit or equivalent training in the foregoing subjects, particularly mathematics, may experience some difficulty in meeting the Department requirements for graduation in four years, especially if they expect to pursue a program leading to professional certification to the American Chemical Society or to the B.S. degree with Honors.

Students who have taken the College Board Advanced Placement Examination in Chemistry and receive a composite score of 4 will be excused from Chemistry 1 and 2, or from Chemistry 4. Those receiving composite scores of 5 may be excused from Chemistry 3 or 5 on the recommendation of the Committee on Undergraduate Study.

PROGRAMS OF STUDY

MINIMUM REQUIREMENTS FOR THE BACHELOR OF SCIENCE DEGREE

General studies requirement; the equivalent of 18 units of German, or 12 units of German and 12 units of either French or Russian; Mathematics 10, 11, 21, 22, 23, or 41, 42, 43; Physics 51, 53, 54, 55, 56, 57, 58; Chemistry 1, 2, 3, or 4, 5; 113, 114, 116, 121, 122, 123, 124, 125, 171, 173, 175, 176, 177. In addition Chemistry 181 is strongly recommended. Premedical students majoring in chemistry may substitute Physics 21, 23, 29 for Physics 51-58 provided they also complete Biology 10 (or 4, 5), 11, 12, 116. All candidates for graduation with chemistry as the major subject are required to have a grade point average of at least 2.00 in their chemistry courses. Students interested in attending overseas campuses should consult their advisers as early as possible in order to avoid scheduling problems.

AMERICAN CHEMICAL SOCIETY CERTIFICATION

Students who wish to be certified as having met the minimum requirements of the American Chemical Society for professional training must complete, in addition to the above requirements, Chemistry 181; at least three units from Chemistry 126, 142, or 190; and at least three units from one of the following: Chemistry 141; any chemistry course numbered above 200 for which permission to register has been granted by the instructor; Biochemistry 101; or an advanced course in mathematics or physics.

HONORS PROGRAM

A limited number of undergraduates may be admitted to the Chemistry Honors Program at the beginning of the senior year. Those completing the program satisfactorily will receive the degree of Bachelor of Science in Chemistry with Honors.

To be admitted to the program, the student must have a grade point average of at least 3.00 in all course work in the University and of 3.30 in courses in chemistry, physics, and mathematics. In addition to the minimum requirements for the B.S. degree, the student must complete nine units of Chemistry 190 to be taken three units per quarter for three quarters; 3 or 4 units from Chemistry 126, 181, 221, 223, 225, 241, 251, 253, 271, 273, 275; and nine additional units of courses from the above list or from Biochemistry 101, 102, Mathematics 130, 131, 132, physics lecture courses numbered 100 and higher, or other advanced courses approved by the student's adviser and by the supervisor of his work in Chemistry 190.

Students who wish to be admitted to the Honors Program but who do not meet all of the above formal requirements, may petition the Department for admission.

TYPICAL SCHEDULE FOR FOUR-YEAR MINIMUM PROGRAM

**First Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 1, 2, 3. General Chemistry</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>English 1, 2, 3. Freshman English</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>German 1, 2, 3. First-Year German</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Math. 10, 11, 21. Analytic Geometry and Calculus</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>14</strong></td>
<td><strong>14</strong></td>
<td><strong>15</strong></td>
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</tr>
</tbody>
</table>

**Second Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 121, 123, 125. Organic Chemistry</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Chem. 122, 124. Organic Laboratory</td>
<td>3</td>
<td>3</td>
<td>—</td>
<td></td>
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<tr>
<td>German 22, 23. Second-Year Reading</td>
<td>3</td>
<td>3</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Math. 22, 23. Analytic Geometry and Calculus</td>
<td>3</td>
<td>3</td>
<td>—</td>
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</tr>
<tr>
<td>Physics 51, 53, 54. Mechanics, Sound, Electricity</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Social Science</td>
<td>5</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Electives (See Note 1)</td>
<td>—</td>
<td>4</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>15</strong></td>
<td><strong>16</strong></td>
<td><strong>15</strong></td>
<td></td>
</tr>
</tbody>
</table>
Candidates for advanced degrees must have a minimum grade point average of 3.00 for all chemistry lecture courses as well as for all courses taken during graduate study. Required courses may not be taken under the "Pass-Fail" option. All students are expected to give full time to their graduate work once they have begun research. All prospective Ph.D. candidates, regardless of the source of their financial support, will be expected to gain teaching experience as an integral part of their graduate training. During the period in which a thesis is being read by members of the staff, candidates must be available for personal consultation until the thesis has had final Departmental approval. In addition to Departmental requirements, candidates for advanced degrees must meet the general University regulations as stated in the section "Degrees" in this bulletin.

### Third Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 113, 114.</td>
<td>Quantitative Analysis</td>
<td>4</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Chem. 116.</td>
<td>Instrumental Analysis</td>
<td>—</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>Chem. 171, 173, 175. Physical Chemistry</td>
<td>—</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 176. Physical Chemistry Laboratory</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>History 1, 2, 3. Western Civilization</td>
<td>4</td>
<td>4</td>
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<td></td>
</tr>
<tr>
<td>Physics 55, 56, 57, 58. Light, Heat, Atomic Physics</td>
<td>—</td>
<td>4</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Social Science</td>
<td>—</td>
<td>—</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Electives (See Note 1)</td>
<td>—</td>
<td>2</td>
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</tr>
</tbody>
</table>

**Totals** 16 17 15

### Fourth Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 177.</td>
<td>Physical Chemistry</td>
<td>3</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Humanities</td>
<td>4</td>
<td>4</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Electives (See Note 1)</td>
<td>8</td>
<td>11</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

**Totals** 15 15 15

**Note 1.** Elective courses may be chosen from any offered by the Chemistry Department or by other departments of the University. Courses offered by other departments that may be of particular interest to chemistry majors include: Ch.E. 10, 130A, 130B, 150, 204; Economics 1; English 102; Mathematics 44, 130, 131, 132; Physics 61, 110, 111, 140; Statistics 110; Geology 1, 25; Engr. 50; Min.E. 105; Mat.Sci. 107; Microbiology 101; Biology 11, 12, 116; Biochem, 101, 102.

### Teaching Credentials

The requirements for certification to teach chemistry in the secondary schools and junior colleges of California may be ascertained by consulting the section on credentials under "School of Education" in this bulletin and the Credential Secretary of the School of Education.

### Advanced Degrees in Chemistry

#### General Requirements

Qualifying examinations are given prior to the first week of the autumn quarter. Each new graduate student must take these examinations on entrance. Satisfactory performance is required for permission to continue work for an advanced degree. Thesis research may not be started until the candidate has passed the qualifying examinations. Students who do not complete the remaining requirements for an advanced degree within six years after entrance as a graduate student must repeat and pass the qualifying examinations and must meet any other requirements established by the faculty before the degree will be granted.

### Qualifying Examinations

For all students other than those majoring in chemical physics, these examinations will consist of four written examinations of two hours duration each in the fields of analytical, inorganic, organic, and physical chemistry, and will cover such material as ordinarily is given in a rigorous one-year undergraduate course in each of these subjects. Students who fail to pass these examinations in the autumn will be permitted to repeat them during the first week of the winter quarter. All qualifying examinations will be given during the period September 20, 21, 1968, and all must be taken at this time.

Students majoring in chemical physics are required to take two of the four qualifying examinations, namely that in physical chemistry and either that in inorganic or organic chemistry, and in addition thereto, a four-hour written examination in chemical physics. An entering student has only one opportunity to take the chemical physics examination, which will be given on September 20, 1968. Students who fail to pass the chemical physics examination may qualify for an advanced degree only if they can do so under the program described in the preceding paragraph.

### Master of Science

All applicants for the degree of Master of Science in Chemistry are required to complete, in addition to the requirements for the
Bachelor's degree, a minimum of 39 units of work. Of the 39 units approximately two-thirds must be in the Department and must include at least 12 units of advanced course work in chemistry exclusive of the thesis. Of the 12 units, at least three units must be from Chemistry 221, 223, 225, 251, 253, 271, 273, or 275.

**Master of Arts in Teaching (Chemistry)**

In cooperation with the School of Education, the Department offers a program leading to a degree, Master of Arts in Teaching (Chemistry). This degree is intended for candidates who have a teaching credential and who wish to strengthen further their academic preparation. Detailed requirements are outlined in this bulletin under “School of Education, the Master of Arts in Teaching.”

**Doctor of Philosophy**

The graduate student does not become a formal candidate for the Ph.D. degree until he has passed the Department qualifying and language examinations and has been admitted to candidacy by the University Committee on the Graduate Division. Doctorate candidates will be considered responsible for an integrated knowledge of their field of specialization, which will not be limited to the content of related advanced courses offered by the Department. Normally they will register for at least 30 units of advanced lecture courses. The foreign language requirement for the Ph.D. in chemistry ordinarily will be met in German and in French or Russian. Proposals to substitute for French or Russian another language or a program of course work will be considered by the Department on petition by the candidate. Candidates for the Ph.D. degree are required to participate continually in the Department seminar (Chemistry 300), and in the division seminar of the major subject.

All students majoring in inorganic chemistry are required to take (1) Chemistry 181, 271, 273, and 275 (or be exempted therefrom by passing special examinations administered by the professors in charge of these courses); (2) three units of advanced lecture courses in inorganic chemistry; (3) Chemistry 221 or 223 or 225; (4) six additional units of approved advanced lecture courses.

All students majoring in organic chemistry are required to (1) pass a laboratory proficiency test in qualitative organic analysis; (2) take Chemistry 221, 223 and 225 during the first year, irrespective of background; those who fail to make a grade point average of at least 3.00 in these three courses may not become candidates for the Ph.D. degree in organic chemistry; (3) take three units of Chemistry 227; (4) take Chemistry 271 (or be exempted therefrom by passing a special examination administered by the professor in charge of this course); (5) take six units of advanced lecture courses outside of the field of organic chemistry. Beginning with the second year of graduate work at Stanford, organic chemistry majors are required to participate in a series of advanced problem sessions.

All students majoring in physical chemistry are required to take (1) Chemistry 271, 273, and 275 (or be exempted therefrom by passing special examinations administered by the professors in charge of these courses) during the first year, irrespective of background; those who fail to make a grade point average of at least 3.00 in these three courses may not become candidates for the Ph.D. degree in physical chemistry; (2) six units of advanced lecture courses in physical chemistry, chemical physics, or inorganic chemistry; (3) Chemistry 221, or 223, or 225; (4) six additional units of advanced lecture courses outside of the fields of chemical physics, physical chemistry, and inorganic chemistry.

Students majoring in biochemistry in the Chemistry Department are required to take (1) Chemistry 124 or pass a laboratory proficiency test in qualitative organic analysis; (2) Biochemistry 101 and 102 (eight units) unless an equivalent course in general biochemistry was satisfactorily completed previously; (3) nine units of advanced biochemistry chosen from Chemistry 241, Biochemistry 211, 212, 213, 217, or 218 or allied courses as approved by the Department of Chemistry, and (4) six units of advanced lecture courses in organic, inorganic, or physical chemistry chosen from Chemistry 181, 221, 223, 225, 271, and 273.

The chemical physics program is designed solely as a convenience to the unusual chemistry graduate student with an exceptionally strong mathematics and physics background. A student may carry out graduate studies in chemical physics equally well majoring either in physical chemistry or in chemical
physics. Students majoring in chemical physics are required to take (1) Chemistry 271, 273, and 275 (or be exempted therefrom by passing special examinations given by the professors in charge of these courses); (2) Chemistry 281, 283, and 285; (3) such other courses as may be recommended by the student's adviser.

Before a candidate may request scheduling of the University oral examination, clearance must be obtained from the chairman of the Department Graduate Study Committee. Conditions that must be fulfilled before clearance is granted vary with the different divisions of the Department and may be ascertained by consulting the chairman of the Committee. The University oral examination may not be taken during the summer quarter except after favorable action on a special petition filed not later than the third week of the spring quarter.

It is the policy of the Department to encourage and support in every possible way the pursuit of research and of other work along advanced lines by qualified students. Information concerning staff members with lists of their recent research publications will be found in the Directory of Graduate Research published by the American Chemical Society.

Minor in Chemistry—Candidates for the degree of Doctor of Philosophy in other departments who wish to minor in chemistry must complete with a grade point average of 3.00 or better, at least 12 units of chemistry courses more advanced than those that meet the minimum requirements for the Bachelor's degree in chemistry. At least 3 units must be from Chemistry 221, 223, 225, 251, 253, 271, or 273.

Fellowships and Scholarships

In addition to the University fellowships and scholarships that are open to properly qualified students, there are at present numerous Departmental fellowships in chemistry. The Allied Chemical Corporation Fellowship, Continental Oil Company Fellowship, Dow Chemical Company Fellowship, Edward Curtis Franklin Fellowship, James W. McBain Memorial Fellowship, Stauffer Chemical Company Fellowship, and Frederick P. Whitaker Fellowship are granted only to graduate students. The William H. Nichols Scholarships, David L. and Lavinia E. Sloan Memorial Scholarship, John Maxson Stillman Scholarship, and Ephraim and Amelia Weiss Scholarships are open to graduates and undergraduates; the Robert M. and Katherine F. Loeser Scholarship and the Frank Card Scholarship are available to undergraduates only.

There also are numerous teaching assistantships and research assistantships open to advanced students. Application forms for fellowships, scholarships, and teaching assistantships may be obtained from the office of the Department of Chemistry.

Courses

Note — Deposits required in laboratory courses, against which charges are made for breakage, loss of apparatus, chemicals, etc., are from $10 to $30 per quarter.

Undergraduate Courses

#1. General Chemistry — Prerequisite: high school algebra or Mathematics 0.
4 units, Aut (Staff) lee. (I) MWF 8, (II) MWF 9; lab. (I) T 9-12, (II) T 2:15-5:05, (III) W 2:15-5:05, (IV) Th 9-12, (V) Th 2:15-5:05, (VI) F 2:15-5:05

#2. General Chemistry—Continuation of 1.
4 units, Win (Staff) lee. and lab. sections same as under Chemistry 1.

#3. General Chemistry—Continuation of 2.
5 units, Spr (Staff) lee. (I) MWF 8, (II) MWF 9; lab. (I) TTh 9-12, (II) TTh 2:15-5:05, (III) WF 2:15-5:05

4. General Chemistry—Primarily for engineering and science majors with good mathematical background. Course may not be taken without laboratory. Prerequisite: Mathematics 10 or 41 (may be taken concurrently).
4 units, Aut (Staff) lee. MW 8; lab. sections same as under Chemistry 1.

5. General Chemistry—Continuation of 4.
4 units, Win (Staff) lee. MWF 8; lab. sections same as under Chemistry 1.

111. Quantitative Analysis — Primarily for premedical students. Not for Chemistry or Chemical Engineering majors. Concurrent enrollment in 112 required. Prerequisite: 3
CHEMISTRY

2 units, Spr (Loring) TTh 11
Sum (Staff) MWF 11

112. Quantitative Analysis Laboratory —
Concurrent enrollment in 111 required.
3 units, Spr (Loring) MWF 1:15–4:05 or
TTh 1:15–4:05 and S 9–12
Sum (Staff) MWF 1:15–5:05

113. Quantitative Analysis — For Chemistry or Chemical Engineering majors. Concurrent enrollment in 114 required. Prerequisite: previous or concurrent enrollment in 171.
2 units, Aut (——) TTh 11

114. Quantitative Analysis Laboratory —
Concurrent registration in 113 required.
2 units, Aut (——) MW 1:15–4:05 or
TTh 1:15–4:05

116. Instrumental Analysis — Theory and techniques of electrometric titrations, polarography, electrodeposition, spectrophotometry, refractometry, polarimetry, and chromatography. Prerequisites: 113, 114, 171, and previous or concurrent enrollment in both 173 and Physics 29 or 57.
4 units, Win (——) lec. TTh 10; lab.
TTh 1:15–4:05 or WF 1:15–4:05

119. Organic Chemistry — Aliphatic, aromatic compounds. For students other than Chemistry or Chemical Engineering majors. Prerequisite: 3 or 5.
5 units, Sum (Staff) MTWThFS 9

120. Organic Chemistry Laboratory — Pre-
requisite: concurrent enrollment in 119.
1 unit, Sum (Staff) M or W 1:15–5:05

121. Organic Chemistry — Carbon com-
ounds. Prerequisite: 3 or 5.
4 units, Aut (Bonner) lec. (I)
MWF 11; (II) TThS 10, and one recitation by arrangement

122. Organic Preparations — Laboratory course. Prerequisite: 119, or previous or concurrent enrollment in 123.
3 units, Win (——) MW 1:15–5:05
or TTh 1:15–5:05
Sum (Staff) MWF 1:15–5:05

123. Organic Chemistry — Continuation of
121.
3 units, Win (Bonner) lec. (I)
MWF 11; (II) TThS 10

124. Qualitative Organic Analysis Laboratory — Prerequisite: 122.
3 units, Spr (Altman) MWF 1:15–4:05

125. Organic Chemistry — Continuation of
123.
3 units, Spr (——) MWF 11

126. Advanced Organic Preparations —
Prerequisites: 124 and 125.
3 units, Aut (Bonner) MWF 1:15–5:05

141. Nuclear Chemistry — Properties of nu-
clei and radioisotopes; nuclear reactions; fission, fusion, reactors, and accelerators; radiation detection and measurement; radiation safety; radiation chemistry, radiotracers, radioactivation analysis, and their applications. Prerequisites: 3 or 5, Mathematics 23, and Physics 57, or equivalent.
3 units, Win (Kruger) TTh 11

142. Radiochemistry Laboratory — Nuclear reactions, radiochemical separations, radioactivity genetics, radioisotope production, neutron activation analysis and flux measurements; nuclear fission, radiotracers in physical chemistry and engineering. Prerequisite: 141 or consent of instructor.
3 units, Spr (Kruger) Th 1:15 and one lab.
by arrangement

143. Radioactivation Analysis — The use of radioactivation as a research tool: radioactivation, properties of radioisotopes, sources of irradiations, activation analysis, practices and uses in biology, chemistry, and engineering.
2 units, Spr (Kruger) TTh 11

171. Physical Chemistry — Chemical thermo-
dynamics : fundamental principles, Gibbsian equations, equilibrium conditions, phase rule, systematic deduction of equations, gases, solutions. Prerequisites: 3 or 5, Mathematics 10, 11, 21 (or equivalent) and Physics 51, 53, 54 and previous or concurrent registration in Physics 55 (or Physics 21, 23, 29 in the case of premedical students majoring in chemistry; see under “Minimum Requirements,” p. 209).
3 units, Aut (——) MWF 8

173. Physical Chemistry — Chemical thermodynamics (continued): electrochemical thermodynamics, especially the galvanic cell, conductance phenomena, colloid and surface chemistry. Prerequisite: 171.
3 units, Win (——) MWF 8
175. Physical Chemistry—Introduction to quantum mechanics and molecular structure. Prerequisite: 171.
   3 units, Spr (——) MWF 8

176. Physical Chemistry Laboratory—Vacuum, temperature control, electronic, and optical techniques used in the measurement of enthalpy changes, viscosity, surface tension, vapor pressure, electronic and vibration-rotation molecular spectra, optical rotation, solution conductance, reaction rates, and X-ray crystal scattering. Prerequisites: 116 and previous or concurrent enrollment in Chemistry 175.
   3 units, Spr (Pecora) lec. T 10; lab. TTh 1:15–4:05 or WF 1:15–4:05

177. Physical Chemistry — Introduction to kinetic theory, statistical mechanics, chemical kinetics, transport phenomena. Prerequisite: 175.
   3 units, Aut (——) MWF 11

181. Inorganic Chemistry — A systematic discussion of the chemistry of some of the nonmetallic elements, emphasizing the application of equilibrium, rate, and structural principles. Prerequisite: 175.
   3 units, Win (Taube) MWF 10

GRADUATE COURSES

Undergraduates may register for chemistry courses numbered 200 and above only if admitted to the Honors Program or if special permission has been granted by the instructor in the course.

221. Advanced Organic Chemistry — Lectures. Prerequisites: 125 and 175.
   3 units, Aut (Altman) M 10 and WF 9

223. Advanced Organic Chemistry — Continuation of 221. Prerequisite: 221, or permission of instructor.
   3 units, Win (Johnson) MWF 9

225. Advanced Organic Chemistry — Continuation of 223. Prerequisite: 223, or permission of instructor.
   3 units, Spr (Johnson) MWF 9

227. Selected Topics in Organic Chemistry — May be repeated for credit. Prerequisite: 225, or permission of the instructor.
   3 units, Aut (Djerassi) M 8–10 and W 8

229. Organic Chemistry Seminar — Attendance is required of all graduate students majoring in organic chemistry.
   1 unit, Aut, Win, Spr (Staff) Th 4

   2 units, Spr (Altman, Brauman) by arrangement

   2 units, Aut (Loring) TTh 9, alternate years, given 1968–69

251. Advanced Inorganic Chemistry—The chemistry of complex ions. Prerequisite: 181.
   2 or 3 units, Spr (——) TTh 10

253. Advanced Inorganic Chemistry — Selected topics. Prerequisite: 177.
   2 units, Aut (——) TTh 10

261. Thermodynamics of Irreversible Processes — (Enroll in Chemical Engineering 230A.) A course dealing with the main developments in the thermodynamic treatment of irreversible chemical and electrochemical processes, transport processes, coupling phenomena, etc., with special emphasis on topics and methods of interest to students of chemical engineering, physical chemistry, and related fields. Prerequisite: 173.
   3 units, Aut (Van Rysselbergh) by arrangement, alternate years, given 1969–70

263. Thermodynamics of Irreversible Processes—Complements 261; separately open to qualified students.
   2 units, Win (Van Rysselbergh) by arrangement, alternate years, given 1969–70

265. Electrochemical Concepts and Conventions—A survey of the fundamentals of electrochemistry. Prerequisite: 175.
   1 unit, Win (Van Rysselbergh) by arrangement, alternate years, given 1969–70

267. Electrochemical Thermodynamics and Kinetics—Thermodynamic treatment of reversible cells, electrodes; irreversible phenomena in electrochemical systems, kinetics of electrode processes, polarization and over-
voltage, Tafel law, electrochemical procedures in physical, analytical chemistry. Prerequisite: 175.

2 units, Win (Van Rysselberghe) TTh 9, alternate years, given 1968–69

269. Electrochemical Thermodynamics and Kinetics — Continuation of Chemistry 267. Prerequisite: 265 or 267.

2 units, Spr (Van Rysselberghe) TTh 9, alternate years, given 1968–69

271. Advanced Physical Chemistry—Quantum mechanics. Prerequisite: 175.

3 units, Aut (Harris) MWF 11


3 units, Win (——) MWF 11


3 units, Spr (——) MWF 11

277. Selected Topics in Physical Chemistry — May be repeated for credit. Possible topics include X-ray crystallography, advanced statistical mechanics, crystal field theory, advanced quantum mechanics, magnetic relaxation, advanced thermodynamics, chemical applications of group theory. Prerequisite: 275 or permission of instructor.

3 units, Aut, Win, Spr (Staff) MWF 10

279. Selected Topics on Macromolecules—Lectures. May be repeated for credit.

2 units, Aut (Flory) by arrangement

281. Chemical Physics—Lectures. Prerequisite: 175 or permission of instructor.

3 units, Aut (McConnell) MWF 9, alternate years, given 1969–70

283. Chemical Physics — Continuation of 281. Prerequisite: 281 or permission of instructor.

3 units, Win (McConnell) MWF 9, alternate years, given 1969–70

285. Chemical Physics — Continuation of 283. Prerequisite: 283 or permission of instructor.

3 units, Spr (McConnell) MWF 9, alternate years, given 1969–70

300. Department Seminar — Attendance is required of all graduate students, and all undergraduates registered for Chemistry 190.

1 unit, Aut, Win, Spr (Staff) M 4

RESEARCH AND SPECIAL ADVANCED WORK

190. Introduction to Methods of Investigation—For general character and scope, see Chemistry 200, below. Limited to undergraduate students admitted under the Honors Program or by special arrangement with a member of the teaching staff. Concurrent attendance in Chemistry 300 required.

(Staff) by arrangement

200. Research and Special Advanced Work — Properly qualified students are encouraged to undertake work of research, or other advanced laboratory work along lines not covered by courses already listed, under direction of any member of teaching staff with whom arrangement is made. For all such research and special work, students will register for Course 200 (or Course 190 if in undergraduate standing), giving name of staff member under whom work is carried on and number of units agreed upon. Prerequisite for 190 or 200 in biochemistry and organic chemistry: previous or concurrent registration in Chemistry 124.

(Staff) by arrangement

See also Senior Colloquia.

CLASSICS

Emeriti: Hermann F. Fränkel, Raymond D. Harriman (Professors)

Executive Head: Brooks Otis

Professors: Brooks Otis, Lionel Pearson, Antony E. Raubitschek, T. B. L. Webster

Associate Professor: Edwin M. Good (Religion and Hebrew)


The Department of Classics offers work in the Greek, Latin, and Hebrew languages and literatures, in Greek and Roman History and in Classical Archaeology. It aims to develop in the student three things: a competence in the classical languages, an appreciation, comprehension, and enjoyment of classical literature, and an understanding of the history and culture of the ancient world. The Department is interested both in students who wish to do their major work in Classics and in students who wish to relate
Classics to work in such other departments as English, Philosophy, History, and the Modern Languages. Study of the classics as a major subject equips students for teaching Latin and Greek in high school and college and is also an essential part of a liberal education.

The General Studies Foreign Language requirements can be fulfilled by courses in Greek, Latin, or Hebrew, the Basic requirement (for all students) by completing the work of the second year, as described below in Sections I, II and III, the Additional requirement (for the A.B. degree) by courses at the 100 level. Humanities 61 and courses marked # satisfy Area requirements in Humanities (Fine Arts or Literature).

ADMISSION TO THE DEPARTMENT

Students should enroll as majors in the Department as early as possible, since they must complete the second-year courses in Latin and Greek (Latin 23 or 28, Greek 23) or have reached an equivalent standard through work done elsewhere before they can be admitted to courses on the 100 level. Students interested in Greek should start at latest in the winter quarter of their sophomore year and if possible in their freshman year.

PROGRAMS OF STUDY

BACHELOR OF ARTS

The Degree of Bachelor of Arts in Classics may be taken either in 1: Classics (Latin and Greek), 2: Latin or Greek, or 3: Latin or Greek with a related minor.

A student's program of study should be prepared in advance after consultation with his Departmental adviser. Major students must register each quarter for at least one course in the major subject. A student interested in obtaining certification for teaching Latin in the State of California should consult the Head of the Department or his adviser.

1. Latin and Greek. 28 units in Latin courses and 28 units in Greek, all in courses at the 100 level or higher. At least 4 units at the 100 level in Latin composition and 4 units in Greek composition must be included, and, if recommended by the student's adviser, one or both of the 170 series (Latin 171–173; Greek 171–173). (This major is recommended for students who are interested in graduate work in Classics or in related fields such as Ancient History, Medieval History, Ancient and Medieval Philosophy, etc.)

2. Latin or Greek

a) Latin: 28 units in Latin courses, all at the 100 level or higher, including at least 4 units at the 100 level in Latin composition and, if recommended by the student's adviser, the 170 series (171–173); two courses in Roman history (111, 112); Humanities 61 or some work in Greek history or ancient art or some study of Greek.

b) Greek: 28 units in Greek courses, all at the 100 level or higher, including at least 4 units at the 100 level in Greek composition and, if recommended by the student's adviser, the 170 series (171–173) two courses in Greek history (102–102); Humanities 61 or some work in Roman history or ancient art or some study of Latin.

3. Latin or Greek with related minor. As in "(2)" above for (a) Latin or (b) Greek, with an additional minor program of 20 units in (a) Greek or (b) Latin or French, German, Italian, English, Philosophy or History.

COMBINED MAJORS

Students may with the consent of the Heads of departments concerned offer for the degree of Bachelor of Arts a combined major in Classics (Latin and/or Greek) and English, Classics and Philosophy, Classics and one or more modern languages, Classics and History. Students interested in such a major should consult the Heads of each of the departments concerned.

MINORS

The Department recommends for an undergraduate minor in Classics (Latin or Greek) the following: 20 units of Latin or Greek of which at least 12 shall be on the 100 level or above, and 4 units in related courses (Greek or Roman history, ancient art).

HONORS PROGRAM IN HUMANITIES

For acceptable majors in Classics an Honors Program in Humanities is offered, a description of which will be found under "Humanities Special Programs."
TEACHING CREDENTIALS

For information concerning the requirements for teaching credentials, consult the “School of Education” section of this bulletin and the Credential Secretary, School of Education.

ROME CLASSICAL CENTER

There will be an opportunity for some Classics majors to attend the Intercollegiate Classical Center at Rome. The program in Rome is specially designed for classical undergraduates. The Center is managed by Stanford University for 30 constituent colleges and universities including Stanford. It is open to Stanford majors in Classics (see the Center brochure) and all courses given in the Center receive full credit at Stanford and count toward a Stanford major in Classics. The courses presently given at the Center with the numbers used on Stanford Class cards are:

<table>
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<tr>
<th>Course</th>
<th>Units</th>
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<tr>
<td>CL O 2nd Year Greek</td>
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<tr>
<td>CL L Latin Readings</td>
<td>4</td>
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<tr>
<td>CL G Greek Readings</td>
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<tr>
<td>CL A Art and Archaeology</td>
<td>3</td>
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<tr>
<td>CL H Ancient History</td>
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All students interested in this program should consult the Head of the Department.

ADVANCED DEGREES

MASTER OF ARTS

Students may, under very exceptional circumstances, be accepted as candidates for the degree of Master of Arts who have completed an undergraduate major in Classics (Latin and/or Greek) or its equivalent. The requirements for the degree are:

1. Satisfactory demonstration of competence in Greek and/or Latin composition.

2. Attainment of a standard of scholarship such as would normally be reached by three quarters of study in the Department after fulfilling the requirements for an undergraduate major in the Department. This would normally mean the completion of at least 18 units of graduate courses and 18 units of work at the 150 or 170 levels.

3. The satisfactory completion of one Greek course at the 100 level (if his undergraduate major has been Latin) or one Latin course at the 100 level (if his undergraduate major has been Greek).

4. The passing of an examination testing the candidate’s ability to translate into English from a selected list of Greek or Latin authors.

5. The writing of a thesis.

6. A reading knowledge of French or German is required.

Second-year graduate students, and in some cases first-year students, who are candidates for the Ph.D. degree, may also (on the recommendation of the Department) become candidates for the A.M. degree. In their case the thesis requirement above will be waived provided that they have completed some work beyond the course requirements listed under 2 and 3 above.

DOCTOR OF PHILOSOPHY

University regulations regarding admission and application for candidacy are discussed in the section “Degrees” of this Bulletin.

All candidates for the Ph.D. degree in Classics must fulfill the following requirements:

1. They must complete at least three years (nine quarters) of full-time work, or equivalent, in study beyond the Bachelor’s degree. At least 72 approved units in graduate courses or seminars at 170 level or above must be completed in addition to the doctoral dissertation. At least three consecutive quarters of graduate work and the final units of credit in the program must be taken at Stanford. More detailed information on the Advanced Degree Program is available in mimeographed form in the Classics Department Office.

2. Candidates will be required to pass examinations as follows:

   a) Reading examinations in French and German.

   b) Examinations in translation into English from Greek and Latin authors included in an approved list (drawn up by the Department and available from the Department secretary).

   c) A final written examination in two classical authors (one Greek and one Latin) and in two fields, one of which must be historical. Each student must submit a syllabus for each author and each field. The examination will be drawn up on
the basis of this syllabus after it has been approved by the Department.

d) A colloquium on the candidate's dissertation and an oral examination on two or more special topics, such as selected authors or selected aspects of Greek or Roman literature, history, archaeology, philosophy, epigraphy or palaeography.

e) Candidates must pass examinations in Latin and Greek Composition unless they receive a grade of A in one quarter of Advanced Greek and Latin Composition (Greek 205, Latin 205) or a grade of B in two consecutive quarters of the same.

3. The examinations in translation from Greek and Latin authors will normally be taken in the autumn term of the second or third year of graduate work, the final written examination in the spring term of the same year, the dissertation colloquium and special topics examination in the spring following. The period between the translation and final written examinations will be devoted largely to an intensive preparation for the latter examination, during the course of which candidates will be expected to make full use of relevant secondary material in modern languages. They should therefore plan to satisfy the requirements in composition and French and German as soon as possible, preferably before the time of the translation examination. Except in very special circumstances they will not be allowed to take the final written examination until the other three sets of examinations have been successfully completed.

4. Each candidate (not later than the end of the quarter in which he takes his final written examination) must submit to the Executive Head of the Department a statement of his dissertation topic as approved by his dissertation committee. This committee will normally be appointed (for each candidate) by the Executive Head of the Department at least one quarter before his dissertation topic is due to be submitted. At the same time or earlier a senior member of the Department will be appointed as the candidate's adviser who will thereafter supervise the candidate's writing of the dissertation. An acceptable dissertation must be a genuine contribution to classical scholarship and should be written in an acceptable style. All theses must be written in English.

Minor for the Degree of Doctor of Philosophy—The Department recommends for a graduate minor at least 18 units in Latin or Greek at the 100 level or above, and at least one course at the graduate (200) level. Greek or Latin 171-173 are strongly recommended.

Graduate Program in Humanities

The Department of Classics participates in the Graduate Program in Humanities leading to the degree of Doctor of Philosophy. For a description of that program see the section "Humanities Special Programs" in this bulletin.

Note—So far as possible, names of instructors are given for each course, but some changes, especially in more elementary courses, are inevitable.

I. COURSES IN GREEK

FIRST- AND SECOND-YEAR COURSES

Students may begin the study of Greek in autumn quarter with the series of courses 1-3, or in winter quarter with the series 1A, 1B, which is intended to cover approximately the same ground at a faster pace. Those with some knowledge of Greek should consult a member of the Department to determine at what stage they should start their work. In the second-year courses some meetings will be devoted to grammar and composition exercises.

The General Studies Basic Languages requirement can be fulfilled by successful completion of 23, with 8 units of second-year work. The following table shows the sequence of courses offered each year:

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<tr>
<th>Term</th>
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#1. First-Year Greek—For beginners.

4 units, Aut (Moore) MTWF 10

#2. First-Year Greek—Continuation of 1.

4 units, Win (Moore) MTWF 10

#3. First-Year Greek—Continuation of 2.

4 units, Spr (Moore) MTWF 10

#1A. First-Year Greek—Accelerated course.

5 units, Win (Berg) MTWThF 1:15
#1B. First-Year Greek — Continuation of 1A.
5 units, Spr (Berg) MTWThF 1:15

#22. Second-Year Greek — Xenophon, Plato.
3 to 4 units, Aut (Mellor) TTh 10 and one hour by arrangement

#23. Second-Year Greek — Homer, Odyssey.
3 to 4 units, Win (Mellor) TTh 10 and one hour by arrangement

1 to 2 units, by arrangement

#100. Second-Year Greek—Homer, Iliad.
3 to 4 units, Spr (——) TTh 10 plus one hour by arrangement

THIRD- AND FOURTH-YEAR COURSES

The series 101–103 is offered every year. 151–153 and 161–163 are offered in alternate years and may be taken in succession.

#101. Tragedy—Euripides or Sophocles.
3 to 4 units, Aut (Webster) MWF 10

#102. Tragedy—Continuation of 101.
3 to 4 units, Win (Wigodsky) MWF 10

#103. Attic Prose: The Orators.
3 to 4 units, Spr (Raubitschek) MWF 10

105. Greek Composition, Elementary.
2 units, Aut (Berg) TTh 1:15

115. Greek Composition, Intermediate.
2 units, Win (Berg) TTh 1:15

151. Thucydides.
3 to 4 units, Aut (Pearson) TTh 11 plus one hour by arrangement, given 1969–70

152. Herodotus.
3 to 4 units, Win (Raubitschek) TTh 11 plus one hour by arrangement, given 1969–70

153. Aristophanes.
3 to 4 units, Spr (——) TTh plus one hour by arrangement, given 1969–70

155. Greek Composition, Advanced.
2 units, Spr (——) by arrangement, given 1969–70

160. Individual work.
By arrangement

161. Hesiod and Aeschylus.
3 to 4 units, Aut (Moore) MWF 10

162. Plato and Aristotle.
3 to 4 units, Win (Otis) MWF 10

163. Plato and Aristotle — Continuation of 162.
3 to 4 units, Spr (Moore) MWF 10

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

171. History of Greek Literature: Epic and Lyric.
4 units, Aut (Webster) MWF 1:15

172. History of Greek Literature: Comedy, Tragedy.
4 units, Win (Moore) MWF 1:15

4 units, Spr (Raubitschek) MWF 1:15

See also Courses (Latin and Greek) listed under VII.

GRADUATE COURSES

4 units, Spr (Otis) by arrangement

204. The Constitution of Athens.
4 units, Aut (Raubitschek) by arrangement

205. Prose Composition for Graduates.
2 units, Aut, Win, Spr (Pearson) by arrangement

206. Homer.
4 units, Aut (Webster) by arrangement

207. Plutarch and Contemporaries.
4 units, Win (Pearson) by arrangement

208. Archaeology and Greek Drama.
4 units, Win (Webster) by arrangement

209. Thucydides.
4 units (Raubitschek) by arrangement

4 units, Spr (Webster) by arrangement

212. Menander.
4 units, Spr (Webster)
213. Pindar.
   4 units (Pearson) by arrangement

214. Topography of Athens.
   4 units, Aut (Raubitschek) by arrangement

260. Directed reading.
   By arrangement


300, 302. Greek Seminar.
   301. 4 units, Aut (Raubitschek)
       by arrangement
   302. 4 units, Spr (Raubitschek)
       by arrangement

See also Classics 201, 207, and 208.

II. COURSES IN LATIN

FIRST- AND SECOND-YEAR COURSES

A placement test will be set for freshmen in the autumn (and for other students by arrangement) to determine at what stage they should begin; they will be ranked as follows on the basis of the test:

1. General Studies Basic requirement completed—eligible for third-year course.
2. 3 units needed to complete requirement.
3. More elementary work needed.

#5. Accelerated Course in Elementary Latin.
   5 units, Aut (——) MTWThF 12-1

#6. Accelerated Course in Elementary Latin—Continuation of 5.
   5 units, Win (——) MTWThF 12-1

   5 units, Spr (——) MTWThF 12-1

#23. Introduction to Latin Poetry.
   3 units, Spr (Davis) MWF 9

109. Christian or Medieval Latin Authors—Prerequisite: 7, 23, or equivalent.
   3 units, Spr (——) by arrangement

THIRD- AND FOURTH-YEAR COURSES

The series 151–153 and 161–163 will be offered in alternate years and may be taken in successive years.

#101, 102, 103. The Augustan Age — Horace, Virgil, Livy.
   101. 3 to 4 units, Aut (Pearson) MWF 9
   102. 3 to 4 units, Win (Otis) MWF 9
   103. 3 to 4 units, Spr (Otis) MWF 9

105. Latin Composition, Elementary.
   2 units, Aut (——) by arrangement

   2 units, Win (——) by arrangement

#151. The Letters of Cicero and Pliny.
   3 to 4 units, Aut (Berg) given in 1969-70

#152. Cicero, Oratory.
   3 to 4 units, Win (Pearson) given 1969-70

#153. Roman Comedy or Satire.
   3 to 4 units, Spr (Wigodsky) given 1969-70

155. Latin Composition, Advanced.
   2 units, Spr (——) by arrangement

160. Individual Work.
   By arrangement

#161. Lucretius.
   3 to 4 units, Aut (Wigodsky)

   3 to 4 units, Win (Berg)

#163. Tacitus.
   3 to 4 units, Spr (Mellor)

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

170. Teachers' Course.
   3 units, by arrangement

   4 units, Aut (Wigodsky) MWF 9

   4 units, Win (——) MWF 9

   4 units, Spr (Berg) MWF 9
GRADUATE COURSES

4 units (Wigodsky) by arrangement
204. Horace: Satires and Epistles.  
4 units (Wigodsky) given 1969–70
205. Prose Composition for Graduates.  
2 units, Aut, Win, Spr (Devine) by arrangement
212. Ancient Pastoral.  
4 units, Spr (Berg) by arrangement
214. The Counter-Epic: Ovid, Lucan.  
4 units (Otis) by arrangement
215. Lucretius.  
4 units, Spr (Wigodsky) by arrangement
216. Cicero and His Age.  
4 units (Pearson) by arrangement
220. The Second Century A.D.  
4 units, (Mellor) by arrangement
260. Directed Reading.  
By arrangement
301, 302. Latin Seminar.  
301. 4 units, Win (Otis) by arrangement
302. 4 units, Spr (Otis) by arrangement
See also Classics 201, 207, and 208.

III. COURSES IN HEBREW

#1. First-Year Hebrew — Introduction to classical Hebrew language, emphasizing reading ability in various styles as found in the Hebrew Bible.  
5 units, Win (Good) MTWThF 9
#2. First-Year Hebrew — Continuation of 1.  
5 units, Spr (Good) MTWThF 9
#22. Second-Year Hebrew — Advanced reading in the Hebrew Bible, with particular attention to poetry and poetic structure, critical analysis, and methods of interpretation.  
4 units, Aut (Staff) by arrangement
4 units, Win (Staff) by arrangement
4 units, Spr (Good) by arrangement

IV. COURSES IN CLASSICAL LITERATURE AND CIVILIZATION

No knowledge of Greek or Latin is required for these courses.

#161. The Classical Epic: Homer, Apollonius, Virgil—A study of the epic in respect to structure, character, theme, and imagery.  
3 units, Aut (——) MWF 2:15
#162. Greek Tragedy: Aeschylus, Sophocles, Euripides, and later writers—A study of the history, social function, and development of ancient tragedy.  
3 units, Win (Webster) MWF 11
#164. Plato — The meaning of Plato’s thought will be discovered in the dramatic form of selected dialogues as well as in direct philosophical statement.  
3 units, Spr (Moore) MWF 11
#171. Greek Religion—The origins and development of Greek religious phenomena from Mycenae to Byzantium.  
3 units, Aut (Berg) MWF 1:15, given 1969–70
#172. Classical Influences in Modern Literature — Themes from classical myth and history in selected Renaissance and later writers, parallel readings from ancient literature.  
3 units, Win (Wigodsky) MWF 1:15
#173. Classical Political Theory—Ancient political ideas (Plato, Aristotle, Polybius, Cicero) and their impact on modern theory.  
3 units, Spr (Raubitschek) MWF 11
#174. Roman Law and Political Institutions—An introductory study of Roman private and public law: the family, the administration of justice, the practice of government.  
3 units, Spr (Pearson) MWF 1:15, given 1969–70

V. COURSES IN GREEK AND ROMAN HISTORY

The series 101, 102, 103 and 111, 112, 113 will be offered in alternate years and may be taken in succession.

101. Greek History, I—The Greek city states
from earliest times down to the age of Pericles and the Peloponnesian War.

4 to 5 units, Aut (Pearson) MTWTh 2:15

102. Greek History, II—The end of Athenian supremacy, the rise of Macedon, Alexander the Great, the Hellenistic age.

4 to 5 units, Win (Pearson) MTWTh 2:15

104. Greek History, III — A more specialized course for students with some previous study of Greek history: the Peloponnesian war (413-404 B.C.).

4 to 5 units, Spr (Pearson) MTWTh 2:15

111. Roman History, I—The Roman republic from earliest times to the age of Cicero and Caesar.

4 to 5 units, Aut (Mellor) TWTh 2:15 plus one hour by arrangement, given 1969-70

112. Roman History, II — The Roman empire, from the age of Augustus to the death of Constantine.

4 to 5 units, Win (Mellor) TWTh 2:15 plus one hour by arrangement, given 1969-70

114. Roman History, III — A more specialized course for students with some previous study of Roman History.

4 to 5 units, Spr (Mellor) TWTh 2:15 plus one hour by arrangement, given 1969-70

For more advanced students—especially for majors and graduate students in Classics or History—work will be offered on an individual basis:

201. Individual Work in Greek History.
   By arrangement

202. Individual Work in Roman History.
   By arrangement

VI. COURSES IN ARCHAEOLOGY

#101. Greek mythology in Greek Art.
   2 units, Aut (Webster) M 11

#102. Classical Greek Painting and Sculpture.
   2 units, Win (Webster) M 11

#103. Hellenistic Painting and Sculpture.
   2 units, Spr (Webster) M 11

Additional work in the Museum can be arranged.

#105. Art and Monuments of the Romans.
   3 units, Spr (Wigodsky), given 1969-70

See also Art Department.

VII. GENERAL COURSES

201. Introduction to Classical Scholarship.
   3 units, Aut (———) by arrangement

207, 208. Comparative Grammar of Greek and Latin.
   207. 4 units (Devine) by arrangement
   208. 4 units (Devine) by arrangement

COMMUNICATION

Emeritus: Chilton R. Bush (Professor)
Executive Head: Clifford F. Weigle
Director, Institute for Communication Research: Wilbur Schramm
Director, Professional Journalism Fellowship Program: Herbert Brucker. Assistant to the Director: Harry N. Press
Associate Professor: Edwin B. Parker
Instructor: Janet K. Voelker
Lecturers: Jules Dundes, Lyle M. Nelson, Templeton Peck

The Department of Communication engages in research in communication and offers a curriculum which prepares its students for careers in print and broadcast journalism, documentary film, and communication research.

The main objectives of the professional curriculum are to provide a broad program in the social and humanistic studies; to present courses in the processes and effects of communication, and to equip the student with professional values.

A secondary objective is to provide that amount of training in skills and techniques that will sustain the student's interest in his
chosen profession and will assist him in beginning his career.

The technical courses provide not only practice but a content that is an application of some of the principles of the behavioral sciences and humanities. The technical curriculum in this sense is like the curricula of the Schools of Medicine and Engineering which apply the principles of the biological and physical sciences.

ADMISSION

Undergraduate students who have been admitted by the University are accepted as majors provisionally for one quarter. Thereafter, the student's record is reviewed quarterly by the Department.

Undergraduate majors must enroll in the Department not later than the start of the second quarter of their junior year; this requirement may be waived for applicants entering the Department not later than the start of the first quarter of their senior year, provided that they have a University grade-point average of 3.0 or higher.

Students who wish an undergraduate minor in the Department may arrange for a suitable sequence of preprofessional courses.

Prospective undergraduate students should write the Office of Admissions.

Prospective graduate students should write to: Executive Head, Department of Communication, Redwood Hall, Stanford University, Stanford, California 94305.

The Department requires that applicants for graduate admission include verbal and quantitative scores from the Graduate Record Examination (area scores are optional). Applicants who hope to work toward a Ph.D. are also required to submit scores from the Miller Analogies Test. These test requirements may be waived after written petition to the Department only if exceptional circumstances prevent the applicant from taking the tests.

PROGRAMS OF STUDY

BACHELOR OF ARTS

Two Bachelor of Arts degree programs are offered, one in Journalism and one in Broadcasting and Film. Requirements are as follows:

1. Two courses in general or English literature; Psychology 1; Sociology 1 or Anthropology 1. In addition, Journalism students are required to take Economics 1 and Political Science 1 and 10 or 20. (The student who wishes to take both Political Science 10 and 20 may substitute 15A and 15B.)

2. A unified program totaling not less than 20 units of courses numbered 100 or higher shall be arranged, with the approval of the adviser, from one or two other departments such as Anthropology, Art, Economics, English, History, Music, Philosophy, Political Science, Psychology, Sociology, or Speech and Drama.

3. Undergraduate majors must have a grade point average of 2.50 or higher in Communication Department courses in order to receive the departmental recommendation for graduation.

4A. Broadcasting and Film: Communication 1, 100, 101; 123; 141, 142, and 180.

4B. Journalism: Twenty-five to thirty units in communication of which the following courses are required: 1, 50, 51, 107, 108, 140, and 169. In addition, the student preparing for newspaper or press association editorial work will take Communication 175; the student interested primarily in writing for consumer magazines and industrial publications will take Communication 150.

While the Department offers no courses in such subjects as science reporting, technical writing, or public relations, appropriate programs of study can be arranged for interested students. For example, a prospective science writer could be permitted to substitute a unified program of courses in the physical sciences in lieu of requirement "2" above.

Majors in Communication may elect one of the following interdisciplinary honors programs:

Humanities Undergraduate Honors Program
Social Sciences (Honors Program in Social Thought and Institutions)

COMMUNICATION HONORS PROGRAM

In addition to the regular undergraduate programs in communication, a Communication Honors Program is designed for those exceptionally able students who wish, in their major, to pursue an intensive and somewhat independent study of communication. This program is directed toward the integra-
tion of a substantial body of theoretical and factual information and the development of both communication skills and creative scholarly skills by independent study, tutorial guidance, small seminars, and research experience. Particular emphasis is placed on the planning of an individual program for the student that will combine his specialized interests with a body of basic knowledge about communication processes. The plan will be aimed at helping the student prepare for a comprehensive examination to be taken in the final quarter of his senior year, over his entire area of communication study. The plan will include arrangements for continuous supervised work in communication skills or in communication research. A report of the work done under this plan will be submitted as an undergraduate thesis at the end of the next to final quarter of the student's senior year. It is possible for a student to elect both the Communication Honors Program and one of the three interdisciplinary honors programs listed above.

**Master of Arts**

The Master of Arts degree is awarded by the Department in the fields of Journalism, Broadcasting and Film, or Communication Research. Requirements are as follows:

1. The candidate must earn 45 units in graduate residence at Stanford; he must be enrolled as a major in the department for at least two quarters; he must earn an average grade of B on his entire program of study. An independent project under the direction of a major professor must be undertaken. Three to six hours of credit in independent study may be applied to this requirement. A report of the project must be made to the professor directing the independent study. A candidate may petition the Department by the end of the second week of the second quarter for permission to submit the report as a thesis.

2. A unified program of advanced course work is to be arranged with the approval of the adviser. This includes appropriate grounding in research methodology and communication theory and training in one or more communication media.

3. Students in Broadcasting and Film, upon completion of academic work, including the independent project, may be required to pass a comprehensive written examination, after which they spend a three-month internship with a professional film or broadcasting organization. (No tuition is charged for the internship period.) Academic work will include 100, appropriate 105 and 110 courses, 208, 209, 210, 215 and 220.

4. Students in the Journalism A.M. program with neither undergraduate journalism instruction nor professional experience are required to take: Communication 50, 51 (not for graduate credit), 107, 108, 140, 169, 150 or 175, 207, 215, 220, two quarters of 225, and 309. Remainder of the program is to be a cohesive group of courses from one or two related fields. Students with undergraduate journalism training or media experience should check with their advisers to determine which of the above departmental courses will be required.

No particular specialization in undergraduate work is expected of a candidate. Special programs of study may be arranged for individual candidates, which will take account of the nature of their previous preparation.

**Doctor of Philosophy**

The Department offers the Doctor of Philosophy degree in Communication, with programs in Communication Theory and Research, in Developmental Communication and in Public Affairs Communication. All of these degrees are designed primarily for persons interested in teaching and research careers.

In addition to fulfilling the course and residence requirements for the degree, all Ph.D. candidates are required to:

1. Complete requirements for a Master's degree in Communication, and complete a research project. Holders of the Master's degree may be excused from this first year research requirement if the faculty feels that the previous research has been sufficient.

2. Pass a comprehensive written examination in the subjects required of all candidates and in the area of advanced specialty of the particular candidate.

3. Demonstrate reading knowledge of a foreign language. Except by special permission, this language will be Russian, French, or German.

4. Pass the University oral examination, which may be either a comprehensive examination covering the same areas as the
written examination or a defense of the dissertation.

5. Complete pre-dissertation research project (in addition to the Master's or first-year research requirement) or obtain equivalent research experience sufficient to demonstrate research competence.

6. Have at least one year of work experience in the mass media if they are doctoral candidates in Public Affairs Communication, or, if they are doctoral candidates in Communication Research, have at least one year of work experience in the mass media or another communication activity, prior to writing the dissertation.

7. Complete a dissertation satisfactory to an advisory committee of three or more members and to the University Committee on the Graduate Division.

The following are examples of standard Ph.D. programs in Communication Theory and Research and in Developmental Communication:

1. Communication Theory
   Comm. 211. Theory of Communication I
   Comm. 212. Theory of Communication II
   Comm. 213. Theory of Communication III

2. Methodology
   Comm. 217. Communication Research Methods I
   Comm. 218. Communication Research Methods II
   Comm. 219. Communication Research Methods III
   Comm. 275. Communication Research: Content Analysis and Scaling
   C.S. 126. Computing in the Social Sciences and Humanities
   Comm. 309. First-Year Research Project
   Comm. 319. Pre-Dissertation Research Project

3. Statistics
   Psych. 60. Statistical Methods
   Psych. 151. Statistical Methodology
   Psych. 152. Analysis of Data

4. Experimental Psychology (at least two of the following: Psych. 103A and Psych. 103E are strongly recommended)
   Psych. 103A. Experimental Psychology: Higher Mental Processes
   Psych. 103B. Experimental Psychology: Perception
   Psych. 103C. Experimental Psychology: Learning
   Psych. 103D. Experimental Psychology: Social Processes
   Psych. 103E. Experimental Psychology: Social Psychology

5. Psychology (at least two courses in social psychology, at least one in learning theory, and at least one in personality or motivation). Example courses are:
   Psych. 212. Advanced Social Psychology
   Psych. 213. Advanced Personality
   Psych. 220. Human Motivation
   Psych. 251. Seminar in Personality Theory and Assessment
   Psych. 254. Principles of Personality Change I
   Psych. 261. Seminar in Social Psychology
   Psych. 262. Seminar in Verbal Behavior
   Psych. 264. Seminar in Learning Theory
   Psych. 267. Seminar in Person Perception

6. Sociology (at least two graduate level courses in Sociology)
   Example courses are:
   Sociol. 104. Interpersonal Behavior
   Sociol. 131. Advanced Social Psychology
   Sociol. 217. Problems in Theoretical Analysis
   Sociol. 250. Basic Problems in Sociological Theory
   Sociol. 253. Theory Construction
   Sociol. 264. Seminar in Socialization and Social Control
   Sociol. 268. Concepts and Operations in Sociological Analysis
   Sociol. 279. Problems in Study of Social Influence
   Sociol. 285. Problems in the Analysis of Social Stratification

Candidates in Developmental Communication will complete a dissertation in the area of how people, as they mature, learn to use and, in turn, are influenced by the mass media. They need not take courses in social psychology, but, in addition to the courses suggested in the above program they are required to take:

7. Developmental Communication
   Comm. 231. Developmental Communication I
Comm. 232. Developmental Communication II
Comm. 233. Developmental Communication III

8. Developmental Psychology
Psych. 211. Advanced Developmental Psychology
Psych. 246. Methods in Developmental Research

9. Psychology
Psych. 146. Language and Thought
Psych. 213. Advanced Personality
Psych. 220. Human Motivation

Preparation for examinations and for the dissertation for students in the above two programs should include selected courses from among the following:

Comm. 220. Mass Communications in Society
Comm. 255. International Communication
Comm. 256. Communication in Economic and Social Development
Psych. 209. Advanced Perception
Bus. 475, 476. Small Groups I, II
Psych. 253. Psychopathology
C.S. 224. Computer Simulation of Cognitive Processes
C.S. 225. Artificial Intelligence
C.S. 248. Computational Linguistics
Phil. 157A,B. Logic
Phil. 164. Philosophy of Science
Anthro. 167. Language and Culture
Anthro. 158. Culture and Personality
Pol. Sci. 312. Research Seminar on Comparative Politics

Other courses and special advanced reading courses may be selected in conference with the adviser.

The following is an example of the Ph.D. program required in Public Affairs Communication:

1. Communication Theory
Comm. 211, 212. Sequence in Communication Theory

2. Structure and Function of the Mass Media
Comm. 220. Mass Communications in Society
Comm. 225. Problems of the Mass Media (at least two quarters)
Comm. 230. Mass Media and Government
And at least two among the following:
Comm. 240. Seminar in Mass Media History
Comm. 245. Economics of the Mass Media
Comm. 255. International Communication
Comm. 256. Communication in Economic and Social Development

3. Methodology
Comm. 217, 218. Sequence in Research Methods
Comm. 227. Analysis of Documentary Evidence
Comm. 309. First-Year Research Project
Comm. 319. Pre-dissertation Research Project

4. Statistics
Psych. 60. Statistical Methods, or Stat. 50. Elementary Statistics
One other statistics course

5. Law
Law 104. Law in Society

6. Political Science, History, Economics — a unified program of five courses in one of these fields and two courses in one or both of the others. Examples of subject areas and courses:

Political Behavior and Politics:
Pol.Sci. 181. Attitude Formation and Voting Behavior
Pol.Sci. 184. Legislative Behavior
Pol.Sci. 185. Political Parties
Pol.Sci. 382A,B. Research Seminar in American Politics

Political Theory:
Pol.Sci. 152. Modern Political Thought
Pol.Sci. 158. Theoretical Foundations of Political Sociology

Public Law:
Pol.Sci. 170 (270). The Supreme Court and the Constitution
Pol.Sci. 173 (273). Civil Liberties in the U.S.

Modern European History:
Hist. 32. Twentieth Century Europe
Hist. 122A,B. Russian Foreign Relations
Hist. 210 to 225. Graduate seminars in European History
United States History:
Hist. 166, 167. American Intellectual History
Hist. 168, 169. American Social History
Hist. 250 to 260. Graduate Seminars in U.S. History
Economics—History, International and Comparative, Industrial:
Econ. 116. Economic History of the United States
Econ. 118. Underdeveloped Economics
Econ. 120. Comparative Economic Systems
Econ. 158. Organization and Social Control of Industry
Econ. 165. International Economics
Econ. 200. Topics in the History of Economic Thought

Among other relevant possible areas of concentration are: Comparative Politics, International Relations, Public Administration; East Asian, Middle Eastern and Latin American History; Core Theory of Economics. (Students specializing in any area of economics will need to have the equivalent of at least Econ. 1, 105A and 110A for most advanced courses in that department.)

7. At least two courses from the above or other departments chosen in consultation with an adviser, in preparation for the degree examinations and the dissertation. This requirement is designed especially for students who have not concentrated in the social sciences as undergraduates or as graduate students in other programs.

Ph.D. candidacy expires five years after admission to candidacy by the University Committee on the Graduate Division. Reapplication will require reexamination.

Other programs leading toward the Ph.D. and involving communication may be pursued in the Graduate Division Special Programs. Such programs are individually planned for unusually well-qualified students.

One example would be an Information Science program involving communication and computer science. Applicants for such special programs must first be admitted to a Stanford department. Inquiries about programs involving communication should be directed to the Communication Department.

Minor for the Degree of Doctor of Philosophy—Candidates for the degree of Doctor of Philosophy in other departments who elect a minor in Communication will be required to complete a minimum of 15 units of graduate courses in the Communication Department, including one research methods course and either Communication 211 or Communication 212. The Communication 217 requirement may be waived when comparable research methodology courses have been taken in some other department. The remainder of the course program will be adapted to the particular needs of each candidate.

THE INSTITUTE FOR COMMUNICATION RESEARCH

The Institute for Communication Research operates as an office of project research for the faculties of the Department of Communication and other departments, on grants from foundations, communication media, and other agencies, on government contracts, and on its own funds. A few research assistantships are available to qualified graduate students. Among the qualifications which will be highly valued in applicants are high scholarship, training in the behavioral sciences (preferably psychology and sociology, including training in statistics and research methodology), and training for or experience with the mass media. For further information about the Institute write to the Director.

COURSES OPEN TO UNDERGRADUATES AND GRADUATES

I. GENERAL


5 units, Win (Maccoby) MTW 10 and section
70. Introduction to Survey Research — An introductory course in survey research methods. Formulation of problems, study design, sampling, interviewing, data processing and analysis, and writing of reports of public opinion surveys. Designed primarily for undergraduate non-majors. Prerequisite: Psychology 60 or equivalent.
3 units, Spr (Maccoby)

190. Comparative Communication Systems — Foreign press, broadcasting, and film: their control and support; their relations to economic and social development, political systems, and cultural patterns; and their roles in public opinion and national policy.
4 units, Spr (——) by arrangement, given 1969-70

199. Individual Work—Major students with high academic standing are permitted to undertake individual work.
1 to 4 units, any quarter (Staff) by arrangement

II. JOURNALISM

50. Editorial Techniques I — Theory and techniques of news communication for newspapers and radio-TV; analysis of journalist’s audience; representative media; journalistic vocations. To be taken concurrently with Communication 51. Open to non-majors.
3 units, Aut (Stewart) TWTh 11
Spr (Grey) MWF 9

51. Editorial Techniques I Laboratory — Practice in news writing. Weekly conferences, laboratory, outside assignments. To be taken concurrently with Communication 50. Open to non-majors. Prerequisite: typing skill of 35 words per minute.
1 unit, Aut (Stewart) by arrangement
Spr (Grey) by arrangement

107. Editorial Techniques II — Copy editing, headline writing, news display, illustration, typography, printing processes. To be taken concurrently with Communication 108. Prerequisites: 50 and 51.
3 units, Win (Weigle) MWF 9

2 units, Win (Grey) by arrangement

140. History of Anglo-American Journalism — Open to non-majors.
3 units, Aut (Weigle) TTh 9

150. Forms of Journalistic Writing — Practice in writing magazine articles, with emphasis on marketing manuscripts. Conferences. Prerequisites: 50 and 51.
3 units, Win (Stewart) TTh 1:15

152. Magazine Editorial Techniques—Planning, writing, production studied with local magazine editors, correspondents; industrial editing. Prerequisite: 150.
3 units, Spr (Rivers) Th 4:15-6:05, given 1969-70

169. Legal Aspects of Journalism — Libel, contempt, constitutional guaranties, privacy, copyright, inspection of public records. Open to non-majors.
3 units, Spr (Grey) MW 11

175. Reporting of Public Affairs — Local, state, federal courts; municipal, state, federal administration in the local community. Open only to major students with senior or graduate standing.
4 units, Win (Grey) MWF 10

Practice Courses

121. Advanced Practice — Practice work in executive positions on editorial or business staff of The Stanford Daily, Quad, and Chaparral; weekly conferences. Open to undergraduate Communication majors who qualify by election or appointment; not open to graduate students. Students limited to total of 7 units credit. Credit may not be offered in fulfillment of Communication unit requirements for degrees in Communication.
1 to 2 units, each quarter (Weigle) by arrangement

183. San Francisco Newspaper Practice — Majors who have made a high record in their entire program, and especially in 175, are permitted to work in San Francisco in the senior or graduate year, by arrangement with San Francisco newspapers. Work is under supervision of San Francisco newspapermen and faculty of the Department.
5 units, Spr (Weigle) by arrangement

III. BROADCASTING AND FILM

100. Visual and Aural Communication Techniques—An investigation of the techniques of film, television, and sound from
the standpoint of the communication of ideas. Students will produce short still picture, film, television and sound assignments. No previous knowledge of the media is required. This course is a prerequisite for all further production work in film and television. (Open only to graduate students in Autumn Quarter.)

5 units, Aut, Win (Breitrose, ———) MW 1:15–3:05

101. Film Aesthetics—A systematic examination of the nature of the film medium, and of attempts to construct theories of film. Attention is given to the problems of aesthetics and communication from the viewpoints of practitioner, critic, and audience.

4 units, Aut (Breitrose) MWF

105B. Television Production I—Production and direction of documentary television programs. Prerequisites: 100, 123.

4 units, Win (graduate students only) (——) MW 1:15–3:05

Spr (open to undergraduates) (——) MW 1:15–3:05

105C. Film Production I — A beginning course in which students produce their own short films. Prerequisites: #100 and consent of instructor.

4 units, Win (——) TTh 10–12

110B. Television Production II—Prerequisite: 105B.

3 units, given 1969–70

110C. Film Production II — Primarily for graduate students producing film projects for a degree. Admission by recommendation of instructor only. Prerequisite: 105C.

4 units, Spr (——) Th 1:15–4:05

111. Film and Television Directing—Theory and technique of directing actors and non-actors for film and television. Prerequisites: 100, 105B, 105C, 123.

3 units, Spr (——) by arrangement

123. Writing for Broadcasting and Film I—Techniques of research and writing for the visual media.

3 units, Aut (Voelker) TTh 10–12

124. Writing for Broadcasting and Film II—Structure and style in the construction of factual film and television scripts. Prerequisite: 123.

3 units, Win (Voelker) MW 1:15–3:05

125. Writing for Broadcasting and Film III—Seminar in dramatized documentary and fictional forms of film and television scripts. Prerequisite: consent of instructor.

3 units, Spr (Voelker) TTh 10–12

141. History of Film—Studies in the development of the motion picture as an art form and a means of communication. Lab.: Screenings of films announced in class.

4 units, Win (Breitrose) MWF 9;

lab. by arrangement


3 units, Win (Voelker) TTh 9

180. Broadcasting and Film Criticism — The techniques and role of criticism based upon the objectives and potential of these media. For advanced students. Prerequisite: 141 or 142 and consent of instructor.

3 units, Spr (Breitrose) MWF 11

Summer Broadcasting and Film Institute

(See Summer Session Bulletin for 1969.)

COURSES FOR GRADUATES


3 units, Aut (——) W 2:15–4:05

204. Communication Theory — Readings and conferences. By permission of the instructor.

3 units, Aut, Win, Spr (Schramm, Staff) by arrangement

207. Survey of Communication Research Methods—Research designs, sampling, data collection, and data analysis. For Journalism A.M. students.

4 units, Win (——) MW 4:15–6:05

208. Seminar in Broadcasting and Film.

2 units, Aut (Staff) by arrangement

209. Seminar in Broadcasting and Film.

2 units, Win (Staff) by arrangement

210. Seminar in Broadcasting and Film.

2 units, Spr (Staff) by arrangement

211. Theory of Communication I—Seminar and tutorial meetings, extensive readings and papers. For doctoral candidates planning to continue with the sequence on theory.

4 units, Aut (Schramm) W 2:15–4:05
212. Theory of Communication II—Theory of the communication process. Analysis of the experimental literature in attitude change. Prerequisite: consent of instructor.
   4 units, Win (Maccoby) MW 2:15-4:05 and additional meetings by arrangement

   4 units, Spr (——) M 2:15-4:05 and additional meetings by arrangement

   4 units, Aut (Maccoby, Breitrose) Th 7-10 p.m.

216. The Broadcast Editorial—Analyses of radio and television editorials. Students will research, write, deliver and direct their own editorials.
   3 units, Win (Dundes) T 7:30-10:00 p.m.

217. Communication Research Methods I—Methods of research in mass, group, and interpersonal communication. Application of scientific method to communication research. Design of communication studies for laboratory and field experiments and sample surveys. Conceptualization of variables, sampling, data collection, interview techniques, data processing and data analysis. Report preparation. Prerequisite: previous or concurrent registration in elementary statistics.
   4 units, Aut (——) TTh 2:15-4:05

218. Communication Research Methods II—Continuation of 217.
   4 units, Win (Paisley) TTh 2:15-4:05

   4 units, Spr (——) TTh 2:15-4:05

220. Mass Communications in Society—The nature and social responsibilities of the media, the structure of the industry, problems of regulation, management, educational and commercial interests. For first-year graduate students.
   4 units, Spr (Stewart) T 4:15-6:05

222. Documentary Film—Analysis of the techniques and strategies of films designed to effect attitudinal and behavioral change. Prerequisite: consent of instructor.
   4 units, Spr (Breitrose) by arrangement

   1 unit, Aut, Win, Spr (Staff) by arrangement

   4 units, Aut (Grey) by arrangement

   5 units, Win (Staff) by arrangement

231. Developmental Communication I—Changes with age in how people use the mass media, what information they obtain from the media, and how they are influenced by the media.
   4 units, Aut (Leifer) by arrangement

232. Developmental Communication II—Continuation of 231.
   4 units, Win (Leifer) by arrangement

   4 units, Spr (Leifer) by arrangement

240. Seminar in Mass Media History—Review of the literature and research papers in the historical development of newspapers, magazines, broadcasting and film.
   4 units (Staff) by arrangement

245. Economics of the Mass Media—Analysis of the literature in mass media economics and intensive research projects. Primarily for doctoral students in Public Affairs Communication.
   4 units (Staff) by arrangement, given 1969-70

255. International Communication—Chief patterns of mass communications throughout the world; philosophies behind them; economic, social, political reasons why a
given kind of pattern develops where it does; channels by which nations, cultures communicate with each other; kinds of barrier which intervene in those channels; manipulative communication between nations which is characteristic of the "cold war."

4 units, Spr (———) M 2:15-4:05

256. Communication in Economic and Social Development — Seminar on the communication problems of economic and social development, and on the uses of the mass media for national integration, social change, and education in the developing countries. Special uses and difficulties of communication research in these countries. Case studies and planning exercises.

3 to 5 units, Spr (Schramm) T 4:15-6:05

270. Advanced Communication Theory and Method Seminar I — May be repeated for credit. Topic and instructor change each year. Prerequisites: 213 and 219.

3 units, Aut (Staff) by arrangement

271. Advanced Communication Theory and Method Seminar II—May be repeated for credit. Topic and instructor change each year. Prerequisites: 213 and 219.

3 units, Win (Staff) by arrangement

272. Advanced Communication Theory and Method Seminar III—May be repeated for credit. Topic and instructor change each year. Prerequisites: 213 and 219.

3 units, Spr (Staff) by arrangement


4 units, Aut (Paisley) TTh 2:15-4:05

299. Advanced Individual Work—Graduate majors may supplement certain courses with individual projects of distinctly advanced order.

1 to 8 units, any quarter (Staff) by arrangement

300. Thesis.

6 to 10 units, (Staff) by arrangement


3 to 6 units (Staff) by arrangement

319. Pre-Dissertation Research Project — Advanced research for Ph.D. candidates.

(Staff) by arrangement

COMPUTER SCIENCE

Executive Head: George E. Forsythe
Associate Executive Head: John G. Herriot
Associate Professors: Edward A. Feigenbaum, Gene H. Golub
Assistant Professors: Jerome A. Feldman, David J. Gries, D. Rajagopal Reddy, Niklaus E. Wirth
Lecturers: Kenneth M. Colby, John R. Ehrman, Bertram Raphael, Arthur L. Samuel, Giovanni Wiederhold
Research Associates: Bruce G. Buchanan, Lester D. Earnest, Manfred H. Hueckel
Affiliated Faculty:
Professors: Rudolf E. Kalman (Electrical Engineering and Operations Research), Robert V. Oakford (Industrial Engineering), Dana S. Scott (Logic and Mathematics; on leave 1968-69)
Assistant Professor: Anthony C. Hearn (Physics)

OFFERINGS AND FACILITIES

The Department aims to acquaint a variety of students with the technological and intellectual roles of automatic digital computers, and to educate research workers in computer science. In spite of the diversity of the applications, the methods of attacking problems with computers show a considerable unity, and computer science is concerned with the underlying principles. The field is still young, and the student will find many more questions than answers.

Of the numerous areas of computer science, the Department has competence in numerical analysis, operations research, artificial intelligence, programming systems and languages, logical design of computer sys-
tems, and computer control of external devices.

Courses in data processing are offered by the Industrial Engineering Department and in the Graduate School of Business. Courses in optimization and mathematical programming will mainly be found in the Operations Research Department.

Since computer science is inherently interdisciplinary, graduate students of computer science are expected to include in their study program a good deal of work in other departments; see the list of suggested courses below.

There is no Bachelor's degree in computer science. Undergraduates who wish to enter the field are advised to major in mathematics and include Computer Science 50A, B, 137, 138, and 139 in their course of study.

In connection with its courses and research, the Department makes considerable use of the Computation Center. See the section "Computation Center" in this bulletin.

The Department conducts a weekly colloquium, presented by the staff and visiting scientists, which covers a spectrum of current research topics.

**Programs of Study**

**Master of Science**

The University's basic requirements for the Master's degree are discussed in the section "Degrees" in this bulletin. The following are Departmental requirements:

A candidate is expected to complete an approved course program of 45 units; at least 36 units will be in this Department, or selected from the list of suggested courses in other departments which appears at the end of the course offerings in Computer Science. These 36 units must include 6 units of Computer Science 239 and 15 additional units of courses numbered 200 or above.

A student whose primary interest is in the numerical aspects of computing should include in his program Mathematics 106, 113, 114, 115, 130, 131, and Computer Science 137, 138, 204, 237A, B, 238, unless he has taken these courses or equivalent ones elsewhere. Computer Science 208 may be substituted for Philosophy 160A, B.

The candidate must have a 2.50 average in his course work and a 3.00 average in his courses taken in the Computer Science Department.

**Doctor of Philosophy**

The University's basic requirements for the doctorate (residence, dissertation, examination, etc.) are discussed in the section "Degrees" in this bulletin. The following are Departmental requirements:

Candidates for the degree of Doctor of Philosophy will follow such courses as are approved by the Department faculty, subject to general University regulations. Each student's program should be arranged to include work in computer science, mathematics, mathematical logic, and possibly such other subjects as statistics, operations research, electrical engineering or psychology, the proportions depending on the student's previous education and his planned research. Since computer science is becoming increasingly formal and abstract, we place considerable emphasis on the student's mathematical education and ability.

In any case there are the following requirements for the standard program:

1) Complete, as a graduate student, an approved coherent program of at least 60 units. The following computer science courses are recommended: Computer Science 204, 208, 224, 225, 231, 238A, B, 237A, B, 238, 239 (6 units), 243, 245, 382 (2 units of presenting papers). An especially well-written paper for course 239 is required.

2) Possess a substantial reading knowledge of one of the languages: French, German, or Russian.

3) Pass a qualifying examination before admission to candidacy.

The qualifying examination is a written examination which covers the basic areas of computer science. Further information may be obtained from the Department secretary.

The most important requirement for the Ph.D. degree is the dissertation. The Department is now prepared to supervise dissertations in the mathematical theory of computation, numerical analysis, programming languages, artificial intelligence, computer control of external devices, and in certain
applications of computers, such as in operations research, and logic.

As part of his training for the Ph.D., each student is required during one or more quarters to perform some teaching, research, or consulting work equivalent to that normally performed by teaching and research assistants.

**PH.D. MINOR**

For a minor in Computer Science the candidate must complete 15 quarter units of Computer Science courses following a program approved by the Computer Science Department Committee on Graduate Study. Automatic approval will be given for any program which includes C.S. 137, 139, 224, or 238 and two additional courses chosen from C.S. 138 and the 200 level 3-unit courses. In addition the candidate must take and pass a special minor examination.

**TEACHING AND RESEARCH ASSISTANTSHIPS**

There are graduate assistantships available in both the Computer Science Department and the Computation Center. Assistants will receive a tuition scholarship for up to nine units of study per quarter during the academic year, and in addition will receive stipends for the nine-month academic year ranging approximately from $2500 to $2800. Some may work full time in the summer for between $590 and $700 per month.

Duties in the academic year involve less than twenty hours of work per week. Part of this is in assisting Stanford people with their programs and methods for solving problems with computers, often in connection with formal or informal programming courses. Part of the time is spent in developing programs and systems for solving problems of general interest on computers, or in assisting senior staff members with research in computer science. Approximately two hours of the work week are spent in attendance at Computer Science Department colloquia and seminars.

Applicants for assistantships are expected to have a background in computing at least as deep as that achieved in courses 50A, B or 136, together with some knowledge of a machine language. A deeper background is preferable. An applicant's major field may be computer science, mathematics, statistics, physics, psychology, electrical engineering, or other discipline in which there is significant research involving the use of automatic digital computers. Because of the great need for improved computing and programming systems as tools for research, preference will generally be given to students of computer science.

Further information may be obtained from the Executive Head of the Computer Science Department. Applications for assistantships should be made to the Financial Aids Office, together with an application for admission to graduate study in some department. Unless the applicant is also applying for admission to the Computer Science Department, he should at the same time write to the Executive Head of the Computer Science Department of his desires to have an assistantship in computing and stating his desired major department.

**COURSES FOR UNDERGRADUATE STUDENTS**

5. Introduction to Programming — This course is an introduction to a specific procedure-oriented language for describing computational processes. There will be practice in solving elementary problems on Stanford's automatic digital computers. The course is limited to freshman and sophomore students. Prerequisites: Mathematics 0 or equivalent.

3 units, Aut (closed) MWF 11
Win (Oakford) TTh 2:15-3:30
Spr (closed) MWF 11

50A,B. Introduction to Computer Science—The significance of computers and the fundamental techniques of computer science. Concept of, and properties of algorithms; language, notation and style for describing algorithms; analysis of computational problems and development of algorithms for their solution; use of a programming language to solve problems over a wide range of applications on a digital computer. Prerequisite for 50A: Mathematics 21 or 42 or equivalent. Prerequisite for 50B: 5 or 50A or equivalent.

#50A. 3 units, Aut (closed) lec. MW 1:15;
(—) discussions F 1:15
Win (closed) lec. TTh 10;
(—) discussions
Spr (closed) lec. MW 11;
(—) discussions F 11

50B. 3 units, Spr (closed) MWF 1:15
COURSES FOR UNDERGRADUATE
AND GRADUATE STUDENTS

126. Computing in the Social Sciences and Humanities — It is recommended that students with the prerequisites for courses 50A or 136 take one of those courses. The syllabus is roughly that of course 136, but the problems are selected more from non-numeric applications. Prerequisite: Mathematics 0 or equivalent.

3 units, Aut ( ) MWF 2:15
Win ( ) MWF 2:15
Sum ( ) MTWTh 10

136. Introduction to Algorithmic Processes — Concept and properties of an algorithm; language and notation for describing algorithms; analysis of computational problems and development of algorithms for their solution; use of a specific procedure-oriented language to solve simple numerical and non-numerical problems using an automatic digital computer. Prerequisite: Mathematics 23 or 43.

3 units, Aut ( ) lec. MW 11; ( ) discussions F 11
Win (Herriot) lec. MW 10; ( ) discussions F 10
Spr ( ) lec. TTh 10; ( ) discussions
Sum ( ) MTWTh 9; ( ) MTWTh 11

137. Numerical Analysis — This course and 138 are designed to acquaint seniors and graduate students of science and engineering with methods of solving mathematical problems on automatic digital computers. Problems discussed include numerical differentiation and integration, solution of linear and nonlinear equations, solution of differential equations, and approximation of functions. Introduction to the analysis of convergence and errors. Pitfalls in automatic computation and their remedies. Prerequisites: 50A or 136 and Mathematics 130, or equivalents.

3 units, Win ( ) MWF 11;
(Golub) MWF 2:15

138. Numerical Analysis — Continuation of 137. Also the numerical analysis of functions of several variables, including problems of linear algebra. Prerequisites: 137 and Mathematics 113, or equivalents.

3 units, Spr (Herriot) MWF 2:15

139. Computer Organization and Information Structures — Logical structure of computer systems: flow of control, instruction codes, input-output, subroutines, interpretive and assembly systems, pushdown stacks, recent advances in computer organization, etc. Study of information representations and their relation to processing techniques. Several computer projects will be included. Prerequisite: 50A or 136 or equivalent.

3 units, Aut ( ) TTh 2:15-3:30;
( ) MWF 1:15
Win ( ) MWF 1:15

150. Combinatorial Analysis — Introduction to general combinatorial theory; theory of graphs, network flow and matroids; convex polytope structures.

Permutations and combinations, partitions, generating functions and recursions. Properties of directed and undirected, planar and nonplanar graphs, trees, cycles and co-cycles and special graphs such as bi-partite, a-cyclic, partially ordered, degree constrained. Extremal problems: the shortest path, minimum spanning tree algorithms; minimum covering, maximum packing, branching and matching problems; the assignment problem; the traveling salesman problem; coloring theorems and conjectures. Dilworth's theorem, Ford-Fulkerson max-flow min-cut theorem, Hall's theorem on distinct representatives, Ramsey's theorem. Groups and their graphs, matrix associated with a group, incidence matrices, matroid theory, unimodularity. Euler relations on faces, edges and vertices of convex polytopes; relation to linear inequality theory and duality. Application to finite geometries, orthogonal Latin squares, block designs, switching networks, molecular structures (crystallography), genetic code, project networks, and packing problems. Students will be encouraged to program short algorithms on the computer. Prerequisite: Mathematics 44 or equivalent.

3 units, Win (Dantzig)

199. Undergraduate Honors.
Any quarter (Staff) by arrangement

COURSES INTENDED PRIMARILY
FOR GRADUATE STUDENTS

204. Problem Seminar — The solution by digital computing of various problems, numerical and symbolic, using several lan-
208. Foundations for Computer Science—An introduction to logic, algorithms and computability. Topics from mathematical logic, set theory, recursive function theory and the theory of algorithms. Abstract models of computability: Turing machines, minimal machines, dominoes and rewriting systems. Prerequisite: 139 (may be taken concurrently).

3 units, Aut (—) by arrangement

224. Computer Simulation of Cognitive Processes — Information-processing models of learning, problem-solving, pattern recognition, etc., using computer simulation methods and list-processing languages. Prerequisite: 238, or demonstrable knowledge of LISP language obtained through LISP short courses or otherwise.

3 units, Win (Colby, Feigenbaum) TTh 1:15-2:30

225. Artificial Intelligence—Introduction to problem solving and heuristic programming. Survey of chess- and checker-playing programs; theorem-proving programs; General Problem Solver; mathematical, linguistic, and industrial applications. Question-answering programs, and natural-language communication with machines. Other topics as time allows. The course is designed to dovetail with 224 with minimum overlap, but 224 is not a prerequisite. Prerequisite: 238, or demonstrable knowledge of LISP language obtained through LISP short courses or otherwise.

3 units, Spr (Samuel) by arrangement

231. Structure of Digital Computers—Boolean algebra; analysis and synthesis of combinatorial and sequential networks; electronic components used in logical gates. The design of a simple digital processor, arithmetic unit, program control, memories. Use of this processor and its simulation on another computer. Various existing forms of machine organization. Prerequisite: 139 or equivalent.

3 units, Aut (——) MWF 9

233. Topics in Numerical Analysis—Selected topics in numerical analysis. Prerequisite: 138 or equivalent.

3 units, Spr (——) by arrangement

236A,B. Systems Programming and the Theory of Formal Languages—The technique of constructing systems programs: supervisory programs (monitors), input-output systems, interpreters and compilers for procedure-oriented languages like ALGOL. Selected topics from the theory of formal languages: syntactic analysis and semantic interpretation. Prerequisite: 139 or equivalent.

236A. 3 units, Win (Gries) TTh 2:15-3:30
236B. 3 units, Spr (Gries) TTh 2:15-3:30


237A. 3 units, Aut (Golub) MWF 10
237B. 3 units, Win (——) MWF 10
237C. 3 units, Spr (——) by arrangement

238. Computing with Symbolic Expressions — The LISP programming language with applications to symbolic differentiation, integration, simplification of algebraic expressions, and compiling. Design of list-processing systems. Prerequisite: 136 or substantial programming experience.

3 units, Aut (Hearn) TTh 11:00-12:15

239. Computer Laboratory — A substantial computational program is undertaken and well documented. Prerequisite: 138 or 139, or equivalent.

Any quarter (Staff) by arrangement

243. Mathematical Theory of Computation — Semantics and syntax of programming languages; formal systems for proving equivalence of programs; computability and unsolvability; computer proof procedures; related topics in mathematical logic. Prerequisite: 238 and Philosophy 160A,B, or equivalents.

3 units, given 1969-70
245. Topics in Artificial Intelligence—For 1968-69: Introduction to the nature of vision and speech, and the underlying structure common to problem solving in these areas; problems involved in providing a computer with these human-like abilities; survey of existing solutions in picture recognition, speech recognition, picture synthesis, speech synthesis, and control of mechanical hands; will also discuss and point to relevant literature in projective geometry, acoustics, phonetics, and transform theory. Prerequisites: 139 and 238 or equivalents.

3 units, Aut (Reddy) TTh 2:15-3:30

246. Data Reduction and Control Programming — Data collection, storage, and retrieval, curve fitting and hypothesis testing; interrupt processing and associative processing; multiprogramming and time-sharing; control languages and data structures; man-machine communication; simulation and evaluation of systems. Prerequisites: 137, 231, 236A, 238.

Alternate years, given 1969-70

250. Graphic Data Processing—Picture description languages, control languages, and data structures; picture recognition: preprocessing and encoding, 2-D transformations, 3-D transformations, projective transformations, primitive recognizers, and classification; graphic displays and graphic input devices, control programs; applications of graphic techniques. Prerequisites: 137, 231, 236A, 238.

3 units, Spr (Miller) MWF 9

341. Large Scale Systems in Mathematical Programming — (Formerly 370.) Development of efficient solution methods for optimizing special large-scale linear inequality systems such as those encountered in control theory, programming in a Markov chain, investment and economic planning, multi-commodity network flows, multi-production and distribution models, and those that arise as a solution procedure for nonlinear, integer, and stochastic programming problems. The decomposition principle, partitioning proposals, and compact inverse schemes will be developed and applied to various special structures. The role of flexible computer languages to assist in the experimental development will be discussed. Prerequisite: Operations Research 465B, or equivalent.

3 units, Aut (Dantzig) by arrangement

360. Advanced Reading and Research.
Any quarter (Staff) by arrangement

382. Computer Science Seminar—A variety of special-interest seminars are offered each quarter on such topics as (a) numerical analysis, (b) programming, (c) artificial intelligence, (d) pattern recognition. These seminars cover topics of current research in their respective areas.

1 to 2 units, any quarter (Staff)
by arrangement

The following courses offered in other departments may be of especial interest to students of computer science:

Analog Computation—See Electrical Engineering 283.
Data Processing—See Industrial Engineering 141, 141A, 161, 162, 257.
Data Processing in Business Problems—See Business 366, 367.
Mathematical Logic—See Philosophy 160A, B, 161, and 292A,B,C.
Mathematical Models in Behavioral Sciences—See Behavioral Sciences courses.
Mathematical Programming — See Operations Research courses.
Mathematical System Theory—See Operations Research 347A,B.
Mathematics—See Mathematics courses.
Recursion Theory — See Philosophy 293A, B,C.
Statistical Methods of Econometrics — See Economics 272.
Theory of Automata—See Philosophy 162 and Electrical Engineering 384, 484.


EAST ASIAN STUDIES

Committee in Charge: The Committee on East Asian Studies, a subcommittee of the Committee on International Studies

Chairman: John W. Lewis (Professor, Political Science)

The Committee on East Asian Studies administers the master's program in East Asian Studies, an interdisciplinary program in the humanities and the social sciences encompassing Anthropology, Art, Asian Languages, Economics, Political Science, History, Education, and Philosophy.

Background on East Asia or its languages is not required of applicants to the program, although some background is desirable. Graduate Record Examination is required of all native English-speaking applicants.

The student normally completes this program in two years. About one-half of his work is devoted to studying either Chinese or Japanese. An equivalent of three years of either language is minimally required for the degree; at the same time, students are encouraged to continue with some language work beyond the third year as long as they are in the program. The other half of the student's work consists of nine non-language courses distributed as follows:

1. A three-course sequence on East Asian civilization (History 91, 92, 93).
2. Three related courses in a department, including at least one seminar in which a research paper on East Asia is required.
3. Three courses related to East Asia selected from departments of the student's choice.

There is no thesis requirement for the Master's degree in this program. Inquiries concerning this program should be addressed to the director of the Master's Program in East Asian Studies, Room 2-R, Building 1, Stanford University, Stanford, California 94305.
invaluable material on transportation problems, and there are special collections on the institutions and commerce of Latin America, the Orient, and Pacific Coast development. Advanced students have access to the Hoo- \( \text{...} \)r Institution, with its comprehensive collections of original and secondary materials on many foreign nations.

Qualified graduate students in economics are given the opportunity for training and research in the special fields of the Food Research Institute. A few courses for undergraduates are conducted by the Institute, as well. Courses offered by the Institute count toward completion of requirements for degrees in economics.

**PROGRAMS OF STUDY**

**BACHELOR OF ARTS**

The following Departmental requirements are in addition to the University's basic requirements for the Bachelor's degree:

*Enrollment in the Department*—Students who have not yet taken any economics courses at Stanford may be enrolled in the Department upon request. All other students will be enrolled only if they have had a C average or better in their previous work in economics at Stanford; however, deficiencies in this average may be made up by repeating courses.

*Graduation*—The student is urged to select his program of study carefully, with a view to his own special needs and interests. His Departmental adviser will be prepared to advise him on his program at any time.

To be recommended by the Department for the degree of Bachelor of Arts in economics, the student must have satisfied the following requirements:

1. Completion of 45 units in courses in economics, and with the permission of the student's adviser, in the curricula of the Food Research Institute and of Engineering-Economic Systems.
   a) Economics 1, 5, 105, 10, 110, and 111 or their equivalent shall be included in the 45 units. Economics 5 and 10 shall be completed by the end of the junior year.
   b) Economics courses taken at other universities may be included in the 45 units. The Director of Undergraduate Study for the Department will establish the amount of credit to be granted toward completion of the Departmental requirements. However, if the elementary course is repeated at Stanford, credit will not also be given for the elementary course taken at another institution toward the required 45 units, and in any case no more than 5 units credit will be given for such a course.
   c) A minimum of 30 units of courses numbered 100 or above, of which 20 must be taken at Stanford, shall be included in the 45 units, except that for this requirement Economics 190 and 191 will be counted as first- or second-year courses.

2. An average grade of C or better shall have been received for all course units completed at Stanford in economics and the curricula of the Food Research Institute and Engineering-Economic Systems.

3. Completion of a program, approved by the student's adviser, of at least 25 units of courses numbered 100 and above (in history, courses numbered 20 or above) in not more than two of the following subjects: cultural anthropology, history, industrial engineering, mathematics including computer science and statistics (including courses in differential and integral calculus numbered below 100 for which full credit is given), philosophy, political science, psychology, and sociology. This requirement may be satisfied on a pass-fail basis in the degree that is compatible with the rules of the University.

*The Undergraduate Honors Program*—Two programs are offered which lead to a degree of Bachelor of Arts with honors. The purpose of Honors Program I is to encourage more intensive study of economics than is required for the basic major program. The purpose of Honors Program II is to encourage study of economics in close conjunction with other disciplines. The two programs have these requirements in common:

1. Completion of courses in economics numbered 1, 5, 10, 105, 110, and 111.

2. Achievement of a grade point average of at least 3.0 in all economics courses.

The specific requirement of Honors Program I is:
1. Completion of no less than 55 units in economics and the curricula of the Food Research Institute and Engineering-Economic Systems. These units are to include the core courses listed above and 10 units of Honors Seminar 199. The general requirement of 25 units in complementary fields is not waived.

The specific requirements of Honors Program II are:

1. Completion of 70 units in economics and related fields according to a schedule approved in detail by the departmental Director of Undergraduate Studies and undertaken no later than the second quarter of the student's junior year. These units are to include the core courses listed above. The general requirement of 25 units in complementary fields is waived.

2. Completion of one quarter in the Honors Seminar 199, involving presentation of one or more essays based on the Honors Program.

A candidate for admission to the Honors Program should apply to the Director of Undergraduate Study in the third quarter of his junior year if possible.

ADVANCED DEGREES

MASTER OF ARTS

The University's basic requirements for the Master's degree (residence, thesis, etc.) are set forth in the section "Degrees" in this bulletin. The following are Departmental requirements:

Admission to Candidacy—Completion of the Stanford requirements for a Bachelor of Arts degree in economics, or an approximately equivalent training, is required of students who undertake a program of study for the degree of Master of Arts in economics. Provisional enrollment may be permitted, however, in cases in which previous training has been deficient, with the understanding that the deficiency will be remedied in advance of departmental approval of candidacy. Admission to candidacy for the degree will be restricted to students whose record bears promise of successful graduate work.

Recommendation for the Degree—To be recommended to the University Committee on the Graduate Division for the degree of Master of Arts in economics, the student must have satisfied the following requirements:

1. Completion of a program of study at Stanford amounting to not less than 45 units of credit. No courses numbered below 100 and no courses completed with a grade less than C may be counted toward the 45 units required. Ordinarily the program will include at least 30 units of economics, of which at least 15 units (or 10 units in addition to the thesis) must be in courses at the 200 level. Courses in subjects closely related to economics may be included with the approval of the Director of Graduate Study in Economics.

2. Completion of a thesis acceptable to the Department, or of two term papers of acceptable quality in courses numbered 200 or over. Credit will be allowed for the thesis to a maximum of 9 units toward the 45 units required for the degree.

3. An average grade of B or better shall have been received for the first 45 units of course work completed and for all additional units approved by the Department.

DOCTOR OF PHILOSOPHY

The University's basic requirements for the doctorate (residence, dissertation, examination, etc.) are set forth in the section "Degrees" in this bulletin. The following are Departmental requirements:

Admission to Candidacy—The Director of Graduate Study in Economics will recommend the student to the University Committee on the Graduate Division for admission to candidacy for the degree of Doctor of Philosophy in economics when the following conditions have been satisfied:

1. The student must have passed satisfactorily the two comprehensive field examinations in "Price and Allocation Theory" and in "Theory of Income and Economic Fluctuations." These examinations will normally be given at the end of the spring quarter and will cover the subject matter of Economics 202, 203, 204, and 210, 211, 212.

2. Candidates for the Ph.D. degree will be required to demonstrate a reading knowledge of economics in one foreign language, except that additional training may be required of students whose dissertations are concerned with foreign economic systems or require more than ordinary acquaintance
with literature in a foreign language. The language selection must be approved by the Director of Graduate Study.

The requirement may be satisfied in either of two ways: (a) by completion with passing grade of a second-year reading course equivalent, for the language concerned, to French 23; (b) by passing a special reading examination, to be given preferably by a qualified member of the Department of Economics or, in place of this, the relevant language department. This examination will be scheduled once annually.

3. The minimum mathematics requirement of the Department is satisfied by successful completion of Mathematics 43 with a grade of C or better, or its equivalent (as judged by an examination administered by the Department). This requirement should be satisfied as soon as possible after first graduate registration in the Department. Those with little or no previous mathematical background are strongly advised to register their first autumn quarter for Mathematics 41.

While the minimum requirements of the Department will be satisfied by Mathematics 43, continuation in mathematics is recommended. The Director of Graduate Study will advise on suitable additional mathematics and statistics courses of use to economists.

Students admitted to the Department to pursue work toward the Ph.D. are normally expected to satisfy the requirements for admission to candidacy by the end of their first year in residence. Hence, previous preparation in mathematics, a foreign language, or both is desirable.

Recommendation for the Degree—Before being recommended for the degree of Doctor of Philosophy in Economics, the student must have completed the following requirements:

1. Qualification in background subjects.
   a) For those who do not elect Econometrics as a field (see below), an acquaintance with the statistical tools used in economics equivalent to Economics 171.
   b) Economics 200, History of Economic Thought. Students will be expected to satisfy this requirement by the end of their second year in residence.

2. Qualification in six fields of study (if no minor subject is offered) or in three fields of study and a minor subject. All candidates without exception will be expected to qualify in "Price and Allocation Theory" and "Theory of Income and Economic Fluctuations." The remaining fields may be chosen according to the following options:
   a) Option A—Without a Minor Subject. The preparation required will be determined by the professor or professors in charge of each field and will normally consist of a two-quarter sequence at the 200 level or approximately equivalent preparation. An approved program of 15 units in other than economics may, at the discretion of the Director of Graduate Study, be substituted for one field. Students electing Option A are expected to complete the requirements in at least five fields by the end of their second year in residence.
   1) Economic Development or Economic History
   2) Three other fields, one of which may be the field not chosen under 1), chosen from the following list: Monetary Theory, Public Finance, Labor Economics, Structure of Industry, International Economics, Econometrics, Mathematical Economics, Economic Development, Economic History

b) Option B—with a Minor Subject. Students who elect Option B will be expected, if possible, to complete their minor requirement and the third comprehensive by the end of their second year in residence.
   1) Economic History or Economic Development
   2) A minor subject, the choice of which must be approved by the Director of Graduate Study and the requirements for which are determined by the department concerned. Students interested in specializing in Mathematical Economics or Econometrics are encouraged to minor in statistics.
Comprehensive field examinations will be scheduled once annually, usually at the close of the sequence designed to prepare for them. The minimal standard of qualification in each field will be a grade of B on the appropriate examination. However, students will not typically be recommended for the Ph.D degree with a record of only B's in the six comprehensive examinations (Option A). Successful candidates are expected to pass with distinction in some fields of economics.

3. Training in independent research. Participation in two year-long seminars in two fields and preparation of satisfactory reports or papers in each. Under normal circumstances one of the two seminars will be in the field in which the candidate's dissertation lies and his continued participation in that seminar is encouraged. Seminars will in part be designed to assist the student in locating a suitable dissertation topic. Satisfaction of this requirement is expected no later than the end of the third year of graduate residence.

4. Teaching experience. Candidates for the Ph.D. in economics are expected to acquire minimal teaching experience equivalent to that of a teaching assistant in the Department for one quarter. Under exceptional circumstances and upon recommendation of the Departmental Graduate Study Committee, the Director of Graduate Study may excuse a student from this requirement. It is not permitted to satisfy this requirement during the first year of graduate study; it will normally be satisfied by the end of the third year of residence.

5. Satisfactory performance in the University oral examination. Except in special cases, the first four stages of preparation must be completed before the student is admitted to the University oral examination. This examination is held for each student after his Departmental dissertation committee has certified to the Director of Graduate Study in Economics that the dissertation is complete in at least rough-draft form. The examination is based on the dissertation and on the field or fields of economics within which it lies.

Minor for the Degree of Doctor of Philosophy—To be recommended for the degree of Doctor of Philosophy with economics as a minor subject, the student is required to qualify in three fields of economics, one of which must be either Price and Allocation Theory or Theory of Income and Economic Fluctuations. Qualification in these fields is tested in the Departmental comprehensive written examinations that are given once annually. The standard of achievement in these examinations is the same for minor as for major candidates.

Fellowships and Assistantships

The attention of prospective graduate students is directed to the fact that the Department awards a number of fellowships for graduate study in economics. These grants range up to $4,000 (inclusive of tuition) with special allowances under certain circumstances. Furthermore, students who make a good record during their first year may be assured of favorable consideration for further support for a period of up to three more years. This is true regardless of whether the student has come on a Departmental or an outside (NSF, Woodrow Wilson, etc.) fellowship initially.

Completed application forms for graduate fellowships should be filed before January 15 at the Office of Financial Aids and at the same time as completed application forms for admission are filed with the Admissions Office.

Opportunities for employment as research assistants are also available. The salary scale for half-time employment depends upon the student's experience and ability.

Qualified graduate students who wish to combine their studies with part-time teaching may apply for teaching assistantships which carry a stipend of $2,300 for three quarters of half-time teaching and a tuition scholarship covering up to half-time tuition and fees. Graduate students may apply for a teaching assistantship without a tuition scholarship if they are not subject to tuition charges or if they do not require scholarship aid.

Entering students are not normally considered for research or teaching assistantships.
COURSES

Note: It is not possible at the date this announcement goes to press to schedule courses accurately for the year. Application should be made to the secretary of the Department after March for information about the exact times at which courses will be given in 1968–69.

#1. Elementary Economics—The functioning of a modern market economy: the determination of national income and its distribution; the composition of output; the growth of economy.
5 units, Aut, Win, Spr (Staff) MTWThF 9

2. Economic Problems and Issues—Intended for non-majors. A survey of some significant public problems to which the economist can make a policy contribution. The selection will be made from the following list: The Poverty Problem; Economics of Discrimination; Economics of Medical Care; Cultural Institutions in Today's Economy; Traffic Congestion, Cities and Housing; Economics of Education; International Monetary Reform, and so on. This course may be repeated for credit with the consent of instructor. Prerequisite: 1.
3 units

5. Economics of Prices and Markets I—The role of prices in the allocation of economic resources; behavior of consumers and firms; market structure. (May be taken as 5H by graduate students.) Prerequisite: 1 or equivalent.
5 units, Aut, Win, Spr (Staff) MTWThF 9

6. Price Theory and Policy—Content same as Economics 5 but use will be made of mathematical tools in presentation. (May be taken as 106A by graduate students.) Prerequisites: 1 or equivalent and Mathematics 23 or Mathematics 43 or Mathematics 63.
5 units, Aut, Win (Staff) MTWThF

7. Introduction to Statistics—(Enroll in Statistics 7.) Especially designed for students of economics, sociology and other social sciences.
5 units, Aut (Solomon) MTWThF 10

10. Money, Income, and Employment I—An analysis of major sectors and markets in the economic system and of national economic accounts. (May be taken as 10H by graduate students.) Prerequisite: 1 or equivalent.
5 units, Aut, Win, Spr (Staff) MTWTh

105. Economics of Prices and Markets II—Distribution of income; problems in marginal cost pricing; monopoly power, its sources and impact. Prerequisite: 5.
5 units (Staff) MTWTh

106. Price Theory and Policy—Content same as Economics 105 but use will be made of mathematical tools in presentation. Prerequisite: 6 or consent of instructor.
5 units (Staff) MTWTh

110. Money, Income, and Employment II—An analysis of equilibrium, instability, and growth in the economic system as a whole. Prerequisite: 10.
5 units (Staff) MTWTh

111. Money, Income, and Employment III—An analysis of policies and techniques of regulation for stability, growth, and other objectives in the economic system as a whole. Prerequisites: 5 and 110.
5 units (Staff) MTWTh

115. Economic History of Western Europe—Historical trends in the Western European economy from 1750 to past the First World War. Emphasis upon the historical characteristics and economic development of Great Britain, France, and Germany.
5 units (Staff) MTWTh

116. Economic History of the United States—Historical trends in the American economy from the colonial period to the great Depression; special references to problems of national and regional economic development, including social and political influences thereon. Prerequisites: majors 5 and 10; non-majors 1.
5 units (Staff) MTWTh

117. The Postwar U.S. Economy in Historical Perspective—Analysis of selected aspects of U.S. economic experience since World War II, focusing on forces determining growth, stability and income distribution. References to postwar developments in other industrialized nations; primary emphasis on elements of historical continuity and recent departures in the functioning of the economy. Prerequisites: majors 5 and 10; non-majors 1.
5 units (Staff) MTWTh
118. Underdeveloped Economies—Characteristics of backward economies. Elements and mechanism of development. Emphasis on theory, but attention will be given to policy problems and case studies. (May be taken as 118A by graduate students.) Prerequisites: majors 5 and 10; non-majors 1.

5 units (Staff) MTWTh


5 units (Staff) MTWTh

121. Economic Development in East Asian Countries I—A general survey of the economic development of Japan, Mainland China, Korea and Taiwan. Prerequisites: majors 5 and 10; non-majors 1 and consent of instructor.

5 units, Aut (Staff) MTWTh

122. Economic Development in East Asian Countries II—An analysis of development problems and policies common to East Asian countries. Emphasis is on agricultural and industrial policies, saving and investment techniques, foreign trade and aid and economic systems. Prerequisites: majors 5, 10 and 121; non-majors: 1 and 121.

5 units, Win (Staff) MTWTh

123. Economic Development in Latin America—Special reference to the role of finance in Latin American economic development and planning. Prerequisites: majors 5 and 10; non-majors 1.

5 units (Staff) MTWTh

141. Public Finance and Fiscal Policy—Effects of government expenditure, borrowing, and taxation upon resource allocation, national income and employment, prices, and income distribution. Prerequisites: 5 and 10.

5 units (Staff) MTWTh


5 units (Staff) MTWTh

158. Organization and Social Control of Industry — Methods of evaluating economic efficiency; anti-trust laws and the attempts to preserve competition; economic regulation of public utilities, communications, and transportation. Emphasis on independent study. Prerequisites: 5 and 105, or consent of instructor.

5 units (Rosse) MTWTh

165. International Economics — Comparative advantage in production and trade among nations; international monetary mechanism; domestic monetary, fiscal and tariff policies and their relationship to foreign trade. Prerequisites: majors 5 and 10; non-majors 1.

5 units (Staff) MTWTh

170. Introduction to Econometrics I — Statistical methods of special application to economic problems and special statistical problems encountered in testing economic hypotheses with non-experimental data. Introduction to regression and conelation analysis. Prerequisites: 5, 10, 7 (or Statistics 50), Mathematics 41 or equivalent, or consent of the instructor.

5 units (Staff) MTWTh

171. Introduction to Econometrics II—Application of regression analysis to time series and cross-section data. Problems in the formulation of econometric models and introduction to simultaneous equations. Prerequisites: 5, 10, 7 (or Statistics 50), Mathematics 41 or equivalent, 170, or consent of instructor.

5 units (Staff) MTWTh

180. Optimization in Economic Analysis—The applications of classical calculus, the calculus of variations, linear and non-linear programming, activity analysis, and dynamic programs to economic problems. Optimization within the firm and household overtime. Problems in aggregative planning and control. Emphasis on concepts and results rather than techniques and proofs. Prerequisites: Statistics 7, Mathematics 43 or equivalent, and Economics 105 or 106 or equivalent.

5 units (Staff) MTWThF

190. Introduction to Accounting—An introduction to the principles and concepts underlying financial reports such as the income statement, statement of financial position, and the “funds” statement, and to the uses
of such reports. No prior accounting is assumed. Students who have taken or are now taking a college-level accounting course may not enroll. For majors in Economics, this is considered a lower division course.

5 units, Aut, Win (Staff) MTWTh

191. Introduction to Cost Accounting—The use of internal financial data for managerial decision making. Students who have had or are now taking a college-level cost accounting course other than 190 may not enroll. For majors in Economics, this is considered a lower division course. Prerequisite: 190 or equivalent.

5 units, Win, Spr (Staff) MTWTh

199. Senior Seminar in Economics—Advanced specialized topics to be arranged with instructor. Required of all Honors students. Each section will meet throughout the year under the guidance of one instructor. Maximum number of students in each section is ten. Prerequisite: Admission to Honors Program or seniors majoring in economics with a minimum grade point average in economics of 3.00, or consent of instructor.

10 units (Staff)

**Courses Primarily for Graduate Students**


5 units (Lau, Lewis, Skinner) by arrangement


In each group below, courses marked (*) constitute continuous courses. Registration will be accepted and grades given only for the entire sequence.

Six seminars will be offered in any one year.

**A. CORE THEORY CURRICULUM**

(Professors Abramovitz, Hickman, Kolm, Kurz, McKinnon, Reder, Shaw, and Tarshis)

200. Topics in the History of Economic Thought—Landmarks in the development of classical, neoclassical and institutionalist economics; their relation to economic conditions in their time and to modern economics.

5 units (Reder)

*202. Price and Allocation Theory I—Perfect competition. Meaning, conditions of efficiency in economic organization. General and partial equilibrium. Open to advanced undergraduates with consent of the instructor. May be omitted by graduate students with adequate background in the subject. Prerequisite: consent of instructor.

5 units, Aut (Staff)

*203. Price and Allocation Theory II—Different forms of competitive and monopolistic behavior; their effect on efficiency of economic organization. Prerequisite: 202.

5 units (Staff)


5 units, Spr (Staff)

*210, *211, *212. The Theory of Income and Economic Fluctuations—Theory of money, employment, income considered from points of view of comparative statics, causes of instability and long-term change. 210 is prerequisite for 211; 210, 211 are prerequisites for 212. Consent of instructor required for 210, 211, 212.

210. 5 units, Aut (Staff)

211. 5 units, Win (Staff)

212. 5 units, Spr (Staff)

301A,B,C. Seminar in Microeconomics.

10 units (Staff) by arrangement

310A,B,C. Seminar in Macroeconomics.

10 units (Staff) by arrangement

**B. ECONOMIC DEVELOPMENT**

(Professors David, Despres, Hohenberg, Manne, and Taira)

*215. Economic Development I—Comparative analysis of presently underdeveloped economies. The process of development. Alternative theories of growth. Prerequisites: consent of instructor and 202, 203, 204; 210, 211, 212.

5 units, Aut (Staff)

in social overheads, foreign trade, population and manpower. Programming methods.
Prerequisites: consent of instructor and 202, 203, 204; 210, 211, 212.
5 units, Win (Staff)

218. Development Problems of Latin American Export Economies — (Enroll in Food Research 218.) Introduction to the theory of economic development of open economic systems. Analysis of the effects of integration of national and international markets during the process of economic development, with particular emphasis on post-Independence Latin America.
5 units, Win (Reynolds) WF 4:15–6:05

222. Economic Development in East Asian Countries — An analysis of development problems and policies common to East Asian countries. Emphasis is on agricultural and industrial policies, saving and investment techniques, foreign trade and aid and economic systems.
5 units, Spr (Gurley, Lau, Taira)

223. Economic Development in Latin America—Special reference to the role of finance in Latin American economic development and planning.
5 units (Staff)

225. Historical Experience of Economic Growth—(See under Economic History.)
10 units (Staff) by arrangement

321. Seminar in Economic Growth — Prerequisite: consent of instructor.
5 units (Staff) by arrangement

E. PUBLIC FINANCE

(Professors Coen, Curley, Kolm, and Margolis)

*241, *242. Public Finance and Taxation I and II — Role of government expenditures in light of welfare economics; direction and development of expenditures; types of taxes, their distributional and allocative effects; pricing policies in government enterprises; compensatory finance; the public debt. Prerequisites: 204 and 212.
241. 5 units, Aut (Coen)
242. 5 units, Spr (Kolm)

243. Economic Analysis of Governmental Behavior—(Enroll in Engineering-Economic Systems 260.) Development of a set of models to characterize the behavior of governmental bodies. Economic analysis (allocation theory and strategic analysis) will be the principal tools. Units to be studied include administrative, legislative, executive, and judicial bodies. Processes to be studied include budgetary, electoral, functional changes, political leadership, centralization, information, political exchanges, corruption. Criteria to evaluate structural changes suggested by welfare economics and political philosophy will be considered.
3 units, Aut (Margolis) MW 11:00–12:15

341A,B,C. Seminar in Public Finance—Prerequisite: 241 or consent of instructor.
10 units (Staff) by arrangement
F. ECONOMICS OF LABOR
(Professors Reder and Taira)

5 units (Reder)

*248. Wages and Income Distribution—Wage levels, structure; income distribution, effects of education on earnings, special references to empirical data.
5 units (Reder)

345A,B,C. Seminar in Labor Economics.
10 units (Staff) by arrangement

G. ECONOMICS OF INDUSTRY
(Professors Margolis and Rosse)

254. Economics of Industry I—Industry structure, integration, and change; structure and behavior of markets; size of establishments and firms; economics of scale; the multi-product firm; cost and production functions; industry structure and economic efficiency.
5 units (Staff)

256. Economics of Industry II—Investment and growth of the firm; mergers; stochastic theories of industry structure; industry structure, innovation, and technological change; location and transportation; public utilities; problems in the formation of public policy.
5 units (Rosse)

10 units, (Staff) by arrangement

H. INTERNATIONAL ECONOMICS
(Professors Despres, Keesing, McKinnon, and Tarshis)

5 units, Win (Staff)

5 units, Spr (Staff)

365A,B,C. Seminar in International Economics.
10 units (Staff) by arrangement

I. ECONOMETRICS
(Professor Anderson and Statistics Department)

270. Theory of Probability—(Same as Statistics 116.) This course covers the material of Statistics 27 in more detail and with more emphasis on mathematical technique. Students are expected to have a good working knowledge of calculus, including infinite series and double integrals. The course is designed to provide an adequate background for all courses whose prerequisite is probability theory. Prerequisite: Mathematics 44 or equivalent.
4 units, Aut (Siegmund) MTWF 11
Win (Siegmund) MTWF 11
Spr (Siegmund) MTWF 9

271. Elementary Statistical Inference—(Enroll in Statistics 219.) Review of probability; distribution theory; sampling, sampling distributions; univariate, bivariate normal distribution; correlation, regression. Prerequisite: 270.
3 units, Win (Siegmund) MWF 9

5 units (Staff)

*273. Econometrics II—Continuation of 272 emphasizing simultaneous equations methods and problems. Selected applications in economics. Special topics may be introduced in some years. Prerequisites: 272 and consent of instructor.
5 units (Staff)

370A,B,C. Seminar in Econometrics.
10 units (Staff) by arrangement

J. MATHEMATICAL ECONOMICS
(Professor Kurz)

280. Linear Programming—(Enroll in Business 465A.) This course will survey linc
programming, emphasizing standard model formulation, fundamental theorems, variations of the simplex method and parametric programs. Students will solve linear program on computer. Prerequisites: Mathematics 113 and Mathematics 115.

4 units (Staff)

281. Mathematical Programming — Generalized programming, integer programming, decomposition methods, linearization of nonlinear problems, and discussion of current field developments and important applications. Prerequisite: Business 465B.

4 units (Staff)


3 units (Staff)


3 units (Staff)

284. Advanced Dynamic Programming: Optimal Economic Growth—Current techniques for optimal policies of consumption and capital accumulation. Prerequisite: Operations Research 351 or consent of instructor.

3 units (Staff)

285. Special Topics in Mathematical Economics—The topics for 1966–67 will be announced. May be repeated for credit. Prerequisites: consent of instructor and working knowledge of differential calculus are required.

5 units (Staff)


3 units, Win (Cottle) MWF 3:15

385A,B,C. Seminar in Mathematical Economics.

10 units (Staff) by arrangement

ENGLISH

Emeriti: Hardin Craig, John W. Dodds (Professors)

Executive Head: Ian P. Watt

Associate Executive Head: Charles N. Fifer


Associate Professors: Bliss Carnochan, Charles N. Fifer, H. Bruce Franklin, Albert J. Gelpi, Fred C. Robinson, Lucio P. Ruotolo, W. Wesley Trimpi, Jr. Visiting: Wendell Berry

Assistant Professors: John B. Bender, W. William M. Chace, J. Martin Evans, John Felstiner, Kenneth W. Fields, Larry Friedlander, David Halliburton, S. Dale Harris, Anne T. Kostelanetz, Diane W. Middlebrook, Nancy H. Packer, Robert M. Polhemus, Ronald A. Rebholz

Lecturers: Barbara C. Gelpi, Edward P. McClanahan, Clive Miller, Charlotte Painter, Helen P. Trimpi

The Department of English offers work in English and American Literature, English Philology, and Creative Writing. In connection with these programs, it maintains the William Dinsmore Briggs Memorial Library for the use of graduate students and the Jones Room in the University Library as a center for its work in Creative Writing. The Jones Room includes a library, records, and facilities for small meetings.
PROGRAMS OF STUDY

BACHELOR OF ARTS

The following Departmental requirements are in addition to the University's basic requirements for the Bachelor's degree. Only students who have achieved a C average in courses counting toward the Departmental major will be recommended for graduation.

1. Students majoring in English are required to take one course from each of the six divisions listed below; at least four divisions must be represented by starred courses.

a) Language: English 102*, 208, 209.

b) Medieval: English 141*, 181*, 231.


d) Neoclassic: English 183*, 146, 147, 238, 241.

e) Romantic and Modern: English 184*, 148, 149, 150, 151, 152, 154, 173, 242, 244, 252.


2. Students are required to take at least three additional courses (15 units) in English.

a) AH students (except those majoring in Creative Writing) may select their 15 units of electives from the six divisions above and from these other options: English 100, 155, 171, 172, 192, 196, 198, 199, 205, 251, 272, 274, 278, and courses above 300. Strongly recommended are seminars in English and American literature (English 192 and 196) and Senior Independent Study (English 199).

b) Students wishing to major in Creative Writing are required to take, in addition to the six courses in the six divisions, the following: for fiction writers, Narration (English 5), Development of the Short Story (English 198), plus 8 units of Directed Writing (English 133) or of a more advanced course, all with grades of B or better; for poets, Directed Writing of Poetry (English 134), The English Lyric (English 251), plus 8 units of the Writing of Poetry (English 201), all with grades of B or better.

3. Although no formal minor program is required of English majors, all students are strongly urged to take as many relevant courses as possible in other departments. Faculty advisers will assist students in determining the appropriateness of particular courses for individual major programs. Students intending to teach at a college or university should remember that most graduate schools require, for the doctorate in English, a reading knowledge of two or three foreign languages.

HONORS PROGRAM IN ENGLISH

Students who wish to undertake a more intensive and extensive program of study are invited to apply for admission to the Honors Program, preferably during their sophomore year and no later than the autumn quarter of the junior year. Admission is selective.

Students admitted to the program are expected to take a sequence of two Honors seminars in their junior year. One sequence is offered for the autumn-winter quarters, the other for the winter-spring quarters. The seminars deal with works selected by the professors concerned from an Honors Reading List, but do not attempt to cover all the works that appear on it. Honors students are, however, responsible for the entire list and take an oral examination on it at the end of the junior year. The grade awarded for the 10 seminar units depends partly on the student's performance in the seminars, partly on the results of the oral examination. Those students whose performance in both the seminars and the oral is in the judgment of the Honors Committee of a sufficiently high standard go on to write a Senior Honors Essay (10 units).

In addition, Honors students are expected to complete the regular area requirements for the English major (30 units) and to take two elective advanced courses, one of which should be numbered 200 or above (10 units).

On the basis of their performance in the program as a whole, candidates for Honors are awarded either 'Highest Honors,' or 'High Honors,' or 'Honors.' They will have completed 60 units of work in English literature.

Since the major in Creative Writing is limited to students with special aptitudes, it too is regarded as an Honors Program.

COMBINED MAJOR IN CLASSICS AND ENGLISH

Students may with the consent of the Heads of departments concerned offer for the degree of Bachelor of Arts a combined
Major in Classics (Latin and/or Greek) and English. Students interested in such a major should consult the Heads of each of the departments concerned.

HONORS PROGRAM IN HUMANITIES

An Honors Program in Humanities is offered for majors of this Department who wish to supplement their Departmental major by a related and carefully guided program of studies. See the section "Humanities Special Programs" for a description of the Honors Program.

TEACHERS' CREDENTIALS

Students wishing to obtain the Standard Teaching Credential (Secondary) entitling them to teach in grades 7-12 in the public schools of California, or a Junior College Credential for grades 13 and 14, should consult the statement on credentials under "School of Education" in this bulletin and the Credential Secretary of the School of Education for the requirements.

1. General Secondary Credential. Candidates for the Stanford General Secondary Credential with a teaching major in English are required to take the following Departmental courses or their equivalents:

Teaching Major

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>English 1, 2, 3. Freshman English</td>
<td>9</td>
</tr>
<tr>
<td>One course in the English language, English 102 or 209</td>
<td>5</td>
</tr>
<tr>
<td>English 208. Introduction to Modern Linguistics</td>
<td>5</td>
</tr>
<tr>
<td>English 204. Advanced Exposition</td>
<td>3</td>
</tr>
<tr>
<td>English 143. Shakespeare</td>
<td>5</td>
</tr>
<tr>
<td>English 182. Introduction to the Renaissance</td>
<td>5</td>
</tr>
<tr>
<td>English 183. Neoclassicism</td>
<td>5</td>
</tr>
<tr>
<td>English 184. The Idea of the Modern in Nineteenth Century Literature</td>
<td>5</td>
</tr>
<tr>
<td>Courses in American literature (preferably in the chief American poets and American novelists)</td>
<td>10</td>
</tr>
<tr>
<td>Education 184. Literature for Adolescents</td>
<td>3</td>
</tr>
<tr>
<td>Speech and Drama 20 or 30 recommended</td>
<td>3</td>
</tr>
<tr>
<td>Speech and Drama 164A. Principles of Directing or Communication 50 and 51. Editorial Techniques and Lab.</td>
<td>4</td>
</tr>
<tr>
<td>Electives (courses in literary criticism and oral interpretation of literature are strongly recommended)</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
</tr>
</tbody>
</table>

All candidates for a Stanford credential with a teaching major in English are required to take at least three courses in the Stanford Department of English; for the teaching minor, two such courses are required.

Graduate transfer students who are qualified for a teaching major or minor in English should confer with Professor Grommon before taking English 182, 183, or 184.

Teaching Minor

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>English 1, 2, 3. Freshman English</td>
<td>9</td>
</tr>
<tr>
<td>English 204. Advanced Exposition</td>
<td>3</td>
</tr>
<tr>
<td>English 102. Introduction to the English Language or English 209</td>
<td>5</td>
</tr>
<tr>
<td>English 143. Shakespeare</td>
<td>5</td>
</tr>
<tr>
<td>English 184. The Idea of the Modern in Nineteenth Century Literature</td>
<td>5</td>
</tr>
<tr>
<td>Courses in American literature</td>
<td>10</td>
</tr>
<tr>
<td>Elective, preferably in the English novel or English 208, Introduction to Modern Linguistics</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
</tr>
</tbody>
</table>

A candidate for the Stanford Junior College Credential must begin the program during the summer or autumn quarter. He should apply to the Department of English in advance of registration. The Department will accept only those applicants who seem promising candidates for an advanced degree offered by the Department and meet the standards for college instructors — in other words, those fully qualified to study for the Ph.D. degree, whether or not they plan to do so. Other graduate students interested in obtaining a teaching credential are advised to work for the Stanford General Secondary Credential.

2. Stanford Junior College Credential. Candidates who wish to teach English in public junior colleges in California must complete the Master's degree in English. They are not required by the State of California to complete courses in professional education. However, the California State Accreditation Committee points out that a "program of professional preparation for the standard junior college credential should prove of great employment and professional value to those seeking that credential." To qualify for the Stanford Junior College Credential, candidates must meet the following requirements:

a) Completion of the Master's degree in English.

b) Completion of the following professional courses in education:

1) Education 262A or B. Curriculum and Instruction in Secondary School English (3 units), offered only during summer and autumn quarters, or
English 399, Seminar in the Teaching of Composition, offered only during spring quarter.

2) Education 289. Curriculum and Instruction in the Junior College (3 units), offered only in the winter quarter.

3) Education 248. Student Teaching in Junior College (6) units, to include (1) student teaching in a public junior college, unless the candidate has been officially appointed to the teaching staff of the Department of English; and (2) observation of and, if possible, participation in classes in a public junior college, if the candidate has been officially appointed to the teaching staff of the Department of English. To be supervised by representatives of the School of Education and the Department of English. Confer with Professor Alfred Grommon about arrangements for student teaching.

c) Strongly recommended: Education 347. An Overview of American Higher Education (3 units), offered in the autumn quarter. The recommended sequence of courses is as follows: Education 262A or B, or English 399; Education 248; Education 347.

d) Fulfillment of the Constitution Requirement.

e) Confer with Professor Alfred Grommon, School of Education and Department of English.

3. Master of Arts in Teaching. The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and wish further to strengthen their academic preparation. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education. Detailed requirements for the course are outlined in the School of Education section.

ADVANCED DEGREES

For University regulations governing advanced degrees see the section "Degrees" in this bulletin.

Eligibility — A student may enter upon graduate work toward an advanced degree in English at Stanford if he has received a Bachelor's degree of acceptable quality. (Formal application for candidacy is a separate step taken somewhat later.) Students whose previous preparation falls short of the requirements for the degree of Bachelor of Arts in English at Stanford must expect to spend more than the minimum time in residence. Credits for previous graduate work at Stanford or elsewhere more than five years old may be reevaluated or rejected.

Only candidates for the Ph.D., the Master of Arts in an approved Credential Program, the Master of Arts in Teaching (MAT), or the Master of Arts in Creative Writing, will be accepted as graduate students.

Candidates in an approved Credential Program may earn the Master's degree by passing satisfactorily 36 units of specified work, including English 310, one foreign language, and the qualifying examination for the Ph.D. in English. No thesis is required.

Candidates for the Master of Arts in Teaching must complete a minimum of 25 units of specified work in the English Department.

Candidates for the Master's degree in Creative Writing must submit a sample of their writing with their application. Should this sample be approved, the candidate will be provisionally admitted to the program, but will not be finally accepted until he has demonstrated his ability through one quarter's work in an advanced writing course. A candidate may then earn the Master's degree by passing satisfactorily 36 units of specified work (including English 310 and the qualifying advanced writing course) and one foreign language, and by submitting a piece of imaginative writing of substantial length and merit. This must be submitted at least four weeks before the close of the quarter in which the degree is to be granted.

Candidates for the Master's degree in Creative Writing who, after a quarter's work, are not accepted as degree candidates in the writing program may earn the Master's degree in English by completing satisfactorily 36 units of specified work, including English 310, by passing one foreign language and by passing the qualifying examination for the Ph.D. in English.

DOCTOR OF PHILOSOPHY

University regulations regarding this degree are discussed in the section "Degrees"
in this bulletin. The following Departmental requirements, dealing with such matters as residence, dissertation, and examinations, are in addition to the University's basic requirements for the doctorate.

A candidate for the Ph.D. degree must complete three years (nine quarters) of full-time work, or their equivalent, in graduate study beyond the Bachelor's degree. He will be expected to offer at least 72 units of graduate work in addition to his doctoral dissertation. At least three consecutive quarters of graduate work, and also the last course work in the doctoral program, must be taken at Stanford.

A candidate may take the Ph.D. degree in English literature, in English and American literature, in English and comparative literature, in English and humanities, in English and linguistics, in English philology, or in English medieval literature. A description of the degrees in English philology and English medieval literature will be furnished by the Department of English on request.

Requirements of the Ph.D. program in English literature are as follows:

1. Old English and Middle English language and literature (English 310 and 312 or equivalent work elsewhere).
2. A minimum of four seminars, insuring coverage in genres and periods.
3. A minimum of 48 additional units of graduate courses and seminars (200-399), distributed according to the adviser's judgment and the candidate's needs.
4. A written qualifying examination to be taken at the end of the summer after the first year of graduate work. This examination will be based largely upon a reading list supplied the student at the time of his acceptance at Stanford.
5. A university oral examination to be taken no later than the winter quarter of the student's third year of graduate work. This examination will cover the period of the dissertation, together with plans for the dissertation itself based upon a prospectus approved by the adviser.

Requirements of the Ph.D. program in English and American literature are as follows:

1. English 310 and either 311 or 312, except that the candidate may omit 312 instead of 311 only if he has had a course in Chaucer or other Middle English writers.
2. A minimum of 28 units of graduate courses (200-399) in American literature and 28 units in English literature, including at least two seminars in each. The four seminars should be in different periods and genres as approved by the adviser; at least three must be taken at Stanford.
3. At least 8 units of electives to be distributed between English and American literature according to the adviser's judgment of the candidate's background.
4. A written qualifying examination to be taken at the end of the summer after the first year of graduate work. This examination will be based largely upon a reading list supplied the student at the time of his acceptance at Stanford.
5. A university oral examination to be taken no later than the winter quarter of the student's third year of graduate work. This examination will cover the period of the dissertation, together with plans for the dissertation itself based upon a prospectus approved by the adviser.

Requirements of the Ph.D. program in English and comparative literature are as follows:

1. A knowledge of English literature since 1350 comparable to that demanded of candidates for the Ph.D. in English literature. Candidates will take the appropriate parts of the qualifying examination at the end of the summer after the first year of graduate work.
2. A knowledge of the basic structure of the English language (including the structure of Old English) and of Chaucer. This requirement may be met by examination, or by taking eight units of courses chosen from among those offered in linguistics, English philology, and early and middle English literature including Chaucer.
3. A knowledge of two foreign languages comparable to that demanded under the basic program and an advanced knowledge of a third language; or, an advanced knowledge of two foreign languages.
4. A minimum of 36 units in the history, thought, and literature of one period, in two or more languages, one of which must
be English and one European. As much as 24 units of this requirement may be satisfied through courses in Reading and Research.

5. A minimum of four seminars, of which at least three must be in the English Department. No more than two of the four required may be in the same genre or period.

6. A university oral examination covering the period of the dissertation and plans for the dissertation itself. This examination, based on a reading list established by the candidate in consultation with his adviser, should be taken no later than the winter quarter of the third year of graduate study.

Language Requirements—All candidates for the Ph.D. degree (except those in English and comparative literature) must demonstrate a reading knowledge of Latin, German, and French. Another modern foreign language may be substituted for German or French if it is required for the student's projected research. The student will find it to his advantage if he arrives at Stanford with adequate training in at least two foreign languages.

Foreign language requirements for the Ph.D. may be fulfilled in either of the following ways:

1. Achievement of a sufficiently high score on the foreign language examination prepared by the Educational Testing Service.

2. Passage with a grade of B or higher of a course in literature numbered 100 or higher in a foreign language department at Stanford. As an alternative for Latin only, passage of Latin 5 and 6 with a grade of B or higher.

The student must satisfy one foreign language examination during his first year; a second before his university oral examination; the third before he submits his dissertation. Only students who have qualified in all three languages, as well as passing the oral examination, are eligible for dissertation fellowships.

Dissertation—As early as possible during his graduate study, a Ph.D. candidate will be expected to find a topic requiring extensive original research and to enlist the services of a member of the Department as his adviser. The adviser will request the Executive Head to appoint a committee to supervise the dissertation. The candidate should take this crucial step as early in his graduate career as possible. The committee may well advise extra preparation within or outside the Department, and time should be allowed for such work.

Immediately after the dissertation topic has been approved by the adviser, the candidate should file a formal application for candidacy as prescribed by the University. Ph.D. dissertations must be completed and approved within five years from the date of that application. A candidate taking more than five years will be required to reinstate his candidacy by passing the written qualifying examination again.

The dissertation must be submitted to the adviser in rough draft but in substantially final form at least four weeks before the University deadline in the quarter during which the candidate expects to receive his Ph.D. degree. Dissertations may not be submitted during the summer quarter.

GRADUATE PROGRAM IN HUMANITIES

The Department of English participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in English and Humanities. For a description of the Humanities program, and fellowships offered in connection with it, see the section "Humanities Special Programs."

COURSES PRIMARILY FOR UNDERGRADUATES

#1, 2, 3. Freshman English—Writing, chiefly expository, emphasizing the control of meaning through critical and creative thinking, and through mastery of style. Introduction to the criticism of literature. (Polhemus, Director, with Bender, Chace, Evans, Felstiner, Fields, Fifer, A. Gelpi, Halliburton, Harris, Kostelanetz, Middlebrook, Rebholz, Ruotolo, Stone, Watt, and Staff.)

1. Studies of the individual in modern society by essayists, fiction writers, and a few poets.
   3 units, Aut

2. An introduction to fiction, drama, and poetry as literary genres.
   3 units, Win
3. A variety of subjects of humanistic interest.

3 units, Spr

#1F, 2F. Freshman English — For foreign students.
1F. A specially designed course in expository writing which undergraduate foreign students may substitute for 1.
3 units, Win
2F. Continuation of 1F.
3 units, Spr

#4. Freshman English (Seminars) — Open by invitation to a limited number of students of creative ability who have already shown (in English 1, 2, 1S, or 2S) the capacity to write lucid expository prose. There will be small groups devoted to various kinds of writing, including fiction and poetry. The seminar may replace, for those invited, one quarter of regular or special Freshman English. Where 4 is substituted for 3 or 3S, an introduction to poetry will be included.

3 units, Win, Spr (Polhemus, Director, Staff)

5. Narration — Basic problems of narrative and imaginative writing. Prerequisite: 3 or 4.

3 units, Aut (Staff) (I) MWF 10;
(Painter) (II) MWF 11;
(Packer) (III) MWF 1:15
Win (Painter) (I) MWF 10;
(McClanahan) (II) MWF 11;
(Packer) (III) MWF 1:15
Spr (Staff) (I) MWF 11;
(McClanahan) (II) MWF 1:15

#7. Masterpieces of English Literature — Intensive study of a few masterpieces of English literature from various centuries, including poetry, drama, the essay, the novel.

4 units, Spr (Watt) MTWTh 10

#9. Masterpieces of American Literature — Intensive study of a few masterpieces of American literature, including poetry, drama, the essay, the novel.

4 units, Win (Chace) MTWF 1:15

#25. Shakespeare — Rapid reading of about half the plays and poems in chronological sequence.

4 units, Aut (Sensabaugh) TWThF 10
Win (Ford) MTWF 10
Spr (Ford) MTWF 1:15

#75, 76, 77. Introduction to the Chief Types of Literature — Open to all undergraduate students. Large courses may be divided into sections.

75. Introduction to the Novel — Various species of novels in English and in translation; analysis of technique of fiction.

4 units, Aut (Harris) MWF 9

76. Introduction to Poetry — Prosody, poetic forms and types, critical theories regarding poetry. Masterpieces of English poetry will be studied in the light of these theories.

4 units, Aut (Chace) MTWF 11
Win (Stone) MTWF 10

77. Introduction to the Drama — Principal dramatic forms; development of dramatic art; masterpieces of the theater from various periods, countries.

4 units, given 1969–70

World Literature and the History of Ideas —

100. The English Bible as Literature —
Readings in Old and New Testaments and selected books of the Apocrypha, with some attention to the history of the English Bible and use made of Biblical themes in English literature.

5 units, Win (Ford) MTWTh 11

102. Introduction to the English Language — Designed to give the student a knowledge of fundamental matters about the English language; to familiarize him with terminology, classification of language; to enable him to form standards of judgment about good English.

5 units, Win (Meritt) TWThF 11
Spr (Staff) TWThF 11

129. Scientific Writing — Advanced course in exposition especially for science engineering majors. Prerequisite: 3, or equivalent. Open to juniors and seniors only.

3 units, Aut (——) MWF 9, 10, or 11
Win (——) MWF 9, 10, or 11
Spr (——) MWF 9, 10, or 11
Sum (——) MTWF 9

133. Directed Writing: Fiction — Intermediate course in which the student is to practice various forms of fiction on his own initiative.
Open to sophomores so far as space permits. May be repeated for credit. Prerequisite: 5.

Directed Writing: Poetry—Intermediate course in writing various types of verse. May be repeated for credit.

- 3 to 5 units,
  - Aut (Packer) (I) MW 2:15-4:05;
  - (Berry) (II) TTh 2:15-4:05
  - (McClanahan) (III) TTh 2:15-4:05
  - Win (Berry) (I) TTh 2:15-4:05;
  - (Scowcroft) (II) MW 2:15-4:05
  - Spr (Painter) (I) MW 2:15-4:05;
  - (Packer) (II) TTh 2:15-4:05
  - Sum (McClanahan) MW 2:15-4:05

134. Directed Writing: Poetry—Intermediate course in writing various types of verse. May be repeated for credit.

- 4 units, Spr (Middlebrook) TTh 2:15-4:05

135. Fiction Writing—Designed for seniors in creative writing.

- 3 to 5 units, Win (Stegner) MW 2:15-4:05

141. Chaucer — Enrollment in any given term limited to 70. Each student must sign up in the Department office during May pre-registration for a place in one of the sections taught the following year.

- 5 units, Aut (——) TWThF 11
  - Win (Ackerman) MTWF 11
  - Spr (Ryan) MTWF 9

142. Spenser and His Contemporaries.

- 5 units, given 1969-70

143. Shakespeare—Intensive study of eight or nine plays, including sources, stage history, problems in production, important critical material. Prerequisite: 25 or extensive reading of the plays.

- 5 units, Win (Rebholz) MTWF 1:15

144. Milton.

- 5 units, Win (Evans) TTh 4:15-6:05

145. Donne and Jonson.

- 5 units, given 1969-70

146. Swift and Pope.

- 5 units, Win (Loftis) MTWF 11

147. Johnson and His Circle.

- 5 units, Spr (Fifer) MTWF 10


- 5 units, given 1969-70

149. Byron, Shelley, and Keats.

- 5 units, Aut (Ford) MTWF 9

150. Dickens and Trollope.

- 5 units, given 1969-70

151. Matthew Arnold.

- 5 units, given 1969-70

152. Browning and Tennyson.

- 5 units, given 1969-70

154. Modern British Comic Writers — The nature and uses of comic modes — Wilde, Shaw, Waugh and others.

- 5 units, given 1969-70


- 5 units, given 1969-70

171. Contemporary Drama.

- 5 units, given 1969-70

172. Forms of the Modern Novel—Studies in major English, American, and Continental novelists from 1850 to the present.

- 5 units, given 1969-70

173. Twentieth Century English Fiction.

- 5 units, Aut (Scowcroft) MTWThF 1:15
  - Sum (Ruotolo) MTWThF 10

177. American Literature to 1855.

- 5 units, Win (A. Gelpi) MWF 9

178. American Literature, 1855 to the Present.

- 5 units, Spr (Simpson) TWThF 9

181. The Earliest English Literature—Cultural backgrounds, reading (in translation), and critical analysis of Anglo-Saxon heroic legend, elegies, and other forms.

- 5 units, given 1969-70

182, 183, 184. English Literature—A basic survey. Students will attend two or three general lectures weekly and participate in a two-hour seminar.

182. Introduction to the Renaissance.

- 5 units, Aut (Rebholz) MWF 10; seminars by arrangement

183. Neoclassicism.

- 5 units, Win (Loftis) MWF 10; seminars by arrangement


- 5 units, Spr (Ruotolo) MWF 10; seminars by arrangement

188A. Junior Honors Seminar—Required of all juniors in the English Honors Program.

- 5 units, Aut (Bender) by arrangement
  - Win (Rebholz) by arrangement
188B. Continuation of 188A.
5 units, Win (Felstiner) by arrangement
Spr (Kostelanetz) by arrangement

189. Special Work—Under exceptional circumstances advanced undergraduate students may enroll for special work under supervision of some member of the Department for credit not to exceed four units a quarter.

Any quarter, by arrangement

190. Tutorial Work, Department Honors Program.
Any quarter, by arrangement

English 192 and 196 are open only to senior English majors and to others as space allows. Enrollment is strictly limited. Any student wishing to take a seminar must sign up during the previous May preregistration period. The class lists will contain specific topics and prerequisites. Topics will vary from instructor to instructor and quarter to quarter.

192. Seminar in English Literature.
5 units,
Aut (Ruotolo) (I) MW 4:15-6:05;
(Halliburton) (II) TTh 2:15-4:05
(Kostelanetz) (III) TTh 4:15-6:05
Win (Harris) MW 4:15-6:05
Spr (Felstiner) (I) TTh 2:15-4:05;
(Watt) (II) MW 2:15-4:05

196. Seminar in American Literature.
5 units,
Aut (Fields) MW 2:15-4:05
Win (Grommon) (I) MW 2:15-4:05;
(Middlebrook) (II) TTh 2:15-4:05;
(H. Trimpi) (III) Th 2:15-4:05
Spr (Chace) MW 4:15-6:05

198. Development of the Short Story—Required of senior creative writing students in fiction. Open to others as space allows.
5 units, Aut (Stegner) TTh 2:15-4:05

199. Senior Independent Study — Enrollment limited to 50. Open, on approval by the Department, to seniors majoring in English who wish to work throughout the year on a critical or scholarly essay of about 10,000 words. Applicants should submit (1) a sample of their expository prose and (2) a proposed topic for independent study to the Secretary of the Department before preregistration in May of their junior year. Each student who is accepted will be assigned to an instructor, with whom he will prepare an appropriate reading list before the end of the spring quarter.
10 units (for the entire year),
Aut, Win, Spr (Staff)

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

[N.B.] Though these courses are designed primarily for English majors, graduate students in other departments who wish to broaden their programs will find many of them useful on the same basis as the Graduate Division Special Courses. Graduate students enrolled in any of the 5-unit courses below will take them for 4 units.

201. The Writing of Poetry—Primarily for students seriously interested in the composition of poetry. First- and second-year students may be admitted to this course and to 251 upon application. 251 must be taken simultaneously with 201 or before it. Permission of the instructor required. May be repeated for credit.
2 to 5 units, Aut, Win (Berry) MW 2:15-4:05
Spr (Fields) MW 2:15-4:05

203. Advanced Fiction Writing — A workshop group open by permission to graduates and exceptionally advanced seniors. All applicants should leave samples of writing with the Creative Writing secretary at least ten days before the beginning of each quarter.
2 to 5 units,
Aut, Win (Stegner) MW 2:15-4:05
Spr (Scowcroft) TTh 2:15-4:05

204. Advanced Exposition — Advanced course dealing with problems of writing for professional purposes. Prerequisite: 3 or equivalent.
3 units, Aut (Ackerman) MWF 11

205. The History of Literary Theory.
5 units, Spr (W. Trimpi) MWF 2:15-3:05

208. Introduction to Modern Linguistics—A survey of current developments in the study of Modern English with some attention to their applications in the teaching of English.
5 units, Aut (Traugott) MWF 3:15

209. Principles of Standard English—Phonetics, syntax, derivation, etymology, mean-
ings; consideration of recent developments in study of language.

230A. Medieval to Renaissance: The Development of Literary Forms.

5 units, Win (W. Trimpi) MWF 1:15

230B. Continuation of 230A.

5 units, Spr (Trimpi) MWF 1:15

231. Medieval Literature—An introduction to the literature of medieval England, exclusive of Chaucer. The Anglo-Saxon poems are read in translation, the major poems of the fourteenth and fifteenth centuries in the original language. Prerequisite: 141 or equivalent.

5 units, Spr (——) MWThF 1:15


5 units, Win (Sensabaugh) TWThF 11

238. Drama of the Restoration and Eighteenth Century.

5 units, Spr (Loftis) MTTh F 1:15

241. The English Novel through the Eighteenth Century—Study of the most significant novels, with emphasis on development of the form.

5 units, Win (Scowcroft) MTWTh 1:15

242. The English Novel in the Nineteenth Century—Study of the most significant novels, with emphasis on development of the form.

5 units, Spr (Stone) MTWF 10

244. The Impressionist and Experimental Novel—Prerequisite: 172 or graduate standing.

5 units, given 1969–70

251. The English Lyric—Historical examination of lyric poetry considered in respect to distinctions and historical relationships of schools and movements.

5 units, Spr (W. Trimpi) MWF 11


5 units, Win (Kostelanetz) MTWTh 10

263. Emerson, Whitman, and Emily Dickinson.

5 units, Win (A. Gelpi) MTWF 11


5 units, Spr (Simpson) TWThF 11

265. Hawthorne and Melville.

5 units, given 1969–70

266. Chief American Poets, from 1630 to the Present.

5 units, Win (Fields) MTWF 9

267. Emerson and Thoreau.

5 units, given 1969–70

268. Narrative Prose in America—A study of most significant nonfictional narrative works, with emphasis on history and biography, including autobiography.

5 units, given 1969–70

269. Twain, Howells, and James.

5 units, Aut (Simpson) TWThF 9

270. Contemporary American Fiction—Study of representative novels and stories from Hemingway to Nabokov.

5 units, given 1969–70

271. Modern Southern Writers.

5 units, Spr (A. Gelpi) MTWTh 11

272. Twentieth Century British and American Poetry.

5 units, Spr (Middlebrook) MTWTh 10

273. The Portrayal of Europe in American Literature—A study of American writers' responses to European history, values, scenes, and character, with special attention to Henry James, Mark Twain, and Ernest Hemingway. Other writers to be considered: Irving, Hawthorne, Adams, Baldwin, Malamud, and Bellow.

5 units, given 1969–70

274. Literature of World War I.

5 units, Win (Stone) MTWF 11

278. Popular Ballad and Folksong.

5 units, Aut (Simpson) TWThF 11

299. Advanced Work in Writing and Criticism.

Any quarter, by arrangement

Curriculum and Instruction in Secondary School English I—See Education 262.

GRADUATE COURSES

[N.B.] All graduate seminars are limited in enrollment. Students must obtain the approval of the instructor and sign his seminar list before registering.
300. Thesis.

Any quarter, by arrangement

302. Introduction to Renaissance Bibliography—An introduction to tools and methods for graduate study in the Renaissance, especially historical and textual research. Recommended for students who expect to do advanced work in the Renaissance.

1 unit, Win (Evans) W 1:15

304. Seminar in Modern Literary Criticism.

4 units, Win (Halliburton) TTh 4:15–6:05

305. Seminar in the History of Literary Theory.

305A. The Classical and Medieval Backgrounds—(305A may be taken independently of 305B.)

4 units, given 1969–70

305B. The Renaissance — Prerequisite: 305A.

4 units, given 1969–70

306. Seminar in the Criticism of Poetry.

4 units, given 1969–70

307. Seminar in the Novel — Prerequisite: the equivalent of 241, 242, 265, or 270.

307A. Critical Analysis.

4 units, Aut (Scowcroft) TTh 2:15–4:05

307C. Conrad.

4 units, Spr (Watt) TTh 2:15–4:05


4 units, given 1969–70

310. Old English—Elements of Old English grammar; reading exercises.

4 units, Aut (Meritt) (I) TWThF 9;

(——) (II) TWThF 10

Sum (Meritt) MTWThF 9

311. Beowulf—Prerequisite: 310 or equivalent.

4 units, Win (Meritt) TWThF 9

312. Middle English — History, dialects of Middle English; readings of representative selections from the literature. Prerequisite: 310 or equivalent.

4 units, Win (Ackerman) MTWF 10


4 units, Aut (Meritt) TWThF 11

316. Seminar in Elizabethan Language — Vocabulary, pronunciation, grammar, orography of the period. Prerequisite: 312 or equivalent.

4 units, given 1969–70

318. Seminar in Middle English Literature —Prerequisite: 312 or equivalent.

4 units, Aut (Ackerman) MW 2:15–4:05

319. Seminar in the Philological Study of Literary Texts.

4 units, given 1969–70

320. Seminar in Chaucer — Troilus and Criseyde in some years, selected short poems in others; structure, history of the works, their literary significance. Prerequisite: 141 or equivalent.

4 units, Win (Ackerman) MW 4:15–6:05

321. English Literature of the Fifteenth Century.

4 units, Win (——) TTh 4:15–6:05

322. Seminar in Medieval Drama.

4 units, given 1969–70

323. Seminar in Medieval Latin.

4 units, Win (——) by arrangement

325. Shakespeare Seminar — Prerequisites: The equivalent of 25 or 143, 182 or 330, and 237.

4 units, Win (Whitaker) MW 4:15–6:05


4 units, Aut (——) MW 2:15–4:05

331A. Sir Philip Sidney and His Circle.

4 units, Win (W. Trimpi) MW 2:15–4:05

331B. Ben Jonson.

4 units, given 1969–70

331F. English Poetry From 1590 to 1620.

4 units, Spr (Rebholz) MW 2:15–4:05


4 units, given 1969–70

332B. Francis Bacon and His Times.

4 units, given 1969–70

332C. Marlowe and His Contemporaries.

4 units, Aut (Kocher) TTh 4:15–6:05


4 units, Aut (Sensabaugh) TWThF 11

335. Seminar: Forms of Jacobean and Caroline Drama.

4 units, Aut (Sensabaugh) TTh 4:15–6:05
   4 units, given 1969-70

   4 units, Win (Sensabaugh) TTh 2:15-4:05

   4 units, Win (Fifer) MW 2:15-4:05

341. Literary Problems of the Restoration and Eighteenth Century—Prerequisite: 183 or 340, or equivalent.

341A. Seminar in Eighteenth Century Fiction.
   4 units, Win (Watt) TTh 2:15-4:05

341B. Studies in Dryden, Swift, and Pope.
   4 units, Spr (Loftis) TTh 4:15-6:05

341C. Johnson and His Circle.
   4 units, Aut (Fifer) MW 2:15-4:05

   4 units, Aut (Ford) MW 4:15-6:05

351. Literary Problems of the Romantic Period—Prerequisite: 184 or 350, or equivalent treatment of Romantic period.

351B. English Romantic Poets.
   4 units, Sum (Ruotolo) MW 2:15-4:05

351C. Nineteenth Century Poetry.
   4 units, Spr (Ford) MW 4:15-6:05

   4 units, Spr (Harris) MW 2:15-4:05

354. Victorian Prose: Carlyle, Ruskin, and Arnold.
   4 units, given 1969-70

355. Pater and the Pre-Raphaelites.
   4 units, Spr (B. Gelpi) MW 4:15-6:05

358. Seminar: Literary Problems of the Nineteenth Century—Prerequisite: 184 or 350, or equivalent.

358A. Nineteenth Century Comic Fiction.
   4 units, Aut (Polhemus) MW 2:15-4:05

358B. The Bloomsbury Group.
   4 units, Spr (Stone) MW 4:15-6:05

358E. The Nineties—Studies in such writers as James, Shaw, Wilde, Yeats, Beerbohm.
   4 units, Aut (Felstiner) MW 4:15-6:05

361. Seminar in American Critics.
   4 units, given 1969-70

   4 units, given 1969-70

371. Seminar in American Historians as Men of Letters—Prerequisite: 268 or equivalent.
   4 units, given 1969-70

   4 units, Spr (A. Gelpi) TTh 4:15-6:05

377. Seminar in American Literature of the Colonial Period—Prerequisite: 177 or equivalent.
   4 units, given 1969-70

381. Seminar in Problems in American Literature of the Nineteenth Century.

381A. Studies in James, Conrad, and Ford.
   4 units, given 1969-70

381B. Politics and Society in American Literature, 1880-1930.
   4 units, Win (Simpson) TTh 4:15-6:05

381C. Seminar in American Literature of the 1840’s—Study of the major works of this decade (beginning with Emerson’s Essays and The Deerslayer in 1841 and ending with Moby-Dick and Uncle Tom’s Cabin in 1851-52) in relation to each other and to the major issues of the time.
   4 units, given 1969-70

381D. Faulkner.
   4 units, given 1969-70

381E. Ezra Pound.
   4 units, given 1969-70

381F. Modern Southern Fiction.
   4 units, Aut (A. Gelpi) MW 4:15-6:05

382. Utopian Literature.
   4 units, given 1969-70

383. The Existential Hero in Twentieth Century British and American Fiction.
   4 units, Win (Ruotolo) MW 2:15-4:05

395. Research Course—Student pursues a special subject of investigation under su
pervision of some member of Department. Thesis work not to be registered under this course.

Any quarter, by arrangement

399. Seminar in the Teaching of Composition—Open only by permission of the Director of Freshman English.

2 units, Spr (——) W 7–9 p.m.

The English Review Club meets two times quarterly to discuss recent publications and creative work of interest to graduate students in English.

See also Senior Colloquia.

FRENCH AND ITALIAN

Emeriti: Georges E. Lemaitre, Roberto B. Sangiorgi, Stanley A. Smith (Professors); Jessie E. Smith (Assistant Professor)

Executive Head: Raymond D. Giraud


Associate Professors: William C. Calin, Pauline Newman-Gordon, Ralph M. Hester

Assistant Professors: Marc Bertrand, Michael T. Cartwright, Antonio G. Castelli.

Acting: Charles Klopp, Michael Leone

Lecturers: John G. Barson, Marguerite Bauer, Clio P. Dorr, Leda S. Mussio, Jacqueline Ollivier, Jeanne-Françoise Rouffanges

The Department accepts candidates for the degrees of Bachelor of Arts, Master of Arts in French and in Italian (see below under "Advanced Degrees"), and Doctor of Philosophy in French.

PROGRAMS OF STUDY

BACHELOR OF ARTS IN FRENCH

Candidates must have completed the first- and second-year courses in reading, composition, and conversation (or their equivalent) offered in French.

Candidates are expected to complete a minimum of 42 units, selected with the approval of their adviser, from courses numbered 100 and higher. These 42 units must include:

For French majors: 111, 112, 121, and 130, 131, and 132, plus 24 additional units in literature, to include two of 150, 151, 152.

BACHELOR OF ARTS IN ITALIAN

Candidates must have completed the first- and second-year courses in reading, composition, and conversation (or their equivalent) offered in Italian and must show considerable language proficiency.

Candidates are expected to complete a minimum of 36 units, selected with the approval of their adviser, from courses numbered 100 or higher. These 36 units must include Italian 111, 112, 113, 130, 131, and 132, plus 18 additional units in literature to include Italian 150, 151, and 152. With the approval of their adviser, candidates may replace one or two courses with courses in related disciplines, such as History, Art History, and Classics.

TEACHING CREDENTIALS

For information concerning the requirements for teaching credentials, consult the "School of Education" section of this bulletin and the Credential Secretary, School of Education.

MASTER OF ARTS IN TEACHING

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and wish further to strengthen their academic preparation. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education. Detailed requirements for the course are outlined in the School of Education section.

STANFORD PROGRAM IN NANTES — (For French majors only.)

Each year French majors, in their sophomore or junior year, may apply for the Departmental program at the University of Nantes during the following autumn and winter quarters. Students reside in the Cité Universitaire, attending courses both at the University and with the faculty supervisor who accompanies the group. Applications must be received by April 15. Forms and in-
Master of Arts: French

1. Language requirements. Reading knowledge of the second Romance language should be demonstrated by passing an examination not later than the second quarter of residence.

2. Course requirements:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
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<tbody>
<tr>
<td>a) Cours de style avancé French 210</td>
<td>3</td>
</tr>
<tr>
<td>b) Three courses in philology</td>
<td>9</td>
</tr>
<tr>
<td>French 310, 311, 312</td>
<td></td>
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<tr>
<td>c) Five graduate courses in literature at the 300 level</td>
<td>15</td>
</tr>
<tr>
<td>d) One seminar</td>
<td>3</td>
</tr>
<tr>
<td>e) French 399 (thesis) or electives to be chosen with the approval of the graduate adviser</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
</tr>
</tbody>
</table>

Note—Students already holding the A.M. must satisfy the Department that they have met the equivalent of these requirements before admission.

Doctor of Philosophy: French

General Requirements — Candidates are expected to complete the course requirements for the Master of Arts degree in French. All candidates, regardless of their field of specialization, are expected to fulfill the following general requirements:

1. Language requirements. A reading knowledge of Latin and German, to be tested by examination. Another foreign language may be substituted for German, if it is required for the student's projected research.

2. Course requirements. A total of no less than 72 units of graduate work, exclusive of Fr399 (except for 6 units if taken for the writing of a Master's thesis). This course work must include the following: French 310, 311 and 312, if these have not already been completed in the first year; at least three additional courses in literature at the 300 level; four additional seminars in literature, at least two of which are to be outside the candidate's special field of interest. The total of literature courses and seminars must include at least six units of work in each major period.

3. Oral and written examinations. The student must pass, normally in the autumn quarter of the third year of graduate study, oral and written examinations in four fields of French literature, plus philology and the history of the French language, a field being
defined as a century. For examination purposes, centuries are grouped as follows: I, Middle Ages, sixteenth and seventeenth century; II, eighteenth, nineteenth and twentieth century. Students will be examined in two centuries from each group.

4. Submit a doctoral dissertation worthy of publication as a contribution to study in the field.

Minor in Italian—The Department offers a Ph.D. in French with a minor in Italian. Interested candidates are invited to discuss this degree with the Graduate Adviser.

MASTER OF ARTS: Italian
Applicants for the Master of Arts in Italian must have an undergraduate major in Italian with an average grade of B (or the equivalent).

1. Language requirements. Reading knowledge of a second Romance language, to be demonstrated by passing an examination. Recommended: French.

2. Course requirements:

   a) Six courses in Italian literature numbered 200 or higher 18
   b) Introduction to Romance Linguistics, 310 3
   c) Three courses selected from advanced undergraduate or graduate courses in Italian literature or in a related discipline (e.g., Art 210, 211, French 341, 342, etc.) 9
   d) Thesis 6

Total: ........................................ 36

GRADUATE PROGRAM IN HUMANITIES

The Department of French and Italian participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in French and Humanities. For a description of that program see the section “Humanities Special Programs.”

COURSES OPEN TO ALL STUDENTS

The courses in this section do not require a knowledge of any language other than English.

GENERAL COURSE

101. Science of Language—Introduction to the fundamentals of language, its nature and function; phonological, grammatical, and lexical structure of natural languages and their development; outline of the descriptive, comparative, and historical study of language. 3 units (Juilland) given 1969–70

FRENCH

#50. Courtly Love in the Middle Ages—The development of courtly love as it is embodied in masterworks of medieval literature. 3 units, Win (Calin) TTh 2:15

#60. Molière—Representative comedies of Molière in English translation. 3 units (Weinstein) given 1969–70

#70. The Nineteenth Century French Novel in Translation—The “romantic realists”: Stendhal, Balzac, Flaubert, and Zola. 3 units, Win (Giraud) TTh 11

#71. Contemporary French Novelists—Significant authors of contemporary France: Proust, Gide, Malraux, Sartre, Camus, etc. Lectures, readings in English. 3 units, Spr (Cohn) TTh 3:15

#90. The Committed Writer in France from Montesquieu to Sartre—Literary writers who have incorporated a political or social point of view in their fictional works. 3 units, Spr (Weinstein) TTh 11

ITALIAN

#75. Dante in English—Reading, interpretation of Vita Nuova and The Divine Comedy in translation. 3 units, Aut (Cecchetti) MF 3:15

#80. The High Renaissance—Given also at Stanford-in-Italy. The main trends of the Italian Renaissance. Readings from Machiavelli, Ariosto, Tasso, etc. 3 units, Win (Klopp) MW 3:15

#140. The Contemporary Italian Novel in Translation—Reading, discussion of significant novels of such authors as Verga, Pirandello, Svevo, Vittorini, Pavese, Moravia. 3 units, Sum, given 1969–70

FRENCH COURSES

FIRST- AND SECOND-YEAR

(Under the direction of Ralph M. Hester)

Note—Students registering for the first time in a first- or second-year course must take a
placement test, if they have had any training in French before entering Stanford. Tests will be given September 19, 23, 25, and 30 (for autumn quarter); November 18, January 6 and 8 (for winter quarter); February 27, March 31, and April 2 (for spring quarter). The placement test is not given in the summer.

#1. First-Year French.
4 units, Aut, Win, Spr (Staff) MTWThF

#2. First-Year French—Continuation of 1.
4 units, Aut, Win, Spr (Staff) MTWThF

#3. First-Year French—Continuation of 2.
4 units, Aut, Win, Spr (Staff) MTWThF

#5. Intensive French for Beginners — (Equivalent to 1 and 2.) Offers preparation in speaking, writing, and reading the language.
8 units, Sum (Staff) MTWThF

10. Elementary French—A reading course in French for students seeking to fulfill the University requirement of a reading knowledge for the Ph.D. degree. Open to seniors and graduate students only.
3 units, Aut, Win, Spr (Staff) MWF
Sum (Staff) MTWTh 8

#22. Second-Year French—Prerequisite: 3.
3 units, Aut, Win, Spr (Staff) MTWTh

#23. Second-Year French — Continuation of 22.
3 units, Aut, Win, Spr (Staff) MTWTh

30. Conversation française premier degré—Prerequisite: 3 or equivalent.
1 unit, Aut, Win, Spr, Sum (Staff) TTh 9
and TTh 1:15

31. Conversation française deuxième degré—Prerequisite: 23 or equivalent.
1 unit, Aut, Win, Spr (Staff) TTh 9
and TTh 1:15

#54. Cours pratique de littérature—Composition littéraire, lecture et explication de textes littéraires divers. Satisfies General Studies requirements under “C.” Prerequisite: 23 or equivalent.
4 units, Aut, Win, Spr (Staff) MTWThF

#82–86. Intensive French — Given only at Stanford in France.
6 units for each of two quarters, Aut-Win, Spr-Sum (Staff) MTWTh, two hours daily

THIRD- AND FOURTH-YEAR

Language Courses
(Under the direction of Ralph M. Hester)

110. Cours de Phonétique—Prerequisite: 54 or equivalent.
3 units, Spr (Hester) MWF 1:15

111. Composition, grammaire et étude de textes I—Prerequisite: 54 or equivalent.
3 units, Aut (Barson) MWF 8
Win (Bertrand) MWF 1:15
Spr (Barson) MWF 8

112. Composition, grammaire et étude de textes II—Continuation of 111.
3 units, Win (Hester) MWF 9
Spr (Cartwright) MWF 9

121. Cours avancé de français—Prerequisites: 111 and 112 or equivalent.
4 units, Aut (Cartwright) MWF 9

Literature Courses

130. Introduction à la littérature française—Moyen Âge et 16ème siècle: choix de textes, explication de textes, composition littéraire. Prerequisite: 54 or equivalent.
3 to 4 units, Aut (Calin) (I) MWF 10

131. Introduction à la littérature française—17ème et 18ème siècles. Prerequisite: 54 or equivalent.
3 to 4 units, Aut (Bertrand) MWF 2:15
Spr (Newman-Gordon)
MWF 9

132. Introduction à la littérature française—19ème et 20ème siècles. Prerequisite: 54 or equivalent.
3 to 4 units, Win (Cohn) MWF 1:15
Spr (Bertrand) MWF 9

Note—Prerequisites for the following courses are French 130, 131, and 132 or 85, and 86 or equivalent.

140. Littérature de la Renaissance I — Rabelais, les poètes lyonnais, les poètes de la Pléiade.
4 units, Win (Hester) MWF 10

141. Littérature de la Renaissance II — Montaigne, les poètes baroques; le théâtre.
4 unit, Spr (Hester) MWF 11

150. Le XVIIème siècle I — Poésie et roman; les poètes baroques, Théophile de Viau, Saint-Amant, Tristan l’Hermite; les
Fables de La Fontaine; Mme de La Fayette: La Princesse de Clèves.
4 units, Spr (Lapp) M 2:15 and T 2:15–4:05

#151. Le XVIIème siècle II — La tragédie; Racine: Andromaque, Athalie, Britannicus, Iphigénie; Corneille: Horace, Cinna, Polyeucte, Nicomède.
4 units, Aut (Weinstein) MWF 2:15

#152. Le XVIIème siècle III — La Comédie: Corneille et Molière; Pascal, Pensées; La Rochefoucauld, Maximes.
4 units, Win (Weinstein) MWF 2:15

4 units, Aut (Cartwright) MWF 1:15

#161. Le XVIIIème siècle II — Roman et théâtre. Roman: Prévost, Manon Lescaut; Diderot, La Religieuse; Rousseau, La Nouvelle Héloïse. Théâtre: Lesage, Turcaret; Marivaux, Le Jeu de l'Amour et du Hasard; Beaumarchais, Le Barbier de Séville.
4 units, Win (Cartwright) MWF 11

4 units, Aut (Giraud) given 1969–70

4 units, Win (Weinstein) MWF 3:15

4 units, Spr (Giraud) MWF 9

#180. Le XXème siècle I — La Poésie française de Valéry au Surréalisme
4 units, Aut (Newman-Gordon) MWF 11

#181. Le XXème siècle II — Le Théâtre français de Giraudoux à Ionesco.
4 units, Win (Newman-Gordon) MWF 1:15

#182. Le XXème siècle III — Le Roman en France depuis 1898.
4 units, Spr (Newman-Gordon) MWF 10

#190. La Poésie française du Moyen Age à nos jours.
4 units, Spr (Calin) MWF 3:15

199. Individual Work — Open only to majors in French and with special permission of the Department. May be repeated for credit.
1 to 3 units, each quarter (Staff) by arrangement

ADVANCED UNDERGRADUATE
AND GRADUATE COURSES

204. Études de style — Etude stylistique de l'oeuvre de Céline.
3 units, Aut (Juilland) TTh 11

205. Modern French — Phonology, morphology, and syntax.
3 units, Aut (Juilland) given 1969–70

210. Cours de style avancé — Perfectionnement de la langue écrite; tradition de prose et de vers; composition.
3 units, Aut (Juilland) given 1969–70

215. French Existentialist Writers — With special emphasis on Sartre, Camus, Gabriel Marcel, Merleau-Ponty, Malraux, and Simone de Beauvoir.
3 units, Spr (Juilland) TTh 1:15

3 units, Aut (Calin) 2:15–4:05

250. Points de vue critiques au XXème siècle — De Valéry à la Nouvelle Critique.
3 units, Spr (Bertrand) TTh 11

3 units, Win (Bertrand) given 1969–70

GRADUATE COURSES

310. Introduction to Romance Linguistics — Problems in historical and structural linguistics.
3 units, Aut (Juilland) M 2:15–4:05

311. Old French Texts — Reading and interpretation of selected old French texts. Prerequisite: 310.
3 units, Win (Calin) T 10 and Th 4:15–6:05

312. Histoire de la langue française depuis le Moyen Age jusqu'à présent — Prerequisite: 311.
3 units, Spr (Juilland) TTh 4:15
SCHOOL OF HUMANITIES AND SCIENCES

315. Grammaire historique de la langue française.
   3 units, Win (Juilland) TTh 3:15

325. Cours de méthode—Méthode critique et bibliographique, préparation de thèses.
   3 units, Win (Lapp) given 1969-70

   3 units, Spr (Calin) given 1969-70

341. La Renaissance en France I—Les Proseateurs; Rabelais et Montaigne.
   3 units (Lapp) given 1969-70

342. La Renaissance en France II — Les poètes de la Pléiade et les poètes baroques de la fin du XVIème siècle.
   3 units (Lapp) given 1969-70

   3 units, Spr (Calin) given 1969-70

350. Graduate Seminars.
   The Chansons de Geste.
   3 units, Spr (Calin) W 4:15-6:05

   Medieval Allegory: Le Roman de la Rose.
   3 units (Calin) given 1969-70

   Chrétien de Troyes.
   3 units, Win (Remy) M 2:15-4:05

   Montaigne.
   3 units, Spr (Lapp) W 2:15-4:05

   Corneille.
   3 units, Aut (Lapp) given 1969-70

   Molière.
   3 units, Aut (Weinstein) Th 4:15-6:05

   La Fontaine.
   3 units, Spr (Lapp) given 1969-70

   Le Roman au XVIIIème Siècle.
   3 units, Win (Cartwright) W 2:15-4:05

   Hugo.
   3 units, Spr (Giraud) given 1969-70

   Flaubert.
   3 units, Aut (Giraud) W 2:15-4:05

   Mallarmé.
   3 units, Spr (Cohn) given 1969-70

   Stendhal.
   3 units, Spr (Weinstein) Th 4:15-6:05

   Rimbaud.
   3 units, Aut (Cohn) M 4:15-6:05

   Balzac.
   3 units (Weinstein) given 1969-70

   Proust.
   3 units, Win (Newman-Gordon) T 4:15-6:05

353. Le Théâtre classique français — Corneille, Molière, Racine.
   3 units (Weinstein) given 1969-70

361. Rousseau—Lectures in French.
   3 units (Cartwright) given 1969-70

362. Diderot—Lectures in French.
   3 units (Cartwright) given 1969-70

364. Le Théâtre au XVIIIème Siècle.
   3 units, Spr (Cartwright) Th 2:15-4:05

   3 units (Weinstein) given 1969-70

371. Baudelaire.
   3 units, Spr (Cohn) M 4:15-6:05

372. The Symbolist Poets.
   3 units, Win (Cohn) W 4:15-6:05

373. La Critique littéraire au XIXème siècle — Sainte-Beuve, Taine, Brunetière, and others.
   3 units (Weinstein) given 1969-70

380. La “grande génération”—Proust, Gide, Péguy, Claudel, Romain Rolland, Valéry.
   3 units, Aut (Newman-Gordon) Th 2:15-4:05

381. Proust—Lectures in French.
   3 units, Spr (Newman-Gordon) F 2:15-4:05

382. Gide, romancier et moraliste.
   3 units, Spr (Giraud) T 2:15-4:05

   3 units (Giraud) given 1969-70

   3 units (Newman-Gordon) given 1969-70

399. Individual Work — Exclusively for graduate students in French working on thesis or engaged in special work.
   1 to 12 units, each quarter (Staff) by arrangement
ITALIAN COURSES

FIRST- AND SECOND-YEAR

Note—Students registering for the first time in a first- or second-year course must take a placement test if they have had any training in Italian before entering Stanford.

#1. First-Year Italian.
4 units, Aut, Win, Spr (Staff) MTWThF

#2. First-Year Italian.
4 units, Aut, Win, Spr (Staff) MTWThF

#3. First-Year Italian.
4 units, Aut, Win, Spr (Staff) MTWThF

#5. Intensive Italian for Beginners —
Equivalent to 1 and 2. Offers preparation in speaking, writing, and reading the language.

8 units, Sum (Staff) MTWThF

10. Elementary Italian—A reading course in Italian for students seeking to fulfill University requirements of reading knowledge for the Ph.D. degree. Open to senior and graduate students only.
3 units (Staff)

#22. Second-Year Italian—Prerequisite: 3 or equivalent.
3 units, Aut, Win, Spr (Staff)

#23. Second-Year Italian—Continuation of 22.
3 units, Aut, Spr (Staff)

30. Corso di Conversazione—Prerequisite:
3 or equivalent, or permission of instructor.
1 unit, Aut (Staff) TTh 10

#82–86. Intensive Italian — Given only at Stanford in Italy.
6 units for each of two quarters, Aut-Win or Spr-Sum (Staff) MTWTh two hours daily

THIRD- AND FOURTH-YEAR

Language Courses

111. Italian Grammar and Composition.
3 units, Aut (Staff) MWF

112. Italian Grammar and Composition —
Continuation of 111.
3 units, Win (Staff) MWF

113. Italian Grammar and Composition —
Continuation of 112.
3 units, Spr (Staff) MWF

Literature Courses

#130. Introduzione allo studio della letteratura italiana I—Dalle origini alla fine del Quattrocento. Prerequisite: 23 or equivalent.
3 units, Aut (Leone) MWF 1:15

#131. Introduzione allo studio della letteratura italiana II—Dal Cinquecento al tardo Settecento. Prerequisite: 23 or equivalent.
3 units, Win (Klopp) MWF 1:15

#132. Introduzione allo studio della letteratura italiana III—Dal tardo Settecento al Novecento. Prerequisite: 23 or equivalent.
3 units, Spr (Leone) MWF 1:15

#150. Dante, La Divina Commedia—Studio e interpretazione.
3 units, Aut (Cecchetti) MWF 2:15

#151. Dante, La Divina Commedia—Studio e interpretazione.
3 units, Win (Cecchetti) MWF 2:15

#152. Dante, La Divina Commedia—Studio e interpretazione.
3 units, Spr (Cecchetti) MWF 2:15

#160. Letteratura Italiana del Medioevo—
Il corso non include lo studio de La Divina Commedia.
3 units, Aut (——) given 1969-70

#161. Umanesimo e Rinascimento—La letteratura e la cultura italiana dal Petrarca a Lorenzo de' Medici.
3 units, Aut (Castelli) TTh 3:15

#162. Il Pieno Rinascimento—La letteratura e la cultura italiana dall'Ariosto e il Machiavelli al Tasso.
3 units, Spr (Klopp) TTh 3:15

199. Individual Work—Open only to majors in Italian and with special permission of the Department. May be repeated for credit.
1 to 3 units, each quarter (Staff) by arrangement

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

3 units, Win (Cecchetti) MWF 3:15

3 units (Cecchetti) given 1969-70
GEOGRAPHY

Undergraduate courses in Geography will be offered by the Food Research Institute.

GERMAN

Emeriti: Helmut R. Boeninger, Kurt F. Reinhardt (Professors)
Executive Head: F. W. Strothmann
Associate Professors: A. Peter Foulkes, Walter F. W. Lohnes
Assistant Professors: Gisela Luther, Acting: John M. Flores, William C. Mead, Peter C. Ober
Instructors: Gertrude Mahrholz, Ursula Rau

OFFERINGS AND FACILITIES

The Department accepts candidates for the degree of Bachelor of Arts, Master of Arts, and Doctor of Philosophy. The requirements for these degrees are given below under Programs of Study.

MASTER OF ARTS IN TEACHING

The degree of Master of Arts in the Teaching of German is offered jointly by the School of Education and the Department. The program includes 25 units of German in courses selected in consultation with the Department adviser. For a statement of requirements other than German see the section “School of Education” in this bulletin.

GRADUATE PROGRAM IN HUMANITIES

The Department participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in German and Humanities. Students accepted for this program complete the requirements for a Ph.D. in German as given below as well as those described in this bulletin under “Humanities Special Programs.”

Intensive Language Work Abroad

Each undergraduate student accepted by the Committee on General Studies for work at a Stanford center in Germany or Austria completes 12 units of German during the six months of his residence in Europe. The work is primarily designed to develop the student’s ability to understand, speak, and read...
German, but courses are given at various levels. All German courses taken at a center are identified by the number 80 with a second digit indicating the level at which the 12 units were taken. Course identification may vary from 82, the lowest, to 86. A student majoring in German will have the work taken abroad evaluated on his return in terms of the specific degree requirements.

Stanford Hamburg Program

The University maintains a program in Hamburg, Germany, for the benefit of advanced students majoring in German or in History. To participate at least a B average in German is required. Qualified juniors or seniors majoring in German may enroll for two quarters. While in Hamburg, they can complete specific course requirements as well as a number of courses in the elective area. The latter are chosen from courses offered by the University of Hamburg. A.M. candidates and occasional Ph.D. candidates may also take part in the program.

PROGRAMS OF STUDY

Bachelor of Arts

All candidates should normally complete the series of courses offered for first- and second-year students (1, 2, 3, 52, 53). Transfer students or students with several years of high school German will be given a placement test to determine which, if any, of these courses they should take. Students who have completed 22 instead of 52 may be admitted to 53 as German majors on special application. After completing the second-year series or its equivalent, all students majoring in German will include in their program 18 units consisting of two courses in composition (111, 112) and three courses (151, 152, and either 153 or 154) which present a general view of the history of German literature through the reading of major documents from the 18th century to the present day. The courses in literature may be taken in any order, but those in composition need to be in sequence. Students returning from Stanford in Austria or Stanford in Germany will be exempt from certain requirements if they have completed the equivalent of the work while overseas.

For the balance of their work, majors may concentrate either on German language and literature or on German thought and culture. The following paragraphs describe the additional requirements.

The student in German language and literature will take 12 units of course work in listening and speaking, pronunciation, writing, and the history of the language (100, 110, 113, 185) as well as 12 units in literature which may be elected freely from the various courses in literature numbered 140–149 or 180–199.

The student in German thought and culture will take 9 units in courses (171, 172, 173) which are designed to introduce him to the continuum of German intellectual and cultural history; and 6 units in two seminars (196, 197) in which particular problems, cultural movements, or individual authors will be studied. In addition, 12 units of electives are required, of which at least 6 must be taken outside the Department in support of the major program.

Students with either concentration for their major may take honors in German. For this, a minimum G.P.A. of 3.0 is required. The honors essay will be on a topic chosen by the student, generally as a development of work done either in a seminar or a literature course. It will represent 9 units of academic work.

Master of Arts

To be accepted as a candidate for the degree of Master of Arts a student needs to establish that he has completed creditably either an A.B. degree with a major in German or an equivalent of this work. Knowledge of Latin and of French is also desirable. Stanford University requires three full quarters of graduate study (12 graduate units per quarter) before any degree can be granted. A student with graduate work taken at another university, in this country or abroad, is advised that this work will not reduce the three-quarter requirement; however, if he continues his studies, it will shorten the time needed for completion of the Ph.D. degree.

The requirements for the degree of Master of Arts in German are:

1. 36 units of graduate work in the major field, normally the following courses:
   a) 190. Phonology and Morphology.
   b) 200. Methods of Teaching German.
   c) 201 and 202. Advanced Composition.
   d) 205. Modern German Grammar.
DOCTOR OF PHILOSOPHY

Students should read carefully the University regulations governing the conferring of this degree as described in the section "Degrees" in this bulletin.

The Master of Arts degree is a prerequisite for admission to the program. Exceptions are made only for those students who have completed a substantial equivalent at a foreign university.

Near-native proficiency in German is expected of all candidates irrespective of their field of specialization. During the first year at Stanford, all graduate students will be given the MLA Foreign Language Proficiency Test for Teachers and Advanced Students to give them an indication of their achievement in listening-comprehension, speaking, reading, and writing.

The requirements for the degree of Doctor of Philosophy in German are:

1. A working knowledge of Latin and a reading knowledge of one modern language other than English or German.

2. In addition to the course work listed under the requirements for the Master of Arts degree, the student is expected to complete a program concentrating either in literature or in language. If a student is not taking a minor in another field nor participating in the Graduate Humanities program, he may satisfy all course requirements for the Ph.D. degree by completing 54 units of graduate work beyond the A.M. requirements. Since teaching assistants and research assistants can enroll for nine units per quarter, all students who have completed the requirements for the A.M. degree should be able to complete the course work for the Ph.D. degree in six quarters. Students able to enroll for more than nine units per quarter should be able to finish this course work during their fifth post-A.M. quarter.

The special requirements for the doctoral program in literature are as follows:

a) One course in each of the five areas of literature represented in the series 230-280.

b) Three graduate seminars.

c) A minimum of 4 units of philology: Gothic, Old Norse, Old High German and Old Saxon, or Advanced Middle High German.

d) Three units of Individual Work (course 299) to be used to read, under the supervision of the student's adviser, the works listed in the "Graduate Reading List for Ph.D. candidates in German." These three units may be distributed over several quarters.

e) Units of electives to complete the 54-unit post-A.M. requirement. These may be taken either in additional courses in the Department (200 or higher), in a complementary program such as Graduate Humanities, or in Individual Work.

The special requirements for the doctoral program in language are as follows:

a) Introductory work in each area not taken previously: applied linguistics, syntax of modern German, historical development of Germanic grammar, Gothic Old Norse, Old English, Old Saxon, Old High German, Middle High German.

b) Three seminars or advanced courses in Linguistics, Modern German, Early New High German, Middle High German, Old Icelandic or Old English. The choice will vary according to the field of specialization.

c) A minimum of three literature courses (230-280) in areas of special interest.

d) Three units of Individual Work (course 299) to be used to read, under the su-
pervision of the student's adviser, the works listed in the "Graduate Reading List for Ph.D. candidates in German." These three units may be distributed over several quarters.

e) Units of electives to complete the 54-unit post-A.M. requirement. These may be taken either in additional courses in the Department (200 or higher), in a complementary program such as Graduate Humanities, or in Individual Work.

3. Whether candidates specialize in language or in literature, they will write a dissertation that embodies such results of research as would merit publication.

4. Teaching experience is required of all candidates as a condition of receiving the Ph.D. degree. Teaching assistantships are available to help candidates fulfill this requirement, which may be waived only for those students who have had teaching experience in other institutions. All prospective teachers are required to enroll in 200.

**GENERAL COURSES (A)**

The courses in this section are given in English and do not require a knowledge of German. They are open to all students. When registering, students are advised to prefix the identifying letter A to the course number.

#100. Goethe's *Faust.*
3 units, Win (Lohner) given 1969-70

#140. Contemporary German Literature.
3 units, Aut (Flores) MWF 9

#146. Kafka—A discussion of his works.
3 units, Aut (Sokel) given 1969-70

#156. Brecht—Representative works.
3 units, Spr (Foulkes) given 1970-71

#181. Nietzsche—His major works considered in relation to contemporary thought and literature.
3 units, Win (Sokel) given 1969-70

#183. Thomas Mann.
3 units, Aut (Foulkes) given 1970-71

#185. The Existential Quest in the Continental Novel—Reading and discussion of works by Dostoevsky, Rilke, Kafka, Sartre, Camus, and Frisch.
3 units, Win (Sokel) given 1970-71

**GERMAN COURSES**

**FIRST- AND SECOND-YEAR**

(Under the direction of Walter F. W. Lohnes)

Note—Students registering for the first time in a first- or second-year course must take a placement test if they have had any work in German before entering Stanford.

#1. First-Year German.
4 units, Aut, Win, Spr (Staff)

#2. First-Year German—Continuation of 1.
4 units, Aut, Win, Spr (Staff)

#3. First-Year German—Continuation of 2.
5 units, Aut, Win, Spr (Staff)

5. Intensive First-Year German — Equivalent to 1, 2, and 3 combined. Enrollment limited.
12 units, Sum (Staff) MTWTh 8:00-9:30 and 10:30-12:00

10. Elementary German — Accelerated course for beginners, particularly for those seeking to fulfill University requirement of reading knowledge for Ph.D. degree. Open to senior and graduate students only. No auditors permitted.
4 units, Aut, Win (Staff) MTWTh 8
Sum (Staff) MTWThF 8 or 9

#22. Second-Year German — This course completes the basic General Studies language requirement. Prerequisite: 3.
5 units, Aut, Win, Spr (Staff)

6 units, Sum (Staff) MTWTh 9-11

#52. Second-Year German — Emphasizes speaking and writing in addition to reading. Students with a grade of A or B in 3 (or equivalent) may apply for admission. Students electing this course may not take 22. Enrollment limited.
5 units, Aut (Luther) (I) MTWThF 9; (Flores) (II) MTWThF 1:15

#53. Second-Year German — Continuation of 52. A limited number of students who have completed 22 or its equivalent may also be admitted on application.
5 units, Win (Lohnes) (I) MTWThF 9; (Flores) (II) MTWThF 1:15
Spr (Meads) MTWThF 1:15
270 SCHOOL OF HUMANITIES AND SCIENCES

#82–86. Intensive German—Given only at Stanford in Austria and Germany.

6 units for each of two quarters.

99. Individual Reading — Enrollment only by special permission of Department. Thirty-six hours of reading per unit, weekly conference with instructor. May be repeated for credit. Prerequisite: 22 or 52.

1 to 2 units, each quarter (Staff) by arrangement

THIRD- AND FOURTH-YEAR

100. Practice in Listening and Speaking—Listening to original recorded material such as radio programs, plays, and lectures. Discussion and oral presentation of assigned topics. Course may be taken twice for credit. Prerequisite: 53 or equivalent.

3 units, Aut (Rau) MWF 1:15
Spr (Luther) MWThF 10

110. German Pronunciation — Prerequisite: 22.

3 units, Win (Luther) MWF 9

111. Third-Year German Composition — Prerequisite: 53 or equivalent.

3 units, Aut (Rau) (I) TTh 9;
(Ober) (II) TTh 11

112. Third-Year German Composition — Continuation of 111.

3 units, Win (Ober) (I) TTh 11;
(Rau) (II) TTh 11

113. Third-Year German Composition — Continuation of 112.

3 units, Spr (Rau) TTh 9

#121. German Newspapers — This course is especially designed for students who want to keep their German alive. Current newspapers from East and West Germany will be read and discussed. This course may be repeated once. Prerequisite: 22 or 52.

2 units, Aut, Win, Spr (Staff) TTh 1:15

135. Theater — Given only in Hamburg. May be repeated for credit.

2 units, Spr, Sum (Staff) by arrangement

141–146. Courses in the 140-series introduce the student to German literature in the various genres. Prerequisite: 22 or 52.

#141. Lyric Poetry from Goethe to Nietzsche.

3 units, Aut (Luther) given 1969–70

#142. Lyric Poetry from Nietzsche to the Present.

3 units, Aut (Meads) MWThF 10

#143. Drama from Storm and Stress to Expressionism.

3 units, Win (Meads) MWThF 10

#144. Drama from Expressionism to the Present.

3 units, Win (Foulkes) given 1969–70

#145. The Novelle—Shorter prose works from the Romantic Period to the 20th Century.

3 units, Spr (Luther) given 1969–70

#146. Modern Fiction.

3 units, Spr (Foulkes) MWThF 10

151–154. These courses acquaint the student with the development of German literature from the Enlightenment to the present. Significant works of each period are studied intensively and related to their historical context.

#151. The Classical Period — Prerequisite: 53 or permission of instructor.

4 units, Aut (Foulkes) MWThF 10

#152. Romanticism and Realism — Prerequisite: 53 or permission of instructor.

4 units, Win (Staff) MWThF 10

#153. From Naturalism to the Present—Prerequisite: 53 or permission of instructor.

4 units, Spr (Luther) MWThF 10

#154. Major Works in Contemporary German Literature—Given only in Hamburg.

4 units, Spr, Sum (Staff) by arrangement

171–173. These courses introduce the student to the continuum of German intellectual and cultural history from the 18th century to the present. They may be taken as a series or elected as individual courses. Prerequisite: 53 or permission of instructor.

#171. Deutsche Geistesgeschichte I — Von der Aufklärung zur Romantik.

3 units, Aut (Mueller-Vollmer) MWThF 10

#172. Deutsche Geistesgeschichte II — Von der Romantik bis Nietzsche.

3 units, Win (Staff) MWThF 10
#173. Deutsche Geistesgeschichte III—
Von Nietzsche zur Gegenwart.
3 units, Spr (Staff) MWF 1:15

ADVANCED AND GRADUATE
With the exception of 185 and 190, these courses are given in German.

#181. Thomas Mann.
3 units, Spr (Foulkes) MWF 9

#182. Brecht.
3 units (Foulkes) given 1969–70

#183. Hölderlin.
3 units (Lohner) given 1969–70

#184. Goethe’s Faust.
3 units, Win (Ober) MWF 11

#185. History of the German Language.
3 units, Win (Schuelke) MWF 1:15

#187. Die Literatur der Deutschen Demokratischen Republik.
3 units (Flores) given 1969–70

#189. Kafka.
3 units, Aut (Foulkes) MWF 9

190. German Applied Linguistics—Phonology and Morphology. (Same as Education 287.)
2 units, Win (Politzer) T 2:15–4:05

#192. Grabbe and Büchner.
3 units (Mueller-Vollmer) given 1969–70

#193. Rilke.
3 units (Staff) given 1969–70

#194. Novalis.
3 units (Staff) given 1969–70

196–197. Senior Seminars—May be elected by non-majors who have completed three German literature courses.

196. Senior Seminar — Subject to be announced in Time Schedule.
3 units, Aut (Staff) T 2:15–4:05

197. Senior Seminar — Subject to be announced in Time Schedule.
3 units, Win (Flores) T 2:15–4:05

199. Individual Work—Open only to German majors and to students who are working on special projects. Students taking honors in German will use this number for the honors essay. May be repeated for credit.
1 to 15 units, each quarter (Staff) by arrangement

199H. Individual Work — Exclusively for Hamburg University courses completed by undergraduate students in the Stanford Hamburg Program.
1 to 8 units, Spr, Sum (Staff) by arrangement

GRADUATE COURSES

200. Methods of Teaching German—(Same as Education 291.)
3 units, Spr (Lohnes) MWF 11

201. Advanced Composition and Grammar—Prerequisite: qualifying examination.
2 units, Aut (Strothmann) M 4:15–6:05

202. Advanced Composition and Grammar—Continuation of 201.
2 units, Win (Strothmann) TTh 9

205. Modern German—The syntax of modern German.
3 units, Win (Strothmann) MWF 9

221. Gothic and Historical Germanic Grammar—Development of Germanic languages; reading of selected texts from the Gothic Bible.
4 units, Aut (Schuelke) MTWTh 10

223. Old Norse.
4 units, Aut (Schuelke) MTWTh 2:15

224. Old Icelandic Sagas.
4 units, Win (Schuelke) MTWTh 10

225. Old Saxon.
2 units, Win (Schuelke) given 1969–70

227. Old High German.
2 units, Win (Schuelke) given 1969–70

228. Middle High German.
4 units, Spr (Schuelke) MTWTh 10

229. Advanced Middle High German.
4 units, Spr (Schuelke) given 1969–70

231. Das mittelhochdeutsche Epos — Prerequisite: 228.
4 units, Aut (Strothmann) MWF 11

233. Die mittelhochdeutsche Lyrik — Prerequisite: 228.
4 units, Aut (Schuelke) given 1970–71

235. Die Mystik des Mittelalters—Prerequisite: 228.
4 units, Aut (Strothmann) given 1969–70

241. Drama des Barock.
4 units (Lohner) given 1970–71
242. Lyrik des Barock.
4 units, Win (Luther) MWF 2:15

245. Lessing, Wieland und die Aufklärung.
4 units (Mueller-Vollmer) given 1970–71

252. Herder und der Sturm und Drang.
4 units (Sokel) given 1970–71

254. Die Klassik Goethes und Schillers.
4 units, Spr (Lohner) MWF 3:15

256. Der späte Goethe.
4 units (Lohner) given 1969–70

261. Die Romantik.
4 units (Mueller-Vollmer) given 1969–70

262. Heine und das Junge Deutschland.
4 units (Mueller-Vollmer) given 1970–71

4 units (Sokel) given 1969–70

4 units (Sokel) given 1970–71

4 units, Aut (Sokel) MWF 3:15

4 units, Spr (Mueller-Vollmer) TWTh 2:15

4 units, Win (Sokel) MWF 3:15

4 units (Sokel) given 1969–70

4 units (Mueller-Vollmer) given 1969–70

4 units, Aut (Staff) W 4:15–6:05

290. Seminar—Subject to be announced in Time Schedule.
5 units, Aut (Mueller-Vollmer) W 4:15–6:05
Win (Sokel) W 4:15–6:05
Spr (Foulkes) W 4:15–6:05

291. Seminar—Subject to be announced in Time Schedule.
5 units, Win (Staff) M 4:15–6:05

299. Individual Work — Exclusively for graduate students in the Stanford Hamburg Program. 1 to 10 units, Spr, Sum (Staff) by arrangement

HISTORY


Executive Head: George H. Knoles


Associate Professors: Barton J. Bernstein, Gavin I. Langmuir, Mark I. Mancall (on leave 1968–69), Rixford K. Snyder, Peter D. Lyman Stansky, Lyman P. Van Slyke (on leave 1968–69)


Lecturers: Margot Drekmeier, Susan V. Lenkey, George S. Rentz

Instructors: The Staff of the History of Western Civilization

The Department of History offers to all students of the University courses of general cultural and educational value. It seeks not only to provide knowledge in special fields, but also to equip the student for his duties as a citizen and to give him instruction which will aid him in law, journalism, library work; in local, state, and national public service; and in business where a knowledge of domestic and foreign affairs is desirable.

The course in the History of Western Civi-
lization, which surveys the development of the Western world from earliest times to the present, is required by the University of all students as a necessary part of a liberal education, and supplies a foundation for the other work in the Department.

PROGRAMS OF STUDY

BACHELOR OF ARTS

The Department adopted early in 1967 a new program for the undergraduate major in history which will lay emphasis upon a broad and comparative approach to historical studies, and one which will stress independent study and integration of the work accomplished in the major.

As a foundation requirement, each candidate for the A.B. in History: (1) should be enrolled in the Department for six quarters (counting the quarter in which the registration takes place), (2) should complete, if possible in the junior year, a basic seminar which serves as an introduction to the principles of historical study, (3) and should complete at least ten courses in history numbered 20 or higher, with an average grade not below C, and with a minimum of three units each. (The basic seminar is counted as one of these ten.)

To emphasize broad coverage in space and time, it is required that at least two courses must be completed in each of the following three fields: (a) Western Europe (including Britain) and North America (especially the colonial and national history of the present United States), all since 1700; (b) Africa and the Middle East, Asia, Latin America, Russia, and Eastern Europe; (c) the period before 1700, with at least one course in the field of Western Europe before 1700. No single course may be counted to fulfill more than one of these three fields. The Department issues a detailed list indicating how each specific course is classified as to field.

To emphasis comparative study, integration of knowledge from various fields, and independent work, the A.B. program requires the completion of History 200: Comparative Studies in History. This is a program of independent reading which the student may elect to take in either his junior or senior year. It will count as two of the ten required courses, but does not count toward any of the three fields. This program will consist of designated reading on some given broad historical theme, which will vary from year to year and be announced in the preceding spring quarter. It will lead to a four-hour written examination on the designated reading to be passed as a requirement for graduation. Such examinations will be given each year at the end of winter quarter and at the end of spring quarter. Credit will be awarded only on the basis of the examination.

Also, all History majors will complete, under the general studies requirements of the University, History 1, 2, 3: Western Civilization, and the foreign language option in the "Basic Requirements" of the General Studies Program Bulletin. There will be no minor requirement for the A.B. in History.

(Note: The Cory and Riotte scholarships are available for women students in the Department.)

HONORS IN HISTORY

For a limited number of undergraduate majors, the Department offers a special program of senior research leading to Honors in History. Students accepted for this program, in addition to fulfilling the general requirements stated above, will complete a 15-unit senior essay, the work for which will normally begin in spring quarter of the junior year and be completed by the end of winter quarter of the senior year. Much of the work of the first quarter will be of the nature of directed reading under the guidance of an essay adviser to provide an opportunity for background reading and formulation of the essay topic. To enter this program the student must be accepted by a member of the Department who will agree to advise him on the essay. In considering an applicant for such a project, the adviser and the director of the Honors Program will take into account the student's general preparation in the field of the project and will expect at least a B average in the student's previous work, both in history and in the University. For more detailed information, apply to Professor Barton J. Bernstein, Director of the Honors Program.

The James Birdsall Weter scholarships in History are available to a limited number of honors students; and the Weter prizes may be awarded each year to students who submit outstanding essays.
HISTORY IN THE SECONDARY TEACHER'S CREDENTIAL

Applicants for the Stanford Secondary Teacher's Credential in the social studies may get details of the requirements by applying to the Credential Secretary, School of Education.

ADMISSION TO GRADUATE STANDING

All applicants for admission to graduate work are required to take the Aptitude Test of the Graduate Record Examination. This examination may be taken at most American colleges and by arrangement may be taken in nearly all foreign countries. For details concerning this test see the Information Bulletin. Overseas applicants, who may not receive the Information Bulletin promptly, should write directly to the Educational Testing Service, Box 955, Princeton, New Jersey 08540.

GRADUATE STUDY

A student who has been admitted to graduate standing does not automatically become a candidate for a graduate degree, but when he is admitted, it is with the expectation that he will be working toward a Doctor of Philosophy degree, and that he may become a candidate to receive a Master of Arts degree at the end of his first or second year of graduate study.

MASTER OF ARTS

The Department requires the completion of nine courses (totalling not less than 36 units) of graduate work; at least 35 units of this work must be in History Department courses. A candidate whose undergraduate training in history is inadequate, however, must complete 45 units of graduate work in the History Department. The candidate's program must include at least two graduate seminars involving the preparation of research papers and a total of at least 15 units in graduate seminars and graduate colloquia. A reading knowledge of one modern foreign language is required. The Department will not recognize for credit toward the A.M. degree any work that has not received the grade of A, B, or plus.

MASTER OF ARTS IN TEACHING (HISTORY)

The Department cooperates with the School of Education in offering the Master of Arts in Teaching degree. For the general requirements, see description under section "School of Education" in this bulletin. For certain additional requirements made by the Department of History, inquiry should be made to the History Department Office. Note that this program is open only to those with at least one year's teaching experience. Candidates must have a teaching credential.

DOCTOR OF PHILOSOPHY

Students planning to work for the doctorate in history should be familiar with the general degree requirements of the University outlined in the section "Degrees" in this bulletin. Upon enrollment in the graduate program in History, the student will have a member of the department designated as his adviser and he should plan his program in consultation with this adviser. During the first two years of graduate study, the student will spend much of his time taking courses, but he should be aware from the outset that the ultimate objective of his work is not merely the completion of courses, but the preparation for general examinations and for writing a dissertation.

The student's admission to the History Department in the Graduate Division does not establish any rights respecting candidacy for an advanced degree, and application must be made separately for admission to candidacy for the A.M. (not later than the end of the first four weeks of the quarter preceding the one at the end of which the degree is to be awarded) and also for the Ph.D. An applicant for the doctoral program must proceed by two steps: First, he must apply for admission to (not candidacy in) the Ph.D. program. Students seeking admission to the program should file application during their third quarter of enrollment in graduate work at Stanford. (Applicants who have already received the A.M. elsewhere should apply as soon as feasible after completion of one quarter at Stanford.) A committee of the Department will then determine either that the applicant shall be admitted to the Ph.D. program or that he must terminate his work in History at Stanford.

Second, after admission to the program and after the completion of certain further requirements, the student must apply for acceptance for candidacy for the doctorate. He does this (a) after further course work, (b) after demonstrating proficiency in one
European language which is relevant to his research program, by passing (during the first year of graduate study) an examination administered by the appropriate foreign language department, and (c) after choosing a dissertation field in consultation with and with the approval of his adviser. This application is made by filing formal papers at the Graduate Study Office in the Registrar’s Office.

After acceptance in candidacy, the student must meet the following requirements:

(1) He must select, in consultation with his adviser, a major field of study from the list below in which he will concentrate his study and in which he will later take a general examination consisting of a four-hour written comprehensive examination, followed, within the same quarter, by the University oral examination. The major fields are:

- Europe, 300–1400
- Europe, 1400–1789
- Europe Since 1700
- Russia and East Central Europe
- The Near and Middle East
- Africa
- The Far East
- Britain and the British Empire Since 1460
- Latin America
- The United States (including Colonial America)
- Europe, 1000–1400
- Europe, 1400–1600
- Europe, 1600–1789
- Europe, 1700–1871
- Europe Since 1848
- Russia
- East Central Europe
- Russia and East Central Europe to 1800
- Russia and East Central Europe Since 1800
- Near East
- Middle East
- Near and Middle East to 1800
- Near and Middle East Since 1800
- Africa
- Far East to 1600
- Far East Since 1600
- China
- Japan
- England, 450–1460
- Britain and the British Empire, 1460–1714
- Britain and the British Empire Since 1714
- Latin America to 1825
- Latin America Since 1810
- The United States (including Colonial America) to 1865
- The United States Since 1850

(2) For work in his major field, the student may be required to meet additional foreign language requirements. His adviser will inform him of such requirements.

(3) He must select, in consultation with his adviser, one secondary field, which must be outside the major field, though it may partially overlap the major field. In this secondary field, he must pass a four-hour written comprehensive examination not later than one year after admission to the Ph.D. program, and before taking the examination in the major field. The secondary fields are as follows:

- The Ancient Greek World
- The Roman World
- Europe, 300–1000
- Europe, 1000–1400
- Europe, 1400–1600
- Europe, 1600–1789
- Europe, 1700–1871
- Europe Since 1848
- Russia
- East Central Europe
- Russia and East Central Europe to 1800
- Russia and East Central Europe Since 1800
- Near East
- Middle East
- Near and Middle East to 1800
- Near and Middle East Since 1800
- Africa
- Far East to 1600
- Far East Since 1600
- China
- Japan
- England, 450–1460
- Britain and the British Empire, 1460–1714
- Britain and the British Empire Since 1714
- Latin America to 1825
- Latin America Since 1810
- The United States (including Colonial America) to 1865
- The United States Since 1850

(4) In his program of courses, the student must include at least one graduate seminar in his major field and one graduate seminar in his secondary field; a graduate course in general historiography, and, if his major field is the United States, a graduate course in American historiography; a course in methods of teaching history, given by the student’s adviser, or by some other member of the Department designated by the adviser. (Students who have served as teaching assistants may present such experience in lieu of this requirement.)

(5) The student must also complete at least one of the following:

a. A supporting program of 20 units of history in one of the Ph.D. major fields (but outside the student’s major and secondary fields), including at least one graduate seminar or graduate colloquium.

b. A supporting program of 20 units in another discipline relevant to the candidate’s special interest.

c. A formal minor in another discipline.

d. A supporting program of 20 units in a second foreign language, including at
least one course in literature; or demonstration of proficiency in a second foreign language, plus one course in literature. Proficiency may be demonstrated in either of two ways: 1) by passing an examination administered by the appropriate foreign language department; 2) by certification from a member of the History faculty that the student has written a seminar paper for which at least half of his research was done in a foreign language.

(6) He must complete and submit a dissertation which is the result of independent work and is a contribution to knowledge. It should evidence the command of approved techniques of research, ability to organize findings, and competence in expression. For details and procedural information, please apply to the Department.

JOINT PH.D. IN HISTORY AND HUMANITIES

The Department of History participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in History and Humanities. For description of that program, and of fellowships offered in connection with it, see the section “Humanities Special Programs” in this bulletin.

RESEARCH AND TRAINING ASSISTANTSHIPS

The Department has about fifteen student assistantships and several research assistantships and teaching assistantships which are customarily held by candidates for advanced degrees.

RESOURCES FOR GRADUATE STUDY

The above section relates to formal requirements, but the success of a student’s graduate program depends in large part upon the quality of the guidance which he receives from the faculty and upon the library resources available to him. Prospective graduate applicants are advised to study closely the list of History faculty and the course work which this faculty offers. As to library resources, no detailed statement is possible in this bulletin, but areas in which library resources are unusually strong include the following:

The rich, and in some respects unique, collections of the Hoover Institution on the causes, conduct, and results of World War I are being augmented for World War II and the period between these two wars. The materials include government documents, newspaper and serial files, and organization and party publications (especially British and German labor movements and the German Socialist parties). There are also important manuscript collections, including unpublished records of the Paris Peace Conference of 1919 and the Herbert Hoover archives, which contain the records of the Commission for Relief in Belgium; the American Relief Administration; the various technical commissions established at the close of World War I for reconstruction in Central and Eastern Europe; the personal papers of Herbert Hoover as United States Food Administrator; and the personal papers of other important individuals. Other important materials for the period since 1914 relate to revolutions and political ideologies of international importance; colonial and minority problems; propaganda and public opinion; military occupation; peace plans and movements; international relations; international organization and administration, including the publications of the League of Nations, the World Court, the International Labor Office, and the United Nations, as well as the principal international conferences.

The Hoover Institution also possesses some of the richest collections available anywhere on the British labor movement, on Eastern Europe, including the Soviet Union, on East Asia (runs of important newspapers and serials and extensive documentary collections, especially for the period of World War II) and on Africa since 1860, including especially French-speaking Africa, the former British colonies, and South Africa.

The University Library maintains strong general collections in almost all fields of history. It has a very large microtext collection, including, for instance, all items listed in Charles Evans’ American Bibliography, and in the Short-Title Catalogues of English publications, 1475–1700, and virtually complete microfilmed documents of the Department of State to 1906. It also has a number of valuable special collections in the Bender Room, including the Borel Collection on the History of California, many rare items on early American and early modern European history, the Brasch Collection on Sir Isaac Newton and scientific thought during his time, and other such materials.
I. INTRODUCTORY COURSES

The Department offers two course sequences providing general overviews of Western Civilization and of East Asian Civilizations. Western Civilization is required of all students under the General Studies requirements. East Asian Civilizations is recommended for students, both undergraduate and graduate, with broad humanistic interests and especially for those who are studying any aspect of Asian culture.

Since Western Civilization is a General Studies requirement, it is not specifically counted as units toward the History major. Since East Asian Civilizations is optional, it is counted toward the History major.

#1. History of Western Civilization—Western Civilization to circa A.D. 1000; prehistoric man; ancient Orient; Greece, Rome, early Middle Ages.
4 units, Aut (Staff)

#2. History of Western Civilization—Major developments in Western Civilization in later Middle Ages, Renaissance, seventeenth and eighteenth centuries.
4 units, Win (Staff)

#3. History of Western Civilization—Nineteenth, twentieth centuries.
4 units, Sp (Staff)

91. History of East Asian Civilizations — Origin and development of the civilizations of China and Japan.
4 to 5 units, Aut (——)

4 to 5 units, Win (——)

93. History of East Asian Civilizations — The recent period.
5 units, Spr (Buss) MTWThF

II. INTERMEDIATE AND ADVANCED COURSES

Courses numbered 100 through 103 (basic seminars and colloquia) are open only to juniors and seniors majoring in history. Requests for admission to basic seminars and colloquia are submitted to the Department office and involve permission of the instructor.

Courses in senior research are intended primarily (though not exclusively) for Honors candidates engaged in writing senior theses.

A. UNDERGRADUATE SEMINARS AND COLLOQUIA

100. Basic Seminar—An introduction to the method and problems of historical research and writing. Required of undergraduate majors in history.
5 units, Aut, Winter, Spr, Summer (Staff)

101A. Undergraduate Colloquium: Revolution in Early Modern England.
5 units, Spr (Seaver)

101B. Undergraduate Colloquium: European Socialisms in the Nineteenth and Twentieth Centuries.
5 units (Wright) given 1969–70

101C. Undergraduate Colloquium: Intellectual History of the Twentieth Century.
5 units, Aut (Craig)

101D. Undergraduate Colloquium: Intellectual History of the Twentieth Century.
5 units, Win (Degler)

101F. Undergraduate Colloquium in Social History.
5 units, Win (Urban)

101H. Undergraduate Colloquium: Problems of United States Asian Policy.
5 units, Spr (Buss)

1011. Undergraduate Colloquium: Revolution.
5 units (Mancall) given 1969–70

101S. Undergraduate Colloquium: The Island of Taiwan.
5 units (Van Slyke) given 1969–70

101W. Undergraduate Colloquium: European Social Thought, Nineteenth and Twentieth Centuries.
5 units, Aut (Robinson)

102A. Undergraduate Colloquium: Ideas and Society in the Progressive Period.
5 units (Knoles) given 1969–70

102B. Undergraduate Colloquium: The Russian Revolutionary Movement.
5 units, Win (Emmons)

102C. Undergraduate Colloquium: National Integration in Latin America.
5 units (J. Johnson) given 1969–70
102E. Undergraduate Colloquium: Social Classes in Modern History.
5 units, Spr (Smith)

102F. Undergraduate Colloquium: Tropical History.
5 units (Mancall) given 1969-70

102H. Undergraduate Colloquium: The Cultural Dilemma of Modern Africa.
5 units, Spr (G. W. Johnson)

102I. Undergraduate Colloquium: Topics in Byzantine Civilization.
5 units, Aut (Vucinich)

102S. Undergraduate Colloquium: Thought and Expression in the High Middle Ages.
5 units (Bark) given 1969-70

102W. Undergraduate Colloquium: European Urban History, Eighteenth and Nineteenth Centuries.
5 units, Spr (Dawson)

103A. Undergraduate Colloquium: Soviet Foreign Policy.
5 units (Lederer) given 1969-70

103B. Undergraduate Colloquium: Economic Development in Colonial Latin America.
5 units, Win (Bowser)

103C. Undergraduate Colloquium: European International Relations, 1914–1945.
5 units, Spr (Cairns)

5 units, Aut (Lofgren)

103I. Undergraduate Colloquium: Communism and Nationalism.
5 units, Spr (Vucinich)

103S. Undergraduate Colloquium: Modern British Cultural History.
5 units, Aut (Stansky)

103W. Undergraduate Colloquium: Shaping of Twentieth Century America.
5 units, Aut (Bernstein)

200. Reading Course in Comparative History.
5 units each for two quarters; Aut, Win, Spr (Kennedy)

B. THE ANCIENT WORLD

See Classics, Section V, Courses 101, 102, 103, 111, 112, 113, 201, 202, all of which are accepted for credit toward a major in history.

C. MEDIEVAL AND RENAISSANCE EUROPE

104. Medieval Europe, 300–1400—Emphasis on transition from ancient Mediterranean to European civilization, development of medieval social, cultural institutions and ideas.
5 units (Bark) given 1969–70

105. The Emergence of Medieval Europe—Genesis of European civilization from end of Roman political unity through Carolingian period.
3 units (Bark) given 1969–70

107. The High Middle Ages—Such aspects of European civilization in twelfth, thirteenth centuries as papacy and Holy Roman Empire, French and English monarchical states, Crusades, medieval towns, rise of universities, scholasticism, Gothic art.
3 units (Bark) given 1971–72

108. Medieval Antisemitism—An inquiry into the causes of antisemitism in the period in which intense anti-Jewish feeling first developed and many of the characteristic beliefs of modern antisemitism were formulated. Considerable use will be made of sociological theories about ethnic prejudice.
5 units, Spr (Langmuir) MTWTh 10

5 units (Spitz) given 1969–70

109A. Italy at the Age of Humanism and Renaissance.
4 to 5 units, Aut (Krecić) MTWThF

110. Age of the Reformation—Europe in early modern times with special emphasis on the Protestant Reformation and Catholic reform.
5 units (Spitz) given 1969–70

115. Senior Research in Medieval History.
1 to 5 units (Langmuir) by arrangement

117. Senior Research in Renaissance-Reformation History.
1 to 5 units (——) by arrangement, given 1969–70
118. The Byzantine Empire—Major political, religious, social, and cultural development of the Byzantine or East Roman Empire from the founding of Constantinople in the Fourth Century to its fall in 1453.
3 units (Vucinich) given 1969–70

D. MODERN EUROPE
120A. Kievan and Muscovite Russia (to 1689).
4 to 5 units, Aut (Emmons) MTWTh 8
120B. Imperial Russia 1689–1905.
4 to 5 units, Win (Emmons) MTWTh 8
121. Twentieth Century Russia.
4 to 5 units, Spr (Lederer) MTWTh 11
122A. Russian Foreign Relations, 1700–1917.
4 to 5 units (Lederer) given 1969–70
122B. Russian Foreign Relations Since 1917.
4 to 5 units (Lederer) given 1969–70
123. Non-Russian Peoples of the Soviet Union—Major problems concerning the origins and history of some of the more important non-Russian peoples of the U.S.S.R.
3 units (Vucinich) given 1969–70
126. History of the Balkan Peoples Since 1914.
4 to 5 units, Win (Vucinich) MTWTh 10
128. Germany in the Nineteenth Century.
4 to 5 units, Aut (Craig) MTWTh 9
129. Germany in the Twentieth Century.
4 to 5 units, Win (Craig) MTWTh 9
130. The Ancien Régime in France (1589–1789).
4 to 5 units, Aut (Dawson) MTWThF 9
131. The Revolutionary Period in Europe, 1780–1840.
4 to 5 units, Win (Dawson) MTWThF 9
132. France—1848 to 1914.
4 to 5 units, Aut (Cairns) MTWThF
133. France—1914 to 1962.
4 to 5 units, Win (Cairns) MTWThF
134. Intellectual History of Europe in the Seventeenth and Eighteenth Centuries.
4 units, Aut (Drekmeier) MTWThF
4 to 5 units, Spr (Craig) MTWTh

136A. European Intellectual History: Nineteenth Century.
5 units, Win (Robinson) MTWThF
136B. European Intellectual History: Twentieth Century.
5 units, Spr (Robinson) MTWThF
139. Senior Research in Modern European History.
1 to 5 units (Cairns, Craig, Dawson, Emmons, Lederer, Vucinich) by arrangement

E. THE BRITISH COMMONWEALTH AND EMPIRE
140. England to 1460.
5 units, Aut (Langmuir) MTWTh 11
4 to 5 units, Aut (Seaver) MTWF 10
142. Stuart England.
4 to 5 units, Win (Seaver) MTWF 10
143. Britain, 1714–1867—Emphasis on domestic political, economic and social history, but foreign and imperial affairs will be included as they influenced the country’s general development.
4 to 5 units, Win (Stansky)
144. Britain Since 1867—See description of 143 (above).
4 to 5 units, Spr (Stansky)
146. Senior Research in British History.
1 to 5 units (Seaver, Stansky)

F. AFRICA
147A. The Emergence of Africa to 1850—Geography and peoples of Africa, traditional African society and culture, early Sudanic empires, Islamic and Arabic impact, European explorations, the slave trade, later African states, missionaries and commerce, and early European colonial expansion.
4 to 5 units, Aut (G. W. Johnson) MTWTh 11
147B. Modern Africa Since 1850—Partition of Africa by European nations, establishment and functioning of European colonial regimes, African resistance movements, problems of economic and social change, urbanization and African elites, impact of two world wars, African nationalism and
Pan-Africanism, and the drive to independence.

4 to 5 units, Win (G. W. Johnson) MTWTh 11

148A. France and Britain in West Africa—Comparative history of French and British involvement in West Africa: explorations, conquest, colonial systems, political institutions; varieties of African protest, rise of political parties, decline of colonial rule; assessment of colonial legacies; case studies of Ghana and Senegal.

4 to 5 units (G. W. Johnson) given 1969–70

148B. Expansion of Europe Overseas—History of political, economic, and cultural imperialism of European nations from the Renaissance to the twentieth century. Emphasis on reaction of non-European societies to Western culture; problems of acculturation, assimilation, and institutional transfer. Special attention is paid to Africa.

4 to 5 units (G. W. Johnson) given 1969–70

149B. Senior Research in African History. 1 to 5 units (G. W. Johnson)

G. THE UNITED STATES

150. The Colonial Period. 4 units (Miller) given 1969–70

151. The Revolution, Confederation and Constitution. 5 units, Spr (Miller) MTWTh 1:15

153. Interpretive Overview of United States History. 4 to 5 units, Aut (Degler) MTWTh

154. American Diplomatic History to 1898. 4 to 5 units, Win (Lofgren) MTWThF 8

155. Aspects of American Diplomatic History Since 1898. 4 to 5 units, Spr (Lofgren) MTWThF 8

158. The Trans-Mississippi West Since 1846—Political, social, and economic development, with attention to twentieth century aspects. 4 to 5 units (Fehrenbacher) given 1969–70

160. History of the South, 1815–1900—The experience of an American Region. 4 to 5 units, Spr (Degler) MTWTh

166. American Intellectual History: Nineteenth Century—Changing climates of opinion in thought, expression in United States during nineteenth century. 4 to 5 units, Win (Knoles) TWThF 10

167. American Intellectual History: Twentieth Century—American thought and expression during twentieth century; influences acting upon intellectual, cultural development. 4 to 5 units (Knoles) given 1969–70

168. American Social History to 1870—Development of American society from the first settlements to the decade of Civil War and Reconstruction. Particular attention is devoted to the content of national character and culture; the changing functions and forms of religion, the family and education; developing social structure; and the shifting nature of race relations. 4 to 5 units, Aut (Bernstein) MTWThF 1:15

169. American Social History, 1870–1969—Development of American society from Reconstruction until the present, with emphasis on the impact of industrialization and urbanization, the relations of classes, and racial and ethnic groups. These problems will be related to national character and culture, and the changing nature of American social institutions. 4 to 5 units, Win (Bernstein) MTWThF 1:15

170. The United States, 1890–1929. 4 to 5 units, Win (Kennedy) MTWThF

171. The United States, 1929–Present. 4 to 5 units, Win (Kennedy) MTWThF

172. The Era of the Civil War, 1846–1865. 4 to 5 units (Potter) given 1969–70

173. Reconstruction and Race Relations in America, 1865–1967. 4 to 5 units (Potter) given 1969–70

175. Senior Research in United States History. 1 to 5 units (Bernstein, Degler, Kennedy, Knoles, Lofgren, Miller, Potter) by arrangement

H. LATIN AMERICA

176. Latin America to 1825—Discovery, conquest, growth of political, social, eco-
economic institutions; Wars of Independence in Spanish, Portuguese America.
4 to 5 units, Aut (Bowser) MTWTh 11

177. Modern Latin America—Political, social, economic institutions in leading republics since independence.
4 units, Win (J. Johnson) MTWTh 11

179. Historical Evolution of Mexico—Economic, social, development since 1850 and Mexican foreign relations, especially with United States in twentieth century.
3 units (J. Johnson) given 1969–70

180. Neo-Colonial Brazil, 1750–1918—Survey of neo-colonial Brazil from independence and the Imperial era through the First Republic to World War I.
3 units, Win (Wirth) MTWF 9

181. Contemporary Brazil, 1918–1968—Politics and society in transition from agrarian to industrial bases, the rise of nationalism, and Brazil’s role in the hemisphere and international organizations.
3 units, Spr (Wirth) MTWF 9

182. The Negro in Latin America.
4 to 5 units, Spr (Bowser) MTWTh 11

185. Senior Research in Latin American History.
1 to 5 units, Spr (Bowser, J. Johnson, Wirth) by arrangement

I. MIDDLE EAST

4 to 5 units, Aut (Vucinich) MWF 10

Beginnings of Islam in Arabia and the spread of its political system in Asia, Africa, and Europe until the overthrow of the Caliphate by the Mongols. Brief survey of Islamic society and culture.
Note: Two of the three courses in the sequence 187–189 given 1970–71.
3 units, Spr (Rentz)

188. History of the Islamic World, 1258–1803—Expansion and contraction of the Islamic domains and internal changes from the fall of the Abbasid Caliphate to the first occupation of Mecca by the House of Sa’ud. See 187.
3 units, Spr (Rentz)

188A. Directed Reading in the Middle East and in the Islamic World.
5 units (Rentz) by arrangement

189. History of the Islamic World Since 1803—Advance and retreat of European colonialism in Islamic territories, development of modern Islamic states, and recent adjustments in Islamic society. See 187.
3 units (Rentz) given 1969–70

J. EAST ASIA

190. Chinese Social Thought—Problems in the history of Chinese social theory, with special attention to Confucianism and Maoism.
3 units (Mancall) given 1969–70

192. Modern China—1800 to the present, emphasis on rebellions, reforms, revolutions, and resistance to changes.
3 units (Van Slyke) given 1969–70

193. Communist China—Origin and rise of the Chinese Communist party; internal developments and foreign policy of China under the Communists.
3 to 4 units (Van Slyke) given 1969–70

4 units (Smith) given 1969–70

194A. Japan, 1600–1890—Development of institutions and thought; early relations with the West; the Meiji Restoration and the beginnings of modernization. Emphasis on latter half of the period.
3 to 4 units, Aut (Smith) MTWTh 10

194B. Japan Since 1890—Japan’s development as a modern nation; industrialization; urbanization; political and constitutional development; relations with the West; World War II; the Occupation; post-occupation Japan.
3 to 4 units, Win (Smith) MTWTh 10

195. History of Sino-Soviet Relations.
4 units (Mancall) given 1969–70

196. United States and the Far East—Genesis, growth of American interests, policies in Far East, emphasis on immediate background of contemporary period.
4 to 5 units, Aut (Buss) MTWTh 8
197. History of Southeast Asia.  
4 to 5 units, Win (Buss) MTWTh 8

199. Senior Research in Far Eastern History.  
1 to 5 units (Buss, Mancall, Smith, Van Slyke) by arrangement

### III. Graduate Courses

Courses numbered 200–299 are intended primarily for first-year graduate students, but more advanced graduate students may be admitted by permission of the instructor.

210. Graduate Seminar in Early Modern Europe.  
5 units (Spitz) given 1969–70

220. Graduate Seminar on Russian Foreign Relations.  
5 units, Spr (Lederer)

221. Graduate Seminar in Russian History.  
5 units, Aut (Emmons)

225. Graduate Seminar in Eastern Europe and Near East History.  
5 units, Win (Vucinich)

226. Graduate Seminar: Modern European Intellectual History.  
5 units, Aut (Robinson)

228. Graduate Seminar: Intellectual History of Austria and Germany, 1815–1830.  
5 units, Win (Craig)

10 units, Aut, Win (Dawson)

5 units, Win (Cairns)

240. Graduate Seminar in Medieval History.  
3 to 5 units, Win (Langmuir)

10 units, Aut, Win (Seaver)

243. Graduate Seminar in Modern British History.  
5 units, Spr (Stansky)

248. Graduate Seminar: Topics in African History.  
5 units, Win (G. W. Johnson)

5 units (Miller) given 1969–70

5 units, Aut (Kennedy)

254. Graduate Seminar: American Liberalism from Progressivism to the Cold War.  
5 units, Win (Bernstein)

5 units, Aut (Knoles)

260. Graduate Seminar in History of the South.  
5 units, Spr (Degler)

270. Graduate Seminar in Latin American History.  
5 units, Aut (J. Johnson)

282. Graduate Seminar in Modern Brazilian History.  
5 units, Spr (Wirth)

5 units, Win (Bowser)

290. Graduate Seminar in the History of Modern China.  
5 units (Van Slyke) given 1969–70

292. Graduate Seminar in the History of Japan.  
5 units, Spr (Smith)

5 units, Win (Buss)

### IV. Advanced Graduate Courses

Courses numbered 300–399 are intended primarily for second- and third-year graduate students, but first-year graduate students may be admitted by permission of the instructor.

300. Historiography—Writings, influence of great historians, Herodotus to present. Required of all doctoral candidates in history.  
5 units, Win, Spr (Robinson, Langmuir)
301. American Historiography—Main currents in historical research and writing relevant to United States from earliest days.
   5 units, Spr (Knoles)

302. The Teaching of History—Methods of teaching history at the college level.
   1 unit, Aut, Win, Spr (Staff) by arrangement

   5 units, Win (Lau, Lewis, Skinner) by arrangement

304. Latin American Historiography.
   5 units, Aut (Bowser, Wirth)

308. Graduate Colloquium: Topics in Medieval History.
   5 units, Win (Langmuir)

314. Directed Reading in Medieval History.
   Units by arrangement (Langmuir)

315. Graduate Research in Medieval History.
   Units by arrangement (Langmuir)

316. Directed Reading in Renaissance and Reformation.
   Units by arrangement (Spitz) given 1969–70

317. Graduate Research in Renaissance and Reformation.
   Units by arrangement (Spitz) given 1969–70

318. Graduate Colloquium: The Course of Christian Humanism.
   5 units (Spitz) given 1969–70

319. Graduate Colloquium: Humanism and the Reformation.
   5 units (Spitz) given 1969–70

320. Graduate Colloquium: Renaissance Books.
   5 units, Win (Lenkey)

321. Graduate Colloquium: Topics in Tudor-Stuart History.
   5 units, Spr (Seaver)

321A. Graduate Colloquium: Modern Britain.
   5 units, Aut (Stansky)

   5 units, Spr (Emmons)

325. Graduate Colloquium: Eastern Europe and Near East History.
   5 units, Spr (Vucinich)

326. Graduate Colloquium: Twentieth Century Diplomacy.
   5 units (Lederer) given 1969–70

327. Graduate Colloquium: The Origins of the Cold War.
   5 units (Lederer) given 1969–70

328. Graduate Colloquium: Topics in Modern European History.
   5 units, Spr (Craig)

329. Graduate Colloquium: Problems in Nineteenth Century European History.
   5 units (—)

   5 units (M. Drekmeier) given 1969–70

331. Graduate Colloquium: Seventeenth Century Europe.
   5 units, Spr (Dawson)

335. Graduate Colloquium: Europe, 1890–1950.
   5 units, Aut (Cairns)

338. Directed Reading in Modern European History.
   Units by arrangement (Cairns, Craig, Dawson, Emmons, Lederer, Vucinich)

339. Graduate Research in Modern European History.
   Units by arrangement (Cairns, Craig, Dawson, Emmons, Lederer, Vucinich)

345. Directed Reading in British History.
   Units by arrangement (Seaver, Stansky)

346. Graduate Research in British History.
   Units by arrangement (Seaver, Stansky)

348. Graduate Colloquium: Histories of Tropical Africa.
   5 units, Aut (G. W. Johnson)

349A. Directed Reading in African History.
   Units by arrangement (G. W. Johnson)

349B. Graduate Research in African History.
   Units by arrangement (G. W. Johnson)

   5 units, Spr (Miller)
HUMANITIES SPECIAL PROGRAMS

Emeritus: John W. Dodds (Professor)
Executive Head: William A. Clebsch

Professors: Robert M. Brown (Religion),
William A. Clebsch (Religion and Humanities),
Paul H. Kocher (English and Humanities),
B. Davie Napier (Religion),
Philip H. Rhinelander (Philosophy and Humanities)

Associate Professors: Lawrence V. Berman (Religion),
Edwin M. Good (Religion and Hebrew),
Jeffery Smith (Humanities and Philosophy)

Acting Assistant Professor: Lee H. Yearley (Religion)

Instructor: Jerry A. Irish (Religion)

Humanities Special Programs include:
1. Humanities Honors Program.
2. Graduate Program in Humanities.

HUMANITIES HONORS PROGRAM

Committee in Charge: William A. Clebsch (Director),
Philip Dawson, John W. Dodds, J. Martin Evans, David M. Kennedy,
Lucio P. Ruotolo, George F. Sensabaugh, Jeffery Smith (Associate Director)

PURPOSE OF THE PROGRAM

The Humanities Honors Program aims to heighten the student's sense of the relation between various humanistic disciplines, and to increase awareness of basic humanistic values—intellectual, aesthetic, literary, historical, social, and ethical. The Committee in Charge, composed of tutors representing several departments in the Humanities, will help each student to plan a balanced and integrated program.

ADMISSION TO THE PROGRAM

A University average of B is required for admission to the Program and for graduation with Honors in Humanities.

Freshmen and sophomores interested in the Program should consult with the Director or Associate Director of the Humanities.
Honors Program. The consultation should take place at the earliest opportunity, preferably before the end of the freshman year, and in every case early enough to make such scheduling adjustments as may be necessary.

The Program is open to majors in every field, and is normally taken in addition to a departmental major. In some cases, however, the student may enroll as a Humanities major:

1. If he is taking the pre-medical curriculum,
2. If he chooses a major in Humanities with concentration in Religious Studies,
3. If he is permitted, upon petition granted by the Honors Committee, to plan a 40-unit concentration of interdepartmental course work constituting a unified program of study.

Requirements of the Program

1. World Literature—Humanities 61, 62, 63—15 units, sophomore year.
2. Humanities Seminars 191 and 192 or 193—10 units, junior year.
3. Honors Essay—A critical essay, usually centered in the departmental field, but not confined to it (2 units spring, junior year; 5 units autumn and 5 units winter, senior year). A grade of at least B is required on the essay for graduation with Honors in Humanities.

Each student should plan a program that will give him a substantial background for his prospective Honors Essay. This is especially important for students majoring in the social, biological, or physical sciences.

Undergraduate Courses

21. World Personalities—A study of the lives of selected individuals of world significance, such as Socrates, St. Francis, Leonardo da Vinci, Van Gogh.
   4 units, Win (Smith) MWF 1:15, given 1970–71

22. World Personalities: Twentieth Century—A study of the lives of selected individuals of world significance, such as Freud, Gandhi, Madame Curie, Hitler, Churchill, and Kennedy.
   4 units, Spr (Smith) MWF 11, given 1969–70

#61, 62, 63. World Literature and the History of Ideas—An introduction to fundamental ideas of the past; lectures, discussions, reading of selected masterpieces of literature. The course is conceived as a unity; it is strongly recommended that students take all three quarters in sequence. Honors students who attend a Stanford Overseas Campus may be excused from either 62 or 63 at the discretion of the Director.

   5 units, Aut (Rhinelander, Staff) TWTh 11 and two hours by arrangement

#62. Medieval and Renaissance Literature—Boethius, Arthurian romance, Dante, Castiglione, Marlowe, Montaigne, Cervantes.
   5 units, Win (Ryan, Staff) TWTh 11 and two hours by arrangement

#63. Literature of the Enlightenment and the Modern World—Narrative Literature from Romanticism to Joyce—Goethe, Blake, Scott, Balzac, Flaubert, Dostoevsky, Kafka, Proust.
   5 units, Spr (Flores, Staff) MWF 11 and two hours by arrangement

101. Europe as Seen Through Travel Literature—Travel literature as a means of perceiving the physical and spiritual development of the regions of the world; the uniqueness of literary and historical form produced by the perception of cultures by outsiders; emphasis upon European regions and cultures. Each student selects, with the advice of the instructor, one book for careful analysis. Since the books vary constantly, the course may be repeated for credit. Students wishing to take the course to satisfy the language requirement should select a book in their special language and sign up for four units.
   3 to 4 units, Aut, Win, Spr (Hilton) TTh 10

175. Individual Work—For students with definite objectives not met by current course offerings.
   2 to 4 units, each quarter (Staff) by arrangement

191, 192, 193. Interdepartmental Seminars on the Nature of the Humanities—Students in the Humanities Honors Program are re-
quired to complete 191 and either 192 or 193. These seminars are open to a limited number of other students only by permission of the Director, Humanities Honors Program.

191. Principles and Methods of Humanistic Study.
5 units, Aut (Clebsch, Evans, Smith) by arrangement
Win (Smith) by arrangement

192. The Arts as Humanities—The arts, both verbal and non-verbal, and aesthetic principles involved in the study of the Humanities. Prerequisite: 191.
5 units, Win (Smith) by arrangement
Spr (Bender) by arrangement

193. Philosophy and History as Humanities—Prerequisite: 191.
5 units, Win (Mellor) by arrangement
Spr (Rebholz) by arrangement

12 units (Staff) by arrangement

**GRADUATE PROGRAM**

*Committee in Charge:* William A. Clebsch *(Director)*, William C. Calin, Raymond D. Giraud, John D. Goheen, Paul H. Kocher, Kurt Mueller-Vollmer, Brooks Otis, Philip H. Rhinelander, Lawrence V. Ryan, Friedrich W. Strothmann

The Graduate Program in Humanities supplements the doctoral programs of certain departments (Classics, English, French and Italian, German, History, Philosophy, Slavic Languages and Literatures, Spanish and Portuguese, Speech and Drama), with an interdepartmental program devoted to the study of the Western tradition as a whole. The degree offered is a joint Ph.D., awarded in "History and Humanities," "Philosophy and Humanities," "French and Humanities," etc.

Because the Graduate Program in Humanities is designed as a supplement to and not as a substitute for, departmental specialization, its courses may be taken only by students who have been accepted for graduate work by a Ph.D.-granting department and whose applications have been approved by the Committee in Charge. Students entering the program should expect to take it in its entirety and should consult with the Director and their major advisers about its articulation with their departmental studies.

**REQUIREMENTS**

1. For entering the Program: Candidates may apply to the Director for entrance to the Program upon qualifying for graduate study in a Ph.D.-granting department.

2. Within the Program:
   a) Continued work in the candidate's major field in accordance with departmental requirements. For these requirements the prospective student should consult the departmental listings.
   b) Participation in one course for each of six quarters in the "Western Traditions" series—reading, interpretation, and discussion of significant writers. This Western Traditions course is divided, according to the Stanford quarter system, as follows: The Classical and Patristic Periods (1st and 2d quarters); The Medieval Period (3d quarter); The Renaissance (4th quarter); The Eighteenth and Nineteenth Centuries (5th quarter); The Modern Period (6th quarter).
   c) Participation in two Graduate Humanities Seminars. The Seminars discuss basic intellectual and educational problems of the present in the light of Western traditions.
   d) Submission of a Ph.D. dissertation acceptable to both the Humanities Committee and the major department, as well as to the University Committee on the Graduate Division.
   e) The passing of a reading examination in two foreign languages, one ancient and one modern. (Certain departments require a third language.) One of these examinations must be passed during the first two quarters of the candidate's second year of work beyond the A.B. degree.
   f) The passing of a comprehensive written examination in Humanities and the University oral examination.

**GRADUATE COURSES**

301, 302, 303, 304, 305, 306. The Western Traditions.

301. The Classic Period: Greece.
4 units, Aut (Rhinelander) TTh 4:15–6:05
302. The Roman and Patristic Periods.

4 units, Win (Raubitschek) TTh 4:15-6:05

303. The Middle Ages.

4 units, Spr (———) TTh 4:15-6:05

304. The Renaissance.

4 units, Aut (Ryan) TTh 4:15-6:05

305. The Eighteenth and Nineteenth Centuries.

4 units, Win (Giraud) TTh 4:15-6:05

306. The Modern Period.

4 units, Spr (Mueller-Vollmer) TTh 4:15-6:05

351, 353. Seminars.

351. Basic Humanistic Problems.

4 units, Aut (Kocher) MW 2:15-4:05

353. The Functions of a University and the Meaning of Education.

4 units, Spr (Rhinelander) TTh 2:15-4:05

**RELIGIOUS STUDIES PROGRAM**

The Religious Studies Program provides the student with knowledge of religion as a phenomenon of human life. As one of the humanities, the study of religion aims to understand religious works of literature, historical developments of religious tradition and practice, modes of religious thought, and varieties of world views in and among religions. Certain of the offerings are more fully described in the General Studies Bulletin, to which reference should be made.

**CONCENTRATION IN RELIGIOUS STUDIES**

A student taking the Honors Program in Humanities may declare a major in Humanities and offer a concentration in Religious Studies. The concentration, to be planned with the student's adviser, consists of 40 units in religion and related subjects, of which no less than 25 units are in courses in the Religious Studies Program. The 40 units must be distributed as follows:

1. One full course (5 units each) in each of the methods of study of religion. This is fulfilled by one course from each of the four following groups of courses in the Religious Studies Program: 101-109; 120-139; 140-159; 160-179. Exceptions must be approved by the committee on the concentration in Religious Studies.

2. Four full courses (4–5 units each) which comprise a coherent plan of studying the bearing of religion on human existence. The plan, which is subject to approval by the student's adviser, may be built around a period or episode in history (e.g., the Reformation, the Crusades, the settlement of New England), a form of human creativity (e.g., music, art, dance, poetry), a sociological grouping (e.g., the Negro American, Latin Americans, revolutionaries), or a typically human problem (e.g., freedom, identity, pain and evil). The plan must include at least one course in the Religious Studies Program and at least one relevant course in another department. Normally this plan will be related to the subject of the student's Honors Essay in Humanities.

3. The remainder of the 40 units, if any, shall be in any courses proposed by the student and approved by his adviser.

**COURSES**


5 units, Spr (Napier) MTWTh 9


5 units, Win (Good, Staff) given 1969-70

105. The Prophets of Israel—One or more of the most significant Hebrew prophets as poets and thinkers. Prerequisite: permission of instructor.

5 units, Aut (Good) TTh 2:15-4:05

106. Wisdom in the Ancient Near East—Self-conscious intellectuality in the wisdom literature of Mesopotamia, Egypt, and Israel, such as Job, Ecclesiastes, and similar works. Prerequisite: permission of instructor.

5 units, Win (Good) TTh 2:15-4:05

107. Old Testament Poetry — The use of poetry as a vehicle for religious thought and expression in Old Testament religion. Consideration of styles and techniques in representative poetry chosen from the Psalms, the Song of Songs, or other works. Prerequisite: permission of instructor.

5 units, Win (Good) given 1969-70
120. Religion in the Ancient Near East — Types of religious thought and practice in Sumerian, Babylonian, Assyrian, Canaanite, Hittite, and Israelite cultures.

5 units, Aut (Good) MTWTh 9

#121. History of Classical Christian Thought — An introduction to the theological history of Christianity in ancient times; representative theologians and the relation of their thought to classical, Byzantine, and early medieval culture.

5 units, Aut (Clebsch) given 1969-70

#122. History of European Christian Thought — An introduction to the theological history of Christianity in the Europe of the Middle Ages, Renaissance, and Reformation; representative theologians and the relation of their thought to imperial and national European culture.

5 units, Win (Yearley) MTWTh 11


5 units, Spr (Irish) TTh 2:15-4:05

124. Islamic Theology and Philosophy — An introduction to the thought of leading theologians and philosophers through the twelfth century with consideration of the influence of the Greek philosophical tradition.

5 units, Aut (Berman) MW 2:15-4:05

125. Medieval Jewish Thought I — An introduction to the thought of representative theologians and Neoplatonists through Judah ha-Levi. Analysis and discussion of major texts in English translation; may be taken independently of 126.

5 units, Win (Berman) MW 2:15-4:05

126. Medieval Jewish Thought II — A consideration of central problems of the period from Maimonides to Spinoza, such as Aristotelianism and the reaction against it, the conflict between mysticism and philosophy, Spinoza's criticism of the canons of Biblical interpretations; may be taken independently of 125.

5 units, Spr (Berman) TTh 4:15-6:05

127. Aquinas — A study of the thought of Thomas Aquinas in its historical setting.

5 units, Win (Yearley) TTh 4:15-6:05

128. Augustine — study of the thought of Augustine, in its historical setting.

5 units, Win (——) TTh 4:15-6:05, given 1969-70

129. Maimonides — A study of the thought of Maimonides as reflected in his Guide of the Perplexed: scripture and its interpretation; concept of God and universe; prophecy; the political role of the law.

5 units, Win (Berman) given 1969-70

131. Religious Thought in England and America — Leading religious thinkers representing such movements as Reformation, Puritanism, rationalism, pietism, romanticism; their relation to historical, intellectual, and literary developments. Prerequisite: permission of instructor.

5 units Spr (Clebsch) MW 2:15-4:05

132. American Religion — Religious movements and thinkers of various periods; the rise of religious pluralism.

5 units, Win (Clebsch) MTWTh 10

134. Judaism — An introduction to the main currents of Talmudic and post-Talmudic Jewish thought: Midrash, Mishnah, and Talmud; the codification of the law; Karaism; theology and philosophy; Kabbalah and Hasidism.

5 units, Win (Berman) MTWTh 11

135. Islam — A review of the fundamental elements of Islamic thought: analysis of the Koran; the traditional literature; basic concepts of law; sects; theology and philosophy; mysticism.

5 units, Aut (Berman) MTWTh 11

136. Judaism and Islam — Historical study of Jewish influence on Muhammad and the Koran; attitude to Judaism in the Koran and traditional literature; medieval influences in language, philosophy, and mysticism. The contemporary scene. Structural comparison of the two religions.

5 units, Spr (Berman) MW 2:15-4:05

141. Contemporary Trends in Religious Thought — Examination of the thought of present-day theologians such as Barth, Bultmann, Buber, Tillich, Teilard de Chardin, Bonhoeffer, and others, through study of their own writings.

5 units, Aut (Brown, Irish) MTWTh 10

145. The Ecumenical Movement — An examination of the development of ecumenical...
cal concern in the twentieth century in both Protestantism and Roman Catholicism. Particular attention will be given to the World Council of Churches, the Second Vatican Council, and post-Vatican II developments. Prerequisite: one course in Religious Studies.

5 units, Aut (Brown) MW 2:15-4:05

148. Modern Catholic Thought—A survey of creative thinkers whose work has revivified Roman Catholicism in the twentieth century.

5 units, Aut (Yearky) MTWTh 11

151. Uses and Abuses of the New Testament—Consideration of Christological themes during the past century; the historical Jesus, the centrality of Jesus in the "death of God" movement, and Jesus Christ as symbolic form.

5 units, Spr (Irish) MTWTh 10

154. Christian Ethics—Contemporary problems of ethics such as race, war, political decision, sex and marriage, examined from the perspective of writings drawn from both historical and contemporary sources.

5 units, Spr (Irish) MTWTh 11

156. Reason and Revelation in Islamic Thought—Symbolic representation of truth and myth. Law and society. Theories of illumination and organized religion. Analysis of selections from the writings of representative thinkers in English translation.

5 units, Aut (Berman) given 1969-70


5 units, Spr (Berman) given 1969-70

159. The Thought of Dietrich Bonhoeffer—An examination of decisive stages in the development of Bonhoeffer's thought, through study of his major writings, together with exploration of his influence on contemporary thought. Limited to 15 students. Prerequisite: permission of instructor.

5 units, Aut (——) TTh 4:15-6:05, given 1969-70

164. The Thought of Dietrich Bonhoeffer—An examination of decisive stages in the development of Bonhoeffer's thought, through study of his major writings, together with exploration of his influence on contemporary thought. Limited to 15 students. Prerequisite: permission of instructor.

5 units, Win (Brown) MW 2:15-4:05

165. Major Catholic Theologians—The thought of one or more significant Catholic thinkers; 1968-69, Karl Rahner. Prerequisite: permission of instructor.

5 units, Aut (Yearley) TTh 4:15-6:05

168. The Thought of Dietrich Bonhoeffer—An examination of decisive stages in the development of Bonhoeffer's thought, through study of his major writings, together with exploration of his influence on contemporary thought. Limited to 15 students. Prerequisite: permission of instructor.

5 units, Aut (Irish) TTh 4:15-6:05, given 1969-70

183. Confucianism and Taoism

5 units, Spr (Yearley) MTWTh 11

184. Classics of Religious Thought—One major thinker or controversy will be studied in religious and historical setting and for its permanent significance.

5 units, Aut (Irish) TTh 2:15-4:05

185. Mythology in the Ancient World—Cultural and religious uses of mythological texts and motifs, such as creation, death and resurrection, fertility, cosmic struggle, as they appear in various types of literature. Material from Near Eastern, Israelite, Anatolian, Greek, and Christian settings. Prerequisite: junior or senior standing, and permission of instructor.

5 units, Spr (Good) TTh 2:15-4:05
190. Senior Seminar in Religion—Limited to 15 students. Prerequisite: permission of instructor.

*5 units, Spr (Brown) MW 2:15–4:05*

199. Individual Work.

*(Staff) by arrangement*

299. Directed Reading for Graduate Students.

*(Staff) by arrangement*

**LATIN AMERICAN STUDIES**

*Committee in Charge:* The Committee on Latin American Studies, a subcommittee of the Committee on International Studies.

*Chairman:* John J. Johnson (Professor, History)

The Committee on Latin American Studies administers the A.M. program in Latin American Studies, which provides an interdisciplinary approach to the study of Latin America. The departments of Anthropology, Economics, History, Political Science, Sociology, and Spanish and Portuguese participate in the program.

To qualify for admission to the program, applicants must have the equivalent of an A.B. or a B.S. degree and a working knowledge of Spanish or Portuguese. Applicants must also take the Graduate Record Examination and have the results sent to the Office of Graduate Admissions.

The student's program is designed in consultation with the Chairman of the Committee and with faculty of the participating departments, within the framework of the following academic requirements:

a) Ten courses with a minimum of 38 units. At least eight of the ten courses must be basically Latin American in content. Students must receive grades of A, B, or plus in at least seven courses in order to complete the degree. Courses are distributed as follows:

1) Core Seminar (LAS 250, 251, 252)—an interdisciplinary course required of all A.M. candidates in Latin American Studies, taught by faculty from the participating disciplines. Fifteen units; 5 units per quarter.

2) Latin American Bibliography (LAS 260) required of all A.M. candidates in Latin American Studies.

3) Three or four courses in a single base discipline.

4) Two or three courses distributed among other participating disciplines. (Relevant courses may be found in the listings for the participating disciplines.)

b) Demonstrated competence in Spanish or Portuguese at the level of 113 or higher. If Spanish or Portuguese is the student's base discipline, he must show ability in both languages. Courses in Linguistics may be counted toward this concentration.

There is no thesis requirement for the A.M. degree in Latin American Studies. Instead, a paper that gives satisfactory evidence of methodological, analytical, research and writing skills is required from each member of the Core Seminar.

Since the University does not offer a Ph.D. degree in Latin American Studies, students who wish to remain at Stanford after completing their A.M. must be accepted by one of the regular departments.

Inquiries concerning this program should be directed to the Chairman, Committee on Latin American Studies, Bolivar House, Stanford, California 94305.

**COURSES**

152. Undergraduate Seminar in Research Design for Independent Study — Open to students accepted for the Latin American Studies Undergraduate Summer Program.

*4 to 5 units, Spr (Staff) Th 4:15–6:05*

199. Independent Research—Restricted to students in Latin American Studies Undergraduate Summer Program.

*3 to 5 units, Aut (Staff) by arrangement*

250, 251, 252. Core Seminar in Latin American Studies—Introduction to methodologies and the status of research in the social sciences with relation to Latin America.

*4 to 5 units, Aut, Win, Spr (Staff)*

*T 2:15–4:05*

260. Latin American Bibliography — With emphasis on the contemporary period.

*2 units, Spr (Breedlove) T 2:15–4:05*

Summer Intensive Language Program in Spanish and Portuguese—See Spanish and Portuguese.
LINGUISTICS

Committee in Charge: Charles A. Ferguson (Chairman), Robert W. Ackerman, Joseph H. Greenberg, Dorothy A. Huntington, Alphonse Juillard, Phillip B. Petersen, Robert L. Politzer, Joseph A. Van Campen, William C. Ward

Professor: Charles A. Ferguson
Assistant Professor: Andrew M. Devine
Lecturers: Elaine Kaufman, Dinguri N. Mwaniki, Elizabeth C. Traugott

English for Foreign Students
Assistant Professor: Clara N. Bush
Instructors: R. Elizabeth Cecchetti, Frieda Politzer

PROGRAMS OF STUDY

Note—The courses offered by the Committee are primarily intended to prepare candidates for advanced degrees in Linguistics. The undergraduate related courses will give students some acquaintance with the methods, insights, and findings of linguistics, but there is no undergraduate major in Linguistics, and students who wish to enter the field are advised to major in Anthropology or one of the language departments.

MASTER OF ARTS

Candidacy—Candidates for the degree of Master of Arts in Linguistics must have completed an equivalent of the training represented by an A.B. or B.S. degree. The candidate must have completed, with a grade of B or better, the equivalent of at least 9 quarter units of university-level work in each of the following: (a) linguistics; (b) foreign language (above elementary) or English (exclusive of literature and composition courses); (c) social science (e.g., anthropology, sociology, psychology), or mathematics (incl. statistics and computer science), or philosophy. In special cases the requirements may be waived by the Committee, but in no case will credit toward the A.M. be given for elementary linguistics courses taken to fulfill (a). The student’s program should be prepared in advance in consultation with the Chairman of the Committee.

Requirements
1. Language. Candidates must demonstrate, by written examination, their ability to read linguistic research in two foreign languages, normally chosen from French, German, and Russian.
2. Course. 40 units of graduate work, selected among courses listed below, and distributed approximately as follows:
   a) 15 units in general linguistics;
   b) 15 units in a particular language or group of languages (graduate courses of the chosen language department);
   c) 10 units in a particular field of specialization (anthropological linguistics, applied linguistics, child language, comparative Indo-European, computational linguistics, dialectology, language, psycholinguistics, sociolinguistics, statistical linguistics).
3. Examination. Satisfactory passing of a written examination on the principles of Linguistics and on the particular language or group of languages chosen by the student.

MASTER OF ARTS IN TEACHING

The degree of Master of Arts in Teaching is offered jointly by the Committee on Linguistics and the School of Education. Prospective candidates should consult the general requirements for the degree as outlined by the School of Education in this bulletin and make inquiry of the Chairman of the Committee on Linguistics concerning the requirements for the academic major.

MINOR IN LINGUISTICS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

The requirements of the Ph.D. minor in Linguistics are roughly equivalent to those of the A.M. major in Linguistics, above. Programs of courses are to be established in accordance with the student’s interest, in consultation with a committee adviser. A substantial term paper is required instead of a thesis.

DOCTOR OF PHILOSOPHY

Candidacy—Candidates should read carefully the requirements governing the conferring of this degree, as described in the section “Degrees” of this bulletin. For specific requirements and recommendations, the student should consult with the Chairman of the Committee. Candidates must have completed the equivalent of the course requirements for the Master of Arts in Lin-
guistics, or in a given language (e.g., A.M. in French, or in German, or in Russian, etc.), or, with the Chairman's approval, in a related field (e.g., A.M. in anthropology, or in philosophy, or in psychology, or in sociology, or in speech and hearing sciences, etc.).

Requirements

1. Language. Candidates for the Ph.D. must demonstrate reading ability in three foreign languages, two of them to be chosen from French, German, and Russian.

2. Courses (beyond the A.M.), 40 units of graduate work, exclusive of dissertation units, selected among courses listed below, numbered 200 or above, and distributed approximately as follows:
   a) 15 units in general linguistics;
   b) 15 units in a particular language or group of languages (graduate courses of a given language department);
   c) 10 units in a field of specialization (anthropological linguistics, applied linguistics, child language, comparative Indo-European, computational linguistics, dialectology, phonetics, psycholinguistics, sociolinguistics, statistical linguistics).

3. Examinations.
   a) Successful passing of a written Committee examination on:
      1) The principles of general linguistics (descriptive and historical) and the methods and techniques of the main linguistic disciplines (phonology, morphology, syntax, lexicology, dialectology, typology, etc.).
      2) The language(s) of specialization.
      3) The field of specialization.
   b) Successful passing of an oral examination which will normally consist of a defense of the dissertation in the prefinal form.

4. Dissertation. An original dissertation of such substance and scope as would justify publication (15 units).

Note—A list of courses approved for credit in general linguistics and fields of specialization as well as a list approved for languages of specialization can be obtained from the office.

Research

The Committee on Linguistics maintains a program of basic research in linguistics and related fields. The major projects are frequency-based studies of language structure, theory of language universals, and study of child language development. A limited number of research assistantships are available, graduate and post-doctoral.

Courses

Courses recognized toward the A.M. and Ph.D. degrees in Linguistics are those listed below, and those approved by the Committee.

200. Historical Linguistics—Introduction to the principles and methods of historical linguistics; the development of modern schools and trends of historical linguistics in the nineteenth and twentieth centuries.
   3 units, Aut (Traugott) MWF

201. Introduction to Comparative Linguistics (Indo-European)—The emphasis is on phonology and special attention is paid to the development of English.
   3 units, Aut (Devine)

208. Sanskrit Texts and Historical Grammar.
   4 units, Win (Devine)

209. Sanskrit Texts and Historical Grammar—Continuation of 208.
   4 units, Spr (Devine)

210. Lithuanian Texts.
   4 units, Spr (Devine) by arrangement

   4 units, Aut (Traugott) MWF

299. Independent Study.

By arrangement

301, 302, 303. Seminar in Structural Linguistics—Lectures, readings, and reports on the principles, methods, and techniques of the structural approach to language.

301. The Structure of Linguistic Theory.
   3 units, Aut (Juilland) by arrangement

302. The Concept of Word.
   3 units, Win (Juilland) by arrangement

303. Linguistics and Statistics.
   3 units, Spr (Juilland) by arrangement
315. Seminar on Syntax — Topics in the theory of syntax, including the relationship of syntax and semantics. Material from English and other languages.
3 units, Win (Traugott)

332A,B,C. Beginning Hausa.
5 units, Aut, Win, Spr (Kaufman)
given 1969-70

5 units, Aut, Win, Spr (Taira)

334A,B,C. Beginning Swahili.
5 units, Aut, Win, Spr (Kaufman)

335A,B,C. Intermediate Swahili.
5 units, Aut, Win, Spr (Mwaniki)

336A,B. Survey of Swahili Literature—History and present status of Swahili literature with reading of texts. Current problems in the use of Swahili. Open to students with no knowledge of Swahili, with consent of the instructor.
3 units, Aut, Win (Mwaniki)

365. Phonology—Field-oriented training in linguistic analysis as applied to the sound systems of languages. Lecture-discussion and laboratory. Prerequisite: elementary linguistics course or consent of instructor.
4 units, Win (Ferguson) TWTh 9

370. Child Language—A review of present knowledge of the process of language acquisition, from a linguistic point of view. Emphasis will be on first-language acquisition by normal children. Prerequisite: elementary linguistics course or consent of instructor.
4 units, Win (Ferguson) TWTh 11

4 units, Aut (Ferguson) TWTh 9, given 1969-70

372. Sociolinguistics — Selected topics on language and society, including language and social stratification, language standardization, language and national development.
4 units, Spr (Ferguson) TWTh 11

373. Languages of the Middle East—Structural sketches and sociolinguistic background information on the major contemporary languages of Southwest Asia and North Africa.
4 units, Aut (Ferguson) TWTh 11, given 1969-70

399. Independent Study.
By arrangement

ENGLISH FOR FOREIGN STUDENTS

The courses below represent the basic offerings in English for Foreign Students. Each quarter, additional sections of these courses are scheduled at other hours and days as needed. A program in Academic Orientation and Intensive English is offered in the summer for certain Latin American graduate students who have been admitted to degree programs at Stanford for the following autumn quarter.

47. Spoken English I—Basic work in spoken English with emphasis on comprehension and intelligibility. Course also includes the use and comprehension of written English.
6 units, Aut (Staff) MTWThF 9 and one hour by arrangement

48. Spoken English II—Intermediate work in spoken English with emphasis on comprehension and intelligibility. Prerequisite: 47 or consent of instructor.
4 units, Aut, Win (Staff) MWF 9 and one hour by arrangement

49. Spoken English III—For students with some facility in spoken English. Emphasis on fluency, idiom, and current usage. Upon recommendation of the adviser, the course may be repeated for a total of 6 units. Prerequisite: consent of instructor.
1 to 3 units, Aut, Win, Spr (Staff) TTh 10 and one hour by arrangement

58. Written English II—Intermediate work in written English with emphasis on acceptable usage in the mechanics and form of expository writing. Prerequisite: 47 or consent of instructor.
2 units, Aut, Win (Staff) TTh 11

59. Written English III—For students with some facility in written English. Emphasis on fluency, idiomatic usage, and style. Upon recommendation of the adviser, the course may be repeated for a total of 6 units. Prerequisite: consent of instructor.
1 to 3 units, Aut, Win, Spr (Staff) MWF 11

GENERAL COURSES
(See French and Italian)

ANTHROPOLOGY

167. Language and Culture.
261. Linguistic Field Methods.
263. Grammatical Theory.
264. Typology and Universals of Language.
265. Introduction to Linguistics.
270. Languages of Africa.

COMMUNICATION

211. Theory of Communication I.
212. Theory of Communication II.

COMPUTER SCIENCE


ENGLISH

102. Introduction to the English Language.
208. Introduction to Modern Linguistics.
310. Old English.
312. Middle English.
316. Seminar in Elizabethan Language.

FRENCH

(See French and Italian)

225. Histoire de la langue française.
310. Introduction a la linguistique romane, problems de linguistique structurale et historique.
311. Old French Texts.
312. Histoire de la langue française depuis le Moyen Age jusqu'à présent.
315. Grammaire historique de la langue française.

GERMAN

185. History of the German Language.
190. German Applied Linguistics.
205. Modern German.
221. Gothic and Historical Germanic Grammar.
223. Old Norse.
224. Old Icelandic Sagas.
225. Old Saxon.
227. Old High German.
228. Middle High German.
229. Advanced Middle High German.

ROMANCE LINGUISTICS AND PHILOLOGY

(See French and Italian)

203. Vulgar Latin.
204. Introduction to Romance Linguistics.
205. Old Provençal.
207. Old Italian.
250. Seminar in Romance Linguistics.
270. Topics in Structural Linguistics.

PHILOSOPHY

157A. Introduction to Logic.
157B. Intermediate Logic.
181. Philosophy of Language.
201. Mathematical Linguistics.
245. Seminar in Foundations of Psychology.

PSYCHOLOGY

146. Language and Thought.

SLAVIC

196. Russian Pronunciation—Problems of theoretical and applied phonology.
197. Russian Syntax and Lexicology—Introduction to problems of advanced grammar and usage.
200. Proseminar—Introduction to problems of literary and linguistic analysis and research in the Slavic field.
201. Synchronic Morphology of Russian I: Conjugation.
203. Synchronic Morphology of Russian III: Root Structure
211. Introduction to Old Church Slavonic.
212. Advanced Old Church Slavonic. Prerequisite: 211.
228. Divergence of Slavic Languages.
251. Examination of the Structure of non-Russian Slavic Languages.

SPANISH

181. History of Linguistic Thought.
190. Spanish Linguistics.
197. Spanish Lexicon.
204. Modern Spanish I—The Phonology of Modern Spanish.
205. Modern Spanish II—The Syntax of Modern Spanish.
260. History of the Spanish Language.
261. Old Spanish.
263. Historical Spanish Linguistics I.
264. Historical Spanish Linguistics II.
266. Hispanic Dialectology.
299. Individual Work.

SPEECH AND DRAMA
1. Characteristics of Spoken Language.

SPEECH AND HEARING SCIENCES
212. Phonetic Theory.
220. The Psychology of Speech.
223. Speech and Language Development.
230. Speech Science I.
231. Speech Science II.
252. Aphasia.
253. Aphasia in Children.
310. Experimental Phonetics I.
311. Experimental Phonetics II.
312. Experimental Phonetics III.

MATHEMATICS
Emeriti: Stefan Bergman, William A. Manning, George Polya, Gabor Szegö (Professors)
Executive Head: David Gilbarg
Associate Executive Head: Paul W. Berg
Associate Professors: Donald S. Ornstein.
Visiting: Michael D. Morley
Assistant Professors: Michael G. Crandall, Hubert Goldschmidt, Paul Rabinowitz, Mary V. Sunseri. Acting: John B. Walsh
Instructor: James M. Hornell

OFFERINGS AND FACILITIES

The Department of Mathematics offers programs leading to the degrees Bachelor of Science, Bachelor of Science with Departmental Honors, and Doctor of Philosophy. (The Department does not offer a separate program for the Master of Science degree, but this degree may be awarded for a portion of the Doctor's work.)

For undergraduates there are five introductory courses of which four are alternative sequences in analytic geometry and calculus (10, 11, 21, 22, 23, 44, 45, 46, or 41, 42, 43, 44, 45, 46, or 41A, 42A, 43A, 44, 45, 46 or 41, 52, 53, 54, 55). These courses are provided for students who wish to graduate with a major in mathematics and for students in other departments who need or desire mathematics above the level of secondary school mathematics. A general introductory course (31, 32, 33, 34, 35) is offered for students who will not need detailed technical knowledge of calculus. Students electing one of the above series are expected to complete the work in that series. Changes from one series to another are permitted only by special arrangement.

Honors sequence Mathematics 52, 53, and 54, 55 is an honors course in calculus for students intending to major in mathematics or the physical sciences. These courses cover the material contained in Mathematics 42, 43, and 44, 45, 46, but students who take this sequence need to spend less time on drill, and consequently it is possible to explore some of the interesting implications of calculus in science, engineering, and mathematical courses (31, 32, 33, 34, 35) is offered. Prerequisites: Mathematics 41 or equivalent, and the consent of the instructor.

ADVANCED PLACEMENT FOR FRESHMEN

Secondary school students of unusual ability in mathematics often pursue one or more semesters of college-equivalent courses in mathematics while they are still in high school. Under certain circumstances it is possible for such students to secure both advanced placement and credit toward the Bachelor's degree on the basis of these courses. A decision as to placement and credit will be made by the Department after
consideration of the student's performance on the Advanced Placement Examination in Mathematics of the College Entrance Examination Board. This examination is the only one used for this purpose. The Department does not give its own Advanced Placement examination. Arrangements for such advanced placement and credit must be made during the first two weeks of the student's first quarter of attendance at Stanford University, or earlier, or the privilege will lapse. Advisers on advanced placement are currently Professors Mary V. Sunseri and H. M. Bacon.

**Programs of Study**

**Bachelor of Science**

The following Departmental requirements are in addition to the University's basic requirements for the Bachelor's degree:

1. Analytic Geometry and Calculus (Courses 10, 11, 21, 22, 23, 44, 45, 46, or 41, 42, 43, 44, 45, 46, or 41A, 42A, 43A, 44, 45, 46, or 41, 52, 53, 54, 55). These courses should be started during the first year. (Course 117 may be substituted for 46.)

Students intending to major in mathematics are advised to begin or continue the study of French, German, or Russian in the first year.

2. Three quarters of Algebra (113, 114, 120); two quarters of Differential Equations (130, 131); two quarters of Fundamental Concepts of Analysis (115, 116); one quarter of Introduction to Functions of a Complex Variable (106); one quarter selected from Higher Geometry (142), Non-Euclidean Geometry (157), Introduction to Topology (159), Differential Geometry (217A).

3. Nine units of courses in mathematics numbered above 100 in addition to those selected to fulfill requirement "2." The average grade point ratio in these courses and the courses chosen under "2" above must be not less than 2.00.

Students planning graduate study in mathematics are advised to include one or more 200 level courses in their programs and, to facilitate this, to complete 113, 114, 115 and 116 as early as possible.

4. French 23, German 22, or Russian 52; Physics 51, 53, 54, 55, 56, 57, 58.

**Bachelor of Science with Honors**

Admission to the Program — A student may apply for admission to the Honors Program not earlier than the last quarter of his sophomore year, and not later than the first two weeks of the first quarter of his senior year. Application must be made to the Committee on Undergraduate Affairs of the Department of Mathematics. Minimum requirements for consideration of an application are (1) a 3.5 average in Mathematics courses taken at Stanford; (2) completion of at least two quarters of Advanced Calculus (44, 45, or 54, 55) and one quarter of Linear Algebra (113); (3) some evidence of the candidate's interest in and aptitude for advanced work in mathematics. The applicant must (4) submit a detailed program of course work for the remaining quarters of his undergraduate career (see "Program" below for suggestions). This program will be regarded not as strictly binding, but as indicating his intended plan of study; appropriate substitutions can be made later with the approval of his adviser and of the Committee. In reaching a decision on the admission of an applicant, the Committee will pay special attention to items (3) and (4).

Each student enrolled in the Honors Program will

1. Satisfy the requirements for the B.S. in Mathematics, maintaining at least a 3.5 grade average in all mathematics courses.

2. Enroll in the Honors sections of mathematics courses whenever possible.

3. Complete at least 4 units of independent study in Mathematics 199. This will require that the student obtain the consent of a member of the Department Faculty to supervise and evaluate the student's work. This work may be spread over a period of two or more quarters as the student and the faculty member may agree.

4. Complete at least 6 units of additional work as approved by the Committee. This may consist of one of the following options, or of a combination of them:

   a) Additional independent study as in (3) above;

   b) Additional undergraduate course work in mathematics or other subjects having high mathematical content and contributing to a broad mathematical and/or scientific knowledge;
c) Completion of one or more of the basic graduate courses in mathematics such as courses 205, 206, 210, 217. (This is especially recommended for students who plan to enter graduate work in mathematics.)

**Master of Science**

The University's basic requirements for the Master's degree (residence, thesis, etc.) are discussed in the section "Degrees" in this bulletin. The following are Departmental requirements:

Candidates must complete an approved course program which will ordinarily consist of a minimum of 45 units, at least 36 of which will be in this Department. The Master's Thesis is optional: If a thesis is presented, the candidate's program must contain 15 units of 200-level courses (in addition to the thesis). If no thesis is to be presented, the candidate's program must include 24 units of courses numbered 200 or above. The candidate must have a B average over all course work taken in Mathematics, and a B average in the 200 level courses considered separately. Certain exceptions to the 45 unit requirement above are possible. In particular, a student will be recommended for the M.S. degree upon completion of an approved program of 36 units of 200 level Mathematics courses with grades of B or better.

For the degree of Master of Science in Computer Science, see Computer Science Department material in this bulletin.

**Doctor of Philosophy**

The University's basic requirements for the doctorate (residence, dissertation, examination, etc.) are discussed in the section "Degrees" in this bulletin. The following are Departmental requirements:

In order that a student be admitted to candidacy for the Ph.D. degree, he must have successfully completed 45 units of graduate courses (i.e., courses numbered 200 and above). These courses should include Mathematics 205A, B, C, 206A, B, C, 210 A, B. In addition he must pass qualifying examinations given by the Department and demonstrate the ability to read French, German, or Russian.

Beyond the requirements for candidacy, the student must complete a course of study of at least 30 units approved by the Graduate Study Committee of the Department of Mathematics. This program must either display sufficient breadth in mathematics outside the student's field of specialization, or fulfill the requirements for a minor in another department. In addition, the student must pass his second language examination and the University oral examination, and submit an acceptable dissertation. A student must receive a grade of B or better in a course in order that it satisfy a requirement for the Ph.D. degree.

A candidate for the Ph.D. degree in Mathematics may specialize in computer science and submit his dissertation in this area. He must satisfy the usual requirements for the degree as established by the Mathematics Department. Since he must also be expert in certain areas of computer science he should confer early with the Computer Science Department in planning his program. In view of the necessary work in computer science, consideration will be given to a reduction in the variety of other mathematics courses required for the degree.

For the degree of Doctor of Philosophy in Computer Science, see the Computer Science Department material in this bulletin.

For further information concerning degree programs, requirements for a Ph.D. minor in mathematics, fellowships, and assistantships, inquire of the Department secretary.

**Teachers' Credentials**

The requirements for a teaching major in Mathematics for the Standard Teaching Credential (Secondary) are the B.S. degree with major in Mathematics (see above) or, if the candidate has a Bachelor's degree with a major in another subject, the following: Courses 10, 11, 21, 22, 23, 44 (or 41, 42, 43, 44, or 41A, 42A, 43A, 44, or 41, 52, 53, 54) together with 21 units selected from courses numbered 100 or above, and in addition, 15 units selected from courses numbered 100 or above or in courses in other departments requiring extensive application of mathematics. Thirty-six quarter units must be in upper division or graduate standing. Candidates for the General Secondary Credential may count courses 45, 46 and 55 as equivalent to "courses numbered 100 or higher" for the purpose of meeting requirements listed
in this paragraph. The requirements for a teaching minor in Mathematics are Courses 10, 11, 21, 22, 23, 44 (or 41, 42, 43, 44, or 41, 52, 53, 54) together with 12 units as follows: 9 units in mathematics courses numbered 100 or higher; 3 units either in mathematics courses numbered 100 or higher or in courses requiring extensive application of mathematics given in other departments. In order to receive the recommendation of the Department for a teaching major or a teaching minor, the candidate is expected to have an average grade of B in these required courses. If work in mathematics has been taken at another institution, it is expected that at least one course numbered 100 or above will be taken in the Department. Attention is called to Courses 105, 113, 114, 120, 142, 143, 152, 157, and 159, as particularly appropriate to these programs.

MASTER OF ARTS IN TEACHING
(MATHEMATICS)

In cooperation with the School of Education, the Department offers a program leading to a degree, Master of Arts in Teaching (Mathematics). This degree is intended for candidates who have a teaching credential and wish further to strengthen their academic preparation. Detailed requirements are outlined in this bulletin under “School of Education, the Master of Arts in Teaching.”

COURSES

INTRODUCTORY AND UNDERGRADUATE COURSES

Introductory courses will be offered only if ten or more students enroll.

0. Algebra and Trigonometry—Fundamental laws; linear and quadratic equations; inequalities; logarithms; binomial theorem; trigonometric functions, identities, and equations; solution of right and oblique triangles; complex numbers; De Moivre’s theorem.

4 units, Aut, Win (——) MTWThF 10 or 2:15

#1. Elementary Mathematical Analysis I—Structure of the real number system; logic of algebra; fundamental concepts of geometry and trigonometry. No credit allowed if taken after courses numbered 10 or higher.

3 units, Win (Bacon) MWF 8

#2. Elementary Mathematical Analysis II—Introduction to the basic ideas of analytic geometry and calculus; applications. No credit allowed if taken after courses numbered 10 or higher. Prerequisite: 1.

3 units, Spr (Bacon) MWF 8

#10. Analytic Geometry and Calculus—Distance, slope, equations of lines, functions and graphs, derivative of a function, velocity and rates, properties of limits, polynomials and their derivatives, rational functions, rules for differentiation, implicit relations, chain rule for derivatives, differentials, continuity, related rates, curve tracing, maxima and minima with applications, Rolle’s theorem, mean value theorem. Continuation in the course depends upon the student’s passing a qualifying examination given during the first week of the course and covering algebra and trigonometry. Prerequisites: algebra and trigonometry.

3 units, Aut (——) MWF 8, 10, or 2:15

Win (——) MWF 10, 12, or 2:15

#11. Analytic Geometry and Calculus—Continuation of 10. Curves and equations, tangents and normals, Newton’s method for finding roots, circle, parabola, ellipse, hyperbola, translation and rotation of coordinate axes, invariants, conics, indefinite integral, differentiation of sines and cosines, area under a curve, definite integral and the fundamental theorem of calculus, trapezoid rule. Prerequisite: 10.

3 units, Win (——) MWF 8, 10, or 2:15

Spr (——) MWF 10, 12, or 2:15

#21. Analytic Geometry and Calculus—Continuation of 11. Area between two curves, volumes, length of arc, surface of revolution, average value of a function, moments and center of mass, theorems of Pappus, hydrostatic pressure, work, trigonometric functions, inverse trigonometric functions, the logarithmic and exponential functions. Prerequisite: 11.

3 units, Aut (——) MWF 8 or 3:15

Spr (——) MWF 8, 10, or 2:15

#22. Analytic Geometry and Calculus—Continuation of 21. Methods of integration, partial fractions, integration by parts, substitutions, improper integrals, Simpson’s rule, determinants, simultaneous equations, hyperbolic functions, inverse hyperbolic
functions, polar coordinates. Prerequisite: 21.

3 units, Aut (——) MWF 9, 11, or 1:15
Win (——) MWF 8 or 3:15

#23. Analytic Geometry and Calculus — Continuation of 22. Polar coordinates, angle between tangent and radius vector, areas, parametric equations, vector components, differentiation of vectors, curvature, tangential and normal acceleration, space coordinates, vectors, scalar product, planes and lines in space, space curves, cylinders, quadric surfaces, partial derivatives, tangent plane, chain rule for partial derivatives. Prerequisite: 22.

3 units, Win (——) MWF 9, 11, or 1:15
Spr (——) MWF 8 or 3:15

#31. Introduction to Mathematics — Mathematics 31-35 is intended for students whose major area of specialization does not require detailed technical knowledge in mathematics. The series does not serve as a prerequisite to Mathematics 44. The objective of the series is to provide technical knowledge in some areas of mathematics, and to provide a view of mathematics as it developed and as it is today. Topics discussed will be chosen from the following: Mathematics in early civilizations. Discovery of analytic geometry and calculus. Elementary calculus: real number system, differentiation of algebraic functions, trigonometric and exponential functions, applications; anti-derivatives, Riemann integral, area and volume; infinite series, differential equations, applications. Complex numbers. Nineteenth century generalizations of the number systems. Vector spaces and matrix theory; linear dependence, bases, linear transformations, matrix algebra, determinants, eigenvalues, quadratic forms, modern applications. Projective geometry, non-euclidean geometries. The axiomatic method in mathematics. Symbolic logic. Set theory. Trends in modern mathematics. Requirements for admission to 31 same as for 10.

3 units, Aut (——) MWF 10

#32. Introduction to Mathematics — Continuation of 31.

3 units, Win (Hawley) MWF 10

#33. Introduction to Mathematics — Continuation of 32.

3 units, Spr (Hawley) MWF 10

#34. Introduction to Mathematics — Continuation of 33.

3 units, Aut (McGregor) MWF 11

#35. Introduction to Mathematics — Continuation of 34.

3 units, Win (McGregor) MWF 11

#41. Analytic Geometry and Calculus — 41 and 42 together cover the same subjects as 10, 11, 21, and part of 22. Requirements for admission to 41 same as for 10.

5 units, Aut (Sunseri) MTWThF 8;
(Bacon) MTWThF 9;
(——) MTWThF 10
Win (——) MTWThF 12

#41A. Calculus — 41A, 42A, 43A together cover the same topics in the calculus as 41, 42, 43, but topics in plane analytic geometry are omitted. Requirements for admission to 41A are the same as for 10, but in addition the student must have had substantial course work in analytic geometry in high school or college. Admission to 41A will be restricted to students who pass a qualifying examination in analytic geometry to be given during the first week of the quarter. Details of this examination will be explained at the first meeting of the class. This examination will be waived only for those who present transfer college credit in analytic geometry.

5 units, Aut (Sunseri) MTWThF 9

#42. Analytic Geometry and Calculus — Continuation of 41.

5 units, Win (Sunseri) MTWThF 8;
(Bacon) MTWThF 9
Spr (——) MTWThF 12

#42A. Calculus — Continuation of 41A.

5 units, Win (Sunseri) MTWThF 9

#43. Analytic Geometry and Calculus — Continuation of 42. Improper integrals, Simpson's rule, determinants, simultaneous equations, hyperbolic functions, inverse hyperbolic functions, polar coordinates, polar curves, angle between radius vector and tangent line, areas, parametric equations, vector components, differentiation of vectors, tangential and normal acceleration, space coordinates, vectors, scalar product, planes and lines in space, space curves, cylinders and quadric surfaces, functions of several variables, partial derivatives, tangent plane, chain rule for partial derivatives, differential equations of first order (homogeneous, lin-
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ear), special second order differential equations, l’Hospital’s rule. Prerequisite: 42.

5 units, Aut (----) MTWThF 12
Spr (Sunseri) MTWThF 8;
(Bacon) MTWThF 9

#43A. Calculus — Continuation of 42A. Concurrent registration in 44 is permissible.
2 units, Spr (Sunseri) TTh 9

#44. Advanced Calculus I—Infinite series, convergence tests, parallel topics on improper integrals. Uniform convergence. Power series. Prerequisite: 23 or 43, or concurrent registration in 23 or 43 and consent of instructor.

3 units, Aut (----) MWF 9, 11, or 1:15
Win (----) MWF 12
Spr (----) MWF 9 or 11

#45. Advanced Calculus II — Vectors and curves in the plane. Functions of two variables, directional derivatives, gradients, line integrals, double integrals. Plane mappings, vector fields, Green’s theorem. Prerequisite: 44 or concurrent registration in 44.

3 units, Aut (----) MWF 9 or 11
Win (----) MWF 9, 11, or 1:15
Spr (----) MWF 2:15

#46. Advanced Calculus III — Vectors, curves and surfaces in space. Functions of several variables, vector calculus, multiple integrals, surface integrals, Stokes’ theorem, divergence theorem, differential forms. Prerequisite: 45.

3 units, Win (----) MWF 9
Spr (----) MWF 9 or 2:15

#52. Honors Calculus—Honors version of 42, with greater emphasis on the fundamental concepts and rigorous development of the calculus and more extensive discussion of its applications. Prerequisites: 41 or equivalent, and consent of instructor.

5 units, Win (Crandall) MTWTh 10

#53. Honors Calculus—Continuation of 52.
5 units, Spr (Crandall) MTWThF 10

#54. Honors Calculus—54 and 55 together constitute an honors version of 44, 45, 46.
3 units, Aut (----) MWF 10

#55. Honors Calculus—54 and 55 together constitute an honors version of 44, 45, 46.
3 units, Win (----) MWF 10

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

Calculus through Mathematics 44 or consent of the instructor is required for the courses listed below:

105. Introduction to Computer Science —
(Enroll in Computer Science 50A.)

106. Introduction to Theory of Functions of a Complex Variable — Complex numbers, analytic functions, Cauchy-Riemann equations, complex integration, Cauchy formula; elementary conformal mappings. Prerequisite: 45.

3 units, Aut (----) MWF 11;
(----) MWF 1:15;
(----) MWF 2:15
Spr (----) MWF 2:15
Sum (----)

113. Linear Algebra and Matrix Theory—
The study of the algebraic properties of matrices and their interpretation in geometric terms. The relationship between the algebraic and geometric points of view and matters that are fundamental to the study and solution of linear equations are dealt with. Topics include: linear equations, vector spaces, linear dependence, bases and coordinate systems; linear transformations and matrices; similarity and eigenvalues reduction of quadratic forms.

3 units, Aut (----) MWF 9;
(----) MWF 1:15
Win (----) MWF 10;
(----) MWF 1:15
Sum (----)

113H. Linear Algebra and Matrix Theory (Honors).

3 units, Aut (deLeeuw) MWF 9

114. Linear Algebra and Matrix Theory—
Continuation of 113. A deeper study of certain of the topics indicated as well as additional topics chosen among the following: invariant subspaces, canonical forms of matrices, minimal polynomials and elementary divisors; vector spaces over arbitrary fields; inner products; Hermitian and unitary matrices; multilinear algebra.

3 units, Win (----) MWF 9
Spr (----) MWF 10

114H. Linear Algebra and Matrix Theory (Honors).

3 units, Win (deLeeuw) MWF 10
115. Fundamental Concepts of Analysis—A rigorous development of real analysis in Euclidean space: basic point set topology, limits, continuous functions. Especially recommended for students who intend to take graduate work in mathematics.

3 units, Aut (Hill) MWF 11;

Win (——) MWF 2:15


3 units, Win (Hill) MWF 11;

(——) MWF 2:15


3 units, Spr (Hill) MWF 11

120. Modern Algebra—Integral domains, fields, polynomials, divisibility theory, groups. Prerequisite: 113.

3 units, Win (——) MWF 1:15

Spr (——) MWF 1:15

121. Modern Algebra—Continuation of 120.

3 units, Spr (——) MWF 1:15

123. Theory of Probability—This is an introductory course to the theory of probability and some of its applications. The basic concepts of probability, random variables and their distribution functions are treated in the modern manner. Classical limit theorems for sequences of independent random variables are discussed in some detail.

3 units, Aut (Walsh) MWF 11

130. Ordinary Differential Equations—Special equations, exact equations, linear equations; series solutions, numerical solution; Laplace transform and operational methods. Courses 130, 131, 132 form a sequence.

3 units, Aut (——) MWF 8, 11, or 2:15

Win (——) MWF 10

130H. Ordinary Differential Equations (Honors).

3 units, Aut (——) MWF 11


3 units, Win (——) MWF 8, 11, or 2:15

Spr (——) MWF 10

131H. Partial Differential Equations (Honors).

3 units, Win (——) MWF 11


3 units, Spr (——) MWF 8, 11, or 2:15

137. Numerical Analysis—(Enroll in Computer Science 137.)

138. Numerical Analysis—(Enroll in Computer Science 138.)

142. Higher Geometry—Homogeneous and projective coordinates with applications; projective correspondence in forms of one dimension; involution; projective correspondence in forms of two dimensions; collineations, their classification; correlation, polarity; projective, affine, metric properties of conics.

3 units, Aut, alternate years, given 1969–70

150. Combinatorial Analysis—(Enroll in Computer Science 150.)

152A. Elementary Theory of Numbers—Euclid's algorithm, fundamental theorems on divisibility; prime numbers; congruence of numbers; theorems of Fermat, Euler, Wilson; congruence of first and higher degrees; Lagrange's theorem, its applications; residues of power; quadratic residues; introduction to theory of binary quadratic forms.

3 units, Win (——) MWF 2:15


3 units, Aut (Bacon) MWF 8

159. Introduction to Topology—This course will cover some of the basic properties of
metric and topological spaces; compactness, connectedness, and continuity. Special attention will be paid to the Euclidean spaces; and the fixed-point and degree of mapping theorems will be developed. Enrollment is limited to undergraduates.

3 units, Spr (Royden) MWF 9

160A, B. Symbolic Logic—Thorough treatment of validity, provability, consistency, completeness, definability and decision problems for logical calculi, and axiomatic theories. (Enroll in Philosophy 160A, B.)

161. Introduction to Set Theory—Intuitive justification of the axioms. Operations on sets, relations and functions. Equivalence and ordering relations. Equipollence of sets and cardinal arithmetic. Topics on ordinal numbers and axiom of choice as time permits. Prerequisite: 160A or equivalent. (Enroll in Philosophy 161.)

162. Theory of Automata—An introduction to finite automata. Comparison of different notions of computability. Relationship to programming languages and theories of grammars. (Enroll in Philosophy 162.)

175A, B. Foundations of Modern Analysis—Introduction to metric spaces, normed linear spaces, and Hilbert spaces, with applications to differential calculus in a general setting. Prerequisite: consent of the instructor, also 113 or concurrent registration in 113.

Alternate years, given 1969–70

199. Independent Work.
(Staff) by arrangement

COURSES INTENDED PRIMARILY FOR GRADUATE STUDENTS


205A. 3 units, Aut (Phillips) MWF 10
205B. 3 units, Win (Phillips) MWF 10
205C. 3 units, Spr (Phillips) MWF 10

206A, B, C. Theory of Functions of a Complex Variable—Complex integration. Cauchy’s theorem, calculus of residues; power series, infinite products, entire functions, Picard’s theorem; Riemann mapping theorem. Prerequisite: 116 or equivalent.

206A. 3 units, Aut (Schiffer) MWF 11
206B. 3 units, Win (Schiffer) MWF 11
206C. 3 units, Spr (Schiffer) MWF 11

210A, B, C. Modern Algebra—Groups, rings and fields; Galois theory, ideal theory, introduction to algebraic geometry; representations of groups and algebras; multilinear algebra. Prerequisite 120 or equivalent.

210A. 3 units, Aut (Hornell) MWF 1:15
210B. 3 units, Win (Hornell) MWF 1:15
210C. 3 units, Spr (Hornell) MWF 1:15

217A, B. Differential Geometry — Classical differential geometry of curves and surfaces; surfaces of constant curvature, connections with non-euclidean geometry; minimal surfaces. Intrinsic geometry, parallel transport, geodesics; geometry on a surface.

217A. 3 units, Aut (Osserman) MWF 2:15
217B. 3 units, Win (Osserman) MWF 2:15

220A, B, C. Methods of Mathematical Physics—Potential theory, Green’s function, integral equations; Hilbert space approach to problems of mathematical physics; elementary spectral theory; variational methods.

220A. 3 units, Aut (Berg) TTh 2:15–3:30
220B. 3 units, Win (Berg) TTh 2:15–3:30
220C. 3 units, Spr (Berg) TTh 2:15–3:30

221A. Calculus of Variations — Euler-Lagrange equations, sufficient conditions; applications to eigenvalue and scattering problems; direct methods, Dirichlet’s principle.

3 units, Spr (——) MWF 2:15


229C. Dynamic Optimization — (Enroll in Operations Research 348.)

230. Advanced Probability — Fundamental concepts, weak and strong laws of large numbers, convergence of distributions and the central limit theorem, infinitely divisible distributions and stable laws. Prerequisite: 205A.

3 units, Win (Walsh) MWF 1:15

233A, B, C. Markov Processes and Potential Theory—The general theory of continuous time Markov processes in topological space will be developed from the beginning. The
theory of capacities will be discussed and applied to such processes, followed by the probabilistic treatment of abstract potential theory as given by Hunt. Prerequisites: 205A,B,C and 230A,B.

233A. 3 units, Aut (Chung) MWF 2:15
233B. 3 units, Win (Chung) MWF 2:15
233C. 3 units, Spr (Chung) MWF 2:15

235A, B. Selected Topics in Probability Theory and Ergodic Theory.
235A. 3 units, Win (Ornstein) by arrangement
235B. 3 units, Spr (Ornstein) by arrangement

236. Topics in Applied Stochastic Processes — Aspects of branching and cascade processes, queueing, counter, and diffusion processes, and applications to biology, medicine and engineering.

3 units, Spr (Karlin) MWF 9

237A, B, C. Advanced Numerical Analysis— (Enroll in Computer Science 237A, B, C.)


244A. 3 units, Aut (Royden) MWF 10
244B. 3 units, Win (Royden) MWF 10


3 units, Aut (Schiffer) TTh 11:00–12:15

254A, B, C. Ordinary Differential Equations—Fundamental existence theorems, stability and asymptotic behavior of nonlinear systems, Poincaré-Bendixson theorem, linear systems and Sturm-Liouville eigenvalue problems; selected topics from equations in the complex domain; Fuchsian theory, Hamiltonian systems, existence of periodic solutions and orbital stability.

Alternate years, given 1969–70


256A. 3 units, Aut (Hill) MWF 1:15
256B. 3 units, Win (Hill) MWF 1:15
256C. 3 units, Spr (Hill) MWF 1:15


258A. 3 units, Aut (Rabinowitz) MWF 2:15
258B. 3 units, Win (Rabinowitz) MWF 2:15


261A. 3 units, Aut (McCgregor) MWF 9
261B. 3 units, Win (McCgregor) MWF 9
261C. 3 units, Spr (Crandall) MWF 9

266A, B. Group Representations—An introductory course.

266A. 3 units, Win (Spencer) MWF 9
266B. 3 units, Spr (Spencer) MWF 9

271A, B. Mathematics of Wave Motion — Analytical techniques for the calculation of varied wave phenomena, with emphasis on the use of fundamental solutions (localized source functions), asymptotic integration
and integral equations. Illustrative problems obtained from the subjects of elasticity, electromagnetic theory and magnetohydrodynamics.

271A. 3 units, Aut (Levine) MWF 2
271B. 3 units, Win (Levine) MWF 2


3 units, Win (Schiffer) TTh 11:00–12:15


278A. 3 units, Win (Hawley) MWF 2:15
278B. 3 units, Spr (Hawley) MWF 2:15

279A. Mathematical Genetics—Mathematical models in population genetics, ecology, population growth, and epidemiology. The first part of the course deals mainly with deterministic models in population genetics. Prerequisite: consent of instructors.

3 units, Aut (Bodmer, Karlin) by arrangement, alternate years, given 1969–70


281A. 3 units, Aut (——) MWF 9
281B. 3 units, Win (——) MWF 9
281C. 3 units, Spr (——) MWF 9

283A,B,C. Selected Topics in Topology — Topics from: fiber spaces and fiber bundles, characteristic classes, cohomology operations, sheaves, homology of groups. Prerequisite: 281 or equivalent.

283A. 3 units, Aut (Samelson) MWF 9
283B. 3 units, Win (Samelson) MWF 9
283C. 3 units, Spr (Samelson) MWF 9

285A,B. Algebraic Geometry — Algebraic varieties and correspondences, coherent sheaves, preschemes and schemes. Singular and simple subvarieties, divisors and chains, linear systems.

285A. 3 units, Aut (——) MWF 11
285B. 3 units, Win (——) MWF 11

291A,B,C. Set Theory — Full development of set theory on an axiomatic basis. Discussion of various axioms of infinity. Problems of consistency and independence. Prerequisites: 160 A,B, and 161 or equivalent.

Given 1969–70

292A,B,C. Metamathematics — Formalized theories and their models. Validity and definability. Complete and decidable theories; applications to algebra. Recursively axiomatizable theories; incompleteness of elementary number theory; Gödel's theorems. Introduction to Hilbert's consistency problem; proof theory and questions of constructivity. Prerequisites: 160A,B, and 161 or equivalent.

292A. 3 units, Aut (Morley) by arrangement
292B. 3 units, Win (Morley) by arrangement
292C. 3 units, Spr (Morley) by arrangement


293A. 3 units, Aut (Feferman) MWF 11
293B. 3 units, Win (Feferman) MWF 11
293C. 3 units, Spr (Feferman) MWF 11

295. Advanced Automata Theory—(Enroll in Electrical Engineering 484.)

296A,B. Modular Functions and Quadratic Forms—Introduction to the classical theory in one variable, including Hecke operators. The Minkowski-Hasse theorem and Siegel's main theorem. Modular functions in several variables, and Siegel space and its compactification.

296A. 3 units, Aut (Cohen) MWF 11
296B. 3 units, Win (Cohen) MWF 11

360. Advanced Reading and Research.
Any quarter (Staff) by arrangement
MILITARY SCIENCE

Executive Head: Stanley M. Ramey (Colonel, Armor)

Professor: Stanley M. Ramey (Colonel, Armor)

Assistant Professors: James G. Bayer (Major, Infantry), Harry J. Brunner, Jr. (Captain, Signal Corps), C. Darrell Kirkland (Major, Armor)

GENERAL

The Department of Military Science offers a course of instruction and training which, combined with a baccalaureate degree, qualifies a student for a reserve commission in the United States Army. Candidates must fulfill the enrollment requirements listed in this section of the bulletin. Students who are not candidates for a commission may pursue Military Science courses with the permission of the Professor of Military Science.

OBJECTIVE

The objective of the Army ROTC program is to produce junior officers who by their education, training and inherent qualities are suitable for continued development. The aim is to provide a basic military education and in conjunction with other University disciplines to develop individual character and attributes essential to an officer. The Army ROTC training is designed to develop and perfect the qualities of leadership required in both military and civilian life and to give the student an opportunity to reinforce his knowledge with actual practice in the techniques of leadership. In this respect, then, the ROTC is a training ground for tomorrow's leaders in the armed forces as well as in private enterprise and government.

PROGRAM OF STUDY

The program consists of a two-year basic course, a two-year advanced course and a six-week summer camp. The program includes 25 credit units, which are military in nature and are taught by officers of the United States Army. An additional 11 units required by the program are nonmilitary subjects selected by the student with the approval of the PMS within the general fields of Effective Communication, Science Comprehension, General Psychology, or Political Development and Political Institutions. Normally, courses must be taken in numerical sequence. During the summer session courses are given by special arrangement.

CURRICULUM

The curriculum embraces general military science subjects common to all branches of the Army, such as psychology and techniques of leadership, United States Army and national security, United States role in world affairs, military history, teaching principles, basic tactics, map reading, command and staff problems and procedures. For the first year the course consists of one classroom hour per week; and for the second year two classroom hours per week. Each of the last two years consists of two quarters of three classroom hours and one quarter of two classroom hours per week. Throughout the four years leadership laboratory is conducted one hour per week. Extracurricular activities on a voluntary basis are sponsored to develop cadet interests and to provide opportunity to apply principles of leadership, management, and staff procedures.

Several awards for distinction are made each year to those who excel in the program.
DEFERMENT—DELAY

Advanced Course cadets in the Army ROTC program are granted draft deferments. Basic Course cadets may, if fully qualified, be granted such deferments. ROTC graduates may, within quota limitations established for specified subject disciplines and manpower requirements, be granted delay in call to active duty to complete graduate studies.

ENROLLMENT IN ROTC

Courses are open only to Stanford University men who are citizens of the United States and who meet the physical requirements. Students to be enrolled must be not less than 14 years of age, nor of an age that will preclude their appointment in the Army by the 28th birthday. Normally a student must have at least 12 quarters (exclusive of summer work) remaining at time of enrollment. Specific exceptions may be made to meet unusual situations in the latter case. Primary criterion is that every enrolled cadet has the potential of becoming an effective Army officer. Classification tests are given periodically to test the progress of cadets, but principal reliance for selection and retention in the program is placed on the judgment of the Professor of Military Science and his assistants. Interested candidates desiring further information should communicate with the Professor of Military Science.

REGULAR ARMY COMMISSIONS

Cadets who possess outstanding qualities of leadership, high moral character, and excellent academic standing may be designated Distinguished Military Graduates by the Professor of Military Science with the concurrence of the President of the University. Such graduates are eligible to apply for a commission in the Regular Army. Selection for appointment is made by Headquarters, Department of the Army, from a consolidated order of merit list of applicants. Those selected may apply later for graduate education at selected civilian colleges and universities at government expense while receiving full pay.

EMOLUMENTS, UNIFORMS, AND TEXTS

Four-year scholarships are available to high school students who will be chosen in nationwide competition. In addition to payment for tuition, books, and fees for four years, each scholarship cadet draws retainer pay of $50 per month. Students not on scholarship pursuing the last two years of the course will receive retainer pay of $50 per month. Uniforms and texts are supplied without cost.

ADVANCE COURSE SUMMER CAMP

Every student attends one six-week ROTC summer camp normally between the junior and senior academic years. The objective of camp training is to provide the ROTC student with practical experience in tactical, technical, and administrative subjects. Camp training is designed to supplement institutional instruction by providing students with applicatory-type training which cannot be presented adequately at the University. During this training cadets receive pay and travel allowances.

BASIC COURSE SUMMER CAMP

Students who have completed their sophomore year may attend a six-week Summer Camp, if otherwise qualified, in lieu of taking the First- and Second-year courses described below. Successful completion of this camp qualifies the student for enrollment in the Third-Year course. Applicants for this program should contact the Professor of Military Science, Stanford University. It should be remembered that this Basic Course Summer Camp is conducted only when needed to make up shortages in projected Advanced Course enrollment. Quotas are established. Therefore, a Stanford student should carefully evaluate the situation before selecting this method of taking the Basic Course.

COURSES

LEADERSHIP LABORATORY

Leadership laboratory is conducted on Tuesday from 3:15 to 4:15. Here students have the opportunity to develop their ability
to lead. Advancement to command positions in the cadet corps depends on demonstrated ability in leadership.

**FIRST-YEAR COURSES**

   1 unit, Aut (Staff) M 8, 10, 1:15, 2:15, or T 10 or 11

   1 unit, Win (Staff) M 8, 10, 1:15, 2:15, or T 10 or 11

   1 unit, Spr (Staff) M 9, 10, 11, 1:15, 2:15, or 3:15, or T 8, 9, 10, 11, or W 8, 9, 10, 11

**SECOND-YEAR COURSES**

   2 units, Aut (Staff) MW 10, 2:15, or 3:15, or TTh 10

   2 units, Win (Staff) MW 10, 2:15, or 3:15, or TTh 10, or 2:15

   2 units, Spr (Staff) MW 10, 2:15, or 3:15, or TTh 10 or 2:15

**THIRD-YEAR COURSES**

131. Leadership and Counterinsurgency — Basic problems in small unit leadership. Basic principles of counterinsurgency. Prerequisite: 23.
   2 units, Aut (Staff) TTh 8, 9, 10, or 1:15

   3 units, Win (Staff) TTh 8, 9, 10, or 1:15

133. Small Unit Tactics and Communications—Principles of offensive and defensive combat. Communications systems, procedures, and security. Prerequisite: 132.
   3 units, Spr (Staff) (I) W 7–10 p.m.; (Staff) (II) Th 2:15–5:15

**FOURTH-YEAR COURSES**

   3 units, Win (Staff) TTh 9, 10, 11, or 12

   3 units, Win (Staff) TTh 9, 10, 11, or 12

143. The Role of the United States in World Affairs and Service Orientation—Analysis of United States economic power, war potential, aptitude for conduct of war. Similar analysis for other areas and nations of the world. Customs of the service. Career management. Educational programs. Prerequisite: 142.
   2 units, Spr (Staff) TTh 9, 10, 11, or 12

199. Command and Staff Procedures—Theory, practice in developing staff studies and military programs. Prerequisites: completion of basic course and permission of PMS.
   1 unit, Aut, Win, Spr (Staff) by arrangement
MUSIC

Executive Head: William L. Crosten


Associate Professors: George L. Houle (on leave 1968-69), Leland C. Smith

Assistant Professors: Arthur P. Barnes (Director of Bands), John M. Chowning

Music Librarian: Edward E. Colby

Director of Men's Glee Club: Robert R. MacKinnon

Lecturers: Adolph Baller, Earle Blew, Robert Helps (Piano), David Abel (Violin), Bonnie Hampton (Violoncello), Ivan Rasmussen, ................... (Voice), Lloyd Gowen (Flute), Raymond H. Duste (Oboe), Donald O'Brien (Clarinet), ......... (Bassoon), Charles R. Bubb (Brass Instruments), Marjorie Chauvel (Harp), Stanley Buetens (Lute), ......... (Viola da Gamba). Visiting: .................... (Composition)

OFFERINGS AND FACILITIES

The Department's aims are to promote understanding and enjoyment of music in the University at large and to provide specialized training for those who plan careers in music as composers, performers, teachers, or research scholars.

Practice facilities are available in the Dinkelspiel Auditorium Building, which also includes a well-equipped modern theater for concert and operatic productions. In addition to practice pianos, organs and harpsichords, rare instruments from the Harry R. Lange Historical Collection may be used by qualified students.

The Departmental library contains a comprehensive collection of complete editions, scores, books, and records. Supplementing this is the Stanford Memorial Library of Music, which is an invaluable collection of musical manuscripts and first editions.

The Music Department has access to large digital computers on which work is being done in sound synthesis, acoustical analysis, and composition. Advanced composition students interested in electronic music and use of the computer in composition, and students with a particular interest in acoustics are encouraged to make use of this facility.

PROGRAMS OF STUDY

BACHELOR OF ARTS

Undergraduate major — May be planned in one of three ways depending on whether the student wishes:

1) A concentration in composition, performance, or music history.
2) Preparation for secondary school teaching by way of the Stanford Internship Program.
3) A general program of studies without special emphasis on any particular branch of music.

The specific details of each plan will be worked out by the student and his adviser, taking into account the individual's particular talent and interest. Preliminary to that, each prospective major is asked to demonstrate his performing ability in the medium of his choice.

To insure a strong foundation for the individually designed concentrations, all students are required:

A. To include the following courses in their programs:
   1. Music 21-22 (Elements of Music)
   2. Music 11A, B, C (Basic Repertory)
   3. Music 100, 101, 102, 103 (Music History and Theory)
   4. Ensemble: six quarters of work in one or more departmental organizations or in chamber music.

B. To demonstrate a minimum proficiency in piano, which will include sight-reading simple four-part chorale harmonizations as well as playing two prepared pieces on the order of an easier Chopin Prelude or a Clementi Sonatina. This requirement should be fulfilled as early as possible and not later than the beginning of the junior year.

C. To demonstrate ability to hear music accurately and to perform it at sight. These skills will be checked by two examinations, the first to be taken upon completing Music 22, the second to be taken in the first quarter of the senior year.

Music majors will be expected to maintain a grade point average of at least 2.00 in music classes excluding performance activities.
Independent work by advanced students is encouraged as indicated under Music 199.

An Honors Program in Humanities is offered for undergraduate majors in this department who wish to supplement their departmental major by a related program of studies. See Humanities Special Programs for a description of the Honors Program.

Prospective music majors should consult one of the advisers in the Music Department as early as possible in order to plan a program that allows sufficient time for practice as well as for other study. This applies especially to freshmen and to those who wish to concentrate in performance. The sample schedule given below shows how the General Studies requirements may be distributed so as to permit substantial work in music from the beginning of the freshman year.

**Sample Schedule for Four-Year A.B. Program with Major in Music**

(Note: Where the word music appears below without a number, the specific courses taken will depend upon the type of music program the student has chosen to follow.)

<table>
<thead>
<tr>
<th>First Year</th>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>English 1, 2, 3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language 1, 2, 3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Music 21, 22</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
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<tr>
<td>(This two-quarter sequence may begin autumn or winter quarter. In the remaining quarter, substitute a General Studies course or an elective)</td>
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<td></td>
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<tr>
<td>Music 11A, B, C</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Music</td>
<td>2–3</td>
<td>2–3</td>
<td>2–3</td>
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<table>
<thead>
<tr>
<th>Second Year</th>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language 22, 23, and over</td>
<td>100 reading requirement</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td></td>
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<tr>
<td>History 1, 2, 3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
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<tr>
<td>Music 101, 102</td>
<td>4</td>
<td>4</td>
<td>Elect.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Music</td>
<td>4–5</td>
<td>4–5</td>
<td>4–5</td>
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<table>
<thead>
<tr>
<th>Third Year</th>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science (Biology 4, 5 or Physical Sciences 1, 2, 3)</td>
<td>3–4</td>
<td>3–4</td>
<td>0–3</td>
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<tr>
<td>Social Science</td>
<td>5</td>
<td>5</td>
<td>Elect.</td>
<td></td>
<td></td>
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<tr>
<td>Music 100, 103</td>
<td>4</td>
<td>Elect.</td>
<td>4</td>
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<tr>
<td>Music</td>
<td>3–4</td>
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<th>Fourth Year</th>
<th>Course No.</th>
<th>Subject</th>
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<th>W</th>
<th>Sp.</th>
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<td>Additional Science Requirement</td>
<td>3–5</td>
<td>3–5</td>
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<td>Senior Colloquium</td>
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<td>Music and/or Electives</td>
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**Teaching Credential (Secondary) — Internship Program in Music**

Students in the Department may prepare themselves for work toward the Standard Teaching Credential (Secondary) in music.

This work at Stanford is organized in an Internship Program consisting of four quarters of graduate study at the University combined with half-time teaching on salary from September to June as an intern in secondary schools near Stanford.

The program begins only in the summer quarter of each year. Students are admitted to it on recommendation of the Music Department and the School of Education. Applicants must have completed the Stanford A.B. degree in music or its equivalent.

Undergraduate preparation should include the foundation courses in music listed above under A.B. Major, plus the following:

- Music 172. Individual instruction in performance (6 quarters)
- Music 127. Orchestration
- Music 130, 131. Conducting (9 units)
- Music 72B,C,D. Voice and instrumental classes (3–5 units)

**Graduate Degrees in Music**

The following statements apply to all the graduate degrees described below, unless otherwise indicated.

Applicants for admission to graduate study should possess a well-rounded general education as well as sound basic training in the theory, history and performance of music. An entrance test will be given each applicant to measure his competence in the handling of musical materials, in analysis, and in verbal expression. Prior to his initial registration, each student will be given a placement examination in the history and literature of music and in general musicianship (listening and reading skills). At the same time, the student should be prepared: (a) to demonstrate a moderate proficiency in piano; (b) to take the requisite foreign language test as indicated below.

None of Stanford's required undergraduate courses in music may be credited toward an advanced degree.

Only work that receives a grade of A, B, or plus will be recognized as fulfilling the advanced degree requirements in music.

Doctoral students may earn credit for participating in the work of departmental per-
forming organizations, but such credit may not be applied toward the minimum unit requirements for a doctoral degree.

MASTER OF ARTS

The University's basic requirements for the Master's degree (residence, admission to candidacy, etc.) are discussed in the section "Degrees" in this bulletin. Although the A.B. is the normal antecedent to the A.M. degree, persons holding the Bachelor of Music degree may be admitted to Stanford subject to the possibility that they may be asked to do extra work in humanistic fields outside music.

Foreign language requirements—All students are required on entrance to demonstrate: (a) a reading knowledge of one foreign language chosen from French, German, or Italian; (b) a knowledge of the common musical terms in all three of the above languages.

Study program — Students may concentrate in musical research, composition, music education, performance practice, or conducting. To be recommended for the A.M. degree, a candidate must complete a program of 42 units based on the graduate courses offered by the Department and must pass a comprehensive examination. No more than 6 of these 42 units may be earned in ensemble. In addition to the work specifically related to the student's concentration, the study program will include: Music 200; Music 301 (2 quarters); individual or ensemble performance (3 quarters); Master of Arts Project. (Depending on the concentration, the latter will be an investigative essay, a composition, or a demonstration of performance supported by a written commentary. In any case, the A.M. Project should be completed during the last quarter of residence.)

DOCTOR OF EDUCATION

In cooperation with the School of Education the Department offers work leading to the Doctor of Education degree with a concentration in music education. Students in this program normally will take about one-third of their work in Education and two-thirds in Music. General regulations covering this degree are discussed in the Manual on Advanced Graduate Degrees in Education, which may be obtained from the School of Education. The work in music education may center on curriculum studies, principles and methods of teaching, or supervision and administration of music.

DOCTOR OF MUSICAL ARTS

The purpose of the Doctor of Musical Arts program is to offer advanced training in the practice and pedagogy of music. Students may concentrate in composition, conducting, music education, or performance practice — the latter being taken to cover the study of modes of performance from medieval to modern times. Each concentration, however, will be given breadth through collateral studies in other branches of music and in relevant fields outside music as seems desirable.

Enrollment is limited and, except in the field of music education, preference will be given to applicants who are not over thirty years of age.

Admission—In addition to completing the entrance test, an applicant will be asked to submit evidence of accomplishment in his proposed field of concentration. Applicants in music education must have had at least two years of successful teaching experience.

Residence—If there are no deficiencies to be made up, this program may be completed in a minimum of two years of full-time study following the Master's degree. The work must be done entirely in residence at Stanford and must include at least three consecutive quarters of full-time study.

Study program — The candidate must complete, beyond the Master's degree, a minimum of 72 units of work which will be planned individually for each concentration. It must be emphasized, however, that the degree will be awarded on the basis of demonstrated achievement rather than on the accumulation of units.

In addition to such independent study and formal course work as may be done, each program will include: (a) four term projects; (b) a final project or dissertation; (c) a public lecture-demonstration.

Candidates in conducting or performance practice will make an extensive study of repertoire, leading to four demonstrations of their ability to give stylistically acceptable performances of music from different historical periods. Each demonstration is to be supported by a written report containing
analysis of the music in question, discussion of the special performance problems that are involved, and detailed proposals for the solution of those problems.

Candidates in music education will do extensive reading and research in both the philosophy and practice of their field, each candidate ultimately focusing on a special branch according to his particular interest. The students in this area will also complete a minor of at least 12 units in composition, conducting, or performance practice.

Candidates in composition will be expected to produce a number of original works demonstrating their ability to compose in a variety of forms and for the common media of vocal and instrumental music. Insofar as possible, the works submitted will be presented in public performance prepared by the composer.

**Final project or dissertation**—(1) Composition: an extended work for instruments, voices, or electronic media; (2) Music education: a dissertation based on independent research in the candidate's field of specialization; (3) Conducting or performance practice: possibilities open to the candidate include (a) preparing a modern performing edition of an early score; (b) writing an extended critical or historical essay on a selected problem or phase of performance practice.

**Public lecture-demonstration**—This is to be given during the last quarter of residence. It should be about one hour in length, dealing with some aspect(s) of the candidate's final work.

**Foreign language requirements**—All students are required on entrance to demonstrate: (a) a reading knowledge of one foreign language chosen from French, German, or Italian; (b) a knowledge of the common musical terms in all three of the above languages. Concentrators in conducting and performance practice are further required to demonstrate reading ability in a second language chosen from the three listed above. This proficiency must be certified by the end of the first year of doctoral study.

**Departmental examinations**—(1) An advisory examination to be taken during the student's first year in residence, to determine whether he will be recommended to continue work for the degree; (2) A final comprehensive examination to be taken not later than the quarter preceding that in which the candidate expects to receive his degree.

**Teaching assistantships**—It is the policy of the department to appoint each doctoral candidate to a teaching assistantship for at least one quarter.

**Doctor of Philosophy**

A limited number of students with superior qualifications are accepted by the Department for work toward the Ph.D. degree in music.

General University regulations regarding this degree are discussed in the section "Degrees" in this bulletin.

**Admission**—In addition to completing the departmental entrance test, an applicant is asked to submit some evidence of his work in the field of music history such as a term paper or a Master's thesis.

**Residence**—The candidate must spend at least three consecutive quarters beyond the Master's degree as a registered student at Stanford, and must devote at least one quarter in residence to work on his dissertation.

**Basic requirements**—In addition to his dissertation, each candidate must complete a minimum of 60 units of study beyond the Master's degree. The program will normally include: (1) readings in music theory; (2) seminars in musical notation, analysis and performance practice; (3) independent research.

**Specialization**—As soon as feasible, the candidate will select the field of study in which he proposes to do independent research leading ultimately to the writing of a dissertation.

**Foreign language requirements**—A reading knowledge of French and German plus any other language necessary to research in the candidate's field of specialization. The examination in one language must be taken prior to the student's first registration. The second language must be certified by the end of the first year of doctoral study.

**Departmental examinations**—(1) An advisory examination to be taken toward the end of the student's first year of doctoral study, to explore the strengths and weaknesses of his preparation; (2) a qualifying examination to be taken prior to enrolling in dissertation work.
COURSES
FOR GENERAL STUDIES

Any of the following courses may be used as partial fulfillment of the Humanities requirement in the General Studies Program:

#1. Introduction to Music — Musical expression, style, structure explained, illustrated for the listener. No prerequisites.
   3 units, any quarter (Staff)

#2. Symphony—Selected symphonic works from Classic, Romantic, Modern repertories. Prerequisite: 1 or equivalent.
   3 units, Aut ( )

#3. Opera — Opera as a musico-dramatic form; examples from Mozart to present. Prerequisite: 1 or equivalent.
   3 units, Spr (Crosten)

#7. Concerto — Selected concertos, seventeenth century to present. Prerequisite: 1 or equivalent.
   3 units, Win (—

#21, 22. Elements of Music—See below.

FOUNDATION COURSES
FOR A.B. MAJOR

11. Basic Repertory — Directed listening and discussion covering a broad range of music from the Renaissance to the present.
   11 A. 2 units, Aut ( — )
   11 B. 2 units, Win ( — )
   11 C. 2 units, Spr ( — )

21, 22. Elements of Music—Exploration of the elements of sound and time and their organization into musical forms. Development of notation as a means of representing and controlling sound in various media. Ear-training, beginning with acoustical phenomena, will underlie all written work. Lectures and laboratory sections. Open to all students desiring basic technical knowledge of music. No prerequisite for Music 21 except ability to read music.
   21. 4 units, Aut (Smith, ); Win (Chowning, Nanney)
   22. 4 units, Win (Smith, ); Spr (Chowning, Nanney)

100. Music History and Theory (I)—Music in the system of ecclesiastical modes. Prerequisites: 11A,B,C, 21, 22.
   5 units, Aut ( — )

   101. 5 units, Aut (Ratner)
   102. 5 units, Win (Ratner)

   5 units, Spr (Smith)

MUSIC THEORY AND COMPOSITION

123. Composition — Individual projects in creative work. May be repeated for credit. Prerequisite: permission of instructor.
   3 units, Aut, Win, Spr (Smith)

127. Orchestration — Prerequisite: 22 or equivalent.
   3 units ( — )

   220A. Computer Generated Sound — Introduction to sound synthesis and acoustical analysis using the computer. Problems of circuit design in generating sound after having determined the significant parameters through acoustical analysis.
   3 units, Aut (Chowning)

220B. Compositional Programming Techniques—Use of the Fortran programming language as a compositional tool. Problem solving: given a verbal and/or notational description of some complex musical event, how this event can be characterized in an algebraic language such as Fortran.
   3 units, Win (Chowning)

220C. Individual Computer Projects.
   3 units, Spr (Chowning)

221. History of Music Theory.
   3 units, Spr (Ratner)

223. Seminar in Composition—May be repeated for credit.
   4 units, Aut, Win, Spr (Smith)

224, 225. Solfege and Score Reading.
   224. 4 units, Win (Barnes)
   225. 4 units, Spr (Barnes)

   3 units, Spr (Ratner)
228A. 4 units, Aut (Aldrich)
228B. 4 units, Win (Aldrich)
229. Tonality and Structure—Graduate review of harmonic functions; relation between details of progression and total structure.
  4 units (Smith)

HISTORY AND LITERATURE OF MUSIC

Unless otherwise stated, prerequisite for any course in this section is Music 102.

140. Studies in Medieval and Renaissance Music—Prerequisite: 100.
  4 units (Aldrich, Houle)
  141A. Keyboard Music to 1700.
    4 units (Aldrich, Nanney)
  142A. String Quartets of Beethoven.
    4 units (Ratner)
  142B. Operas of Mozart.
    4 units (Crosten)
  143A. Operas of Verdi.
    4 units (Crosten)
144. Studies in Modern Music — Prerequisite: 103.
  144A. Twelve-Tone and Serial Music.
    4 units (Smith)
199. Independent Study—For advanced undergraduates who wish to do work outside the regular curriculum. Before registering for this, a student must present a specific project and must enlist a faculty sponsor. Credit up to 4 units per quarter.

PERFORMANCE

12. Introductory Piano — Class for music majors only.
  1 unit, Aut, Win, Spr (Blew)
72. Group Instruction — For music majors and non-majors who are members of Departmental performing groups.
  1 unit, Aut, Win, Spr (Staff)
72B. Voice Class. (Rasmussen)
72C. Stringed Instruments Classes. (Hampton, Kuhn)
72D. Wind Instruments Classes. (Barnes, Staff)
72E. Recorder Class. (Houle)
72F. Viola de Gamba Class. (——)
72G. Lute Class. (Buetsens)
72H. Percussion Class. (Chowning)

172, 272. Individual Vocal and Instrumental Instruction.
  2 to 3 units, Aut, Win, Spr (Staff)
172A, 272A. Keyboard Instruments (piano, organ, harpsichord).
172B, 272B. Voice.
172C, 272C. Stringed Instruments (violin, viola, violoncello, contrabass, harp).
172D, 272D. Wind Instruments (flute, oboe, clarinet, bassoon, trumpet, horn, trombone, Renaissance and Baroque instruments).

Note—A special fee of $50 per quarter for majors and $100 per quarter for non-majors is charged for enrollment in any branch of 172 or 272.

130. Orchestral Conducting—Prerequisite: 127.
  130A. 3 units, Aut (Salgo) given 1969–70
  130B. 3 units, Win (Salgo) given 1969–70
131. Choral Conducting.
  131A. 3 units, Aut (Schmidt)
  131B. 3 units, Win (Schmidt)
230. Advanced Orchestral Conducting.
  230A. 4 units, Win (Salgo)
  230B. 4 units, Spr (Salgo)
231. Advanced Choral Conducting.
  231A. 3 units, Aut (Schmidt)
  231B. 3 units, Win (Schmidt)
251. Choral Repertory (1500–1750).
    4 units, Aut (Schmidt)
252. Choral Repertory (1750 to Present).
    4 units, Aut (Schmidt) given 1969–70
269. Seminars in Performance Practice — Lectures on methods of analysis appropriate to the music of the period, with emphasis on the relation of analysis to performance. Practice sessions directed toward the principles discussed in the lectures, development of special rehearsal techniques, and preparation of concerts.
269A. Renaissance.
4 units, Aut (Houle)

269B. Baroque.
4 units, Win (Houle)

269C. Medieval.
4 units, Spr (Houle)

269D. Modern.
4 units (Chowning, Smith)

271. Performance Special — For students who take part in performances in Music 269 while not enrolled in that course.
1 unit, Aut, Win, Spr (Houle)

3 to 4 units, Aut, Win, Spr (Salgo, Staff)

ENSEMBLE

All courses listed in this section may be repeated for credit, with a maximum of 24 units allowed toward graduation. Membership in these organizations is not limited to students who register in the courses for credit, and unless otherwise stated, is open to both men and women. An audition, however, is required for admission to any University musical organization. Audition schedules will be announced in advance of each registration period.

160. University Orchestra.
1 to 2 units, Aut, Win, Spr (Salgo) M 7:30 p.m. and Th 7:15 p.m.

161. University Bands.

161A. Concert Band.
1 unit, Aut (Barnes) T 7:15 p.m.
Win (Barnes) MWF 4:15-5:30 p.m.
Spr (Barnes) MWF 4:15-5:30 p.m.

161B. Studio Band.
1 unit, Aut, Win, Spr (Barnes) by arrangement

161C. Sports Activity Bands—Men only for autumn quarter.
1 to 2 units, Aut (Barnes) MWF 4:15-5:30 p.m.
1 unit, Win, Spr (Barnes) by arrangement

162. University Chorus.
1 to 2 units, Aut, Win, Spr (Schmidt) M 7:30-9:30 p.m. and W 4:00-5:30

163. University Choir — Official choir of Memorial Church, which furnishes music for Sunday services, special occasions in Church calendar. Eight members chosen by audition may receive an honorarium for performing duties other than those required of regular Choir.
2 units, any quarter (Schmidt) T 4:15-5:30 and Th 7:00-8:30 p.m. and Sunday 10-12 a.m.

1 unit, Aut, Win, Spr (Schmidt) (I) MTh 12; (II) TF 12

166. Chamber Orchestra — Open to advanced players who have had orchestral experience.
1 to 2 units, Aut, Win, Spr (Salgo) TF 12

1 unit, Aut, Win, Spr (MacKinnon) T 7:15-8:45 p.m. and Th 4:15-5:45

1 unit, Aut, Win, Spr (Barnes) MTh 12

171. Chamber Music—Open to any student with sufficient technical ability to play in small combinations for strings, winds, and keyboard instruments.
1 to 2 units, Aut, Win, Spr (Staff)

MUSIC EDUCATION


265A. 3 units, Sum (Kuhn) MTWTh 3:15

265B. 1 unit, Aut (Kuhn) T 4:15-6:05

265C. 1 unit, Win (Barnes) T 4:15-6:05

265D. 1 unit, Spr (Kuhn) T 4:15-6:05

280. Seminar in Music Education.
4 units, Aut (Kuhn)

281. Administration and Supervision of Public School Music.
4 units, Spr (Kuhn)

GRADUATE RESEARCH AND SPECIAL STUDIES

200. Music Bibliography — Use of bibliographical materials in graduate study; introduction to methods of research.
3 units, Win (Colby)
299. Master of Arts Project.
   4 units, any quarter (Staff)
300. Seminar in Musical Notation.
   300A. 4 units, Aut (Aldrich)
   300B. 4 units, Win (Aldrich)
   300C. 4 units, Spr (Aldrich)
301. Seminar in Music History and Analysis.
   301A. 4 units, Aut (Aldrich, ——)
   301B. 4 units, Win (Crosten, ——)
   301C. 4 units, Spr (Smith, ——)
302. Research in Musicology.
   Aut, Win, Spr (Aldrich, Crosten, Ratner)
      by arrangement
303. Research in Music Education.
   Aut, Spr, Sum (Kuhn) by arrangement
304. Seminar in the Editing of Music — Problems of transcribing music of various
      periods and preparing it for publication in a form intelligible to modern performers.
   304A. 4 units, Aut (——)
   304B. 4 units, Win (——)
321. Readings in Music Theory.
   3 units (Aldrich, Ratner)
323. D.M.A. Term Projects in Composition.
   4 units, Aut, Win, Spr (Smith)
330. D.M.A. Term Projects in Conducting.
   4 units, Aut, Win, Spr (Salgo, Schmidt)
   Any quarter (Staff) by arrangement
369. D.M.A. Term Projects in Performance.
   369A. Early Music to 1800.
      4 units, Aut, Win, Spr (Staff)
   369B. Music from 1800 to the Present.
      4 units, Aut, Win, Spr (Staff)
380. D.M.A. Term Projects in Music Education.
   4 units, Aut, Spr, Sum (Kuhn)
399. D.M.A. Final Project.
   Any quarter (Staff) by arrangement

Assistant Professors: Richard S. Varney (Major, USMC), Roy C. Masterson (Lieutenant, USN), Michael A. Scully (Lieutenant, USN), Gary H. Mattson (Lieutenant, USN)

OFFERINGS AND FACILITIES

The Naval Science Department affords the opportunity for selected male students to receive instruction in essential Naval subjects which, in conjunction with a baccalaureate degree earned through undergraduate work in fields of their own choice, will qualify them for a commission in the United States Naval Service.

The Regular NROTC Midshipman is chosen in nation-wide competition and attends the University under Navy sponsorship. In addition to payment for tuition, books, and fees, he draws retainer pay of $50 per month.

Four-Year Contract NROTC students are selected by the Professor of Naval Science at the beginning of the academic year from among applicants of the incoming freshman class. Four-Year Contract Students receive an allowance of $50 per month during the last two years.

Two-Year Contract NROTC students are selected normally from applicants in their sophomore year; however, students beyond the sophomore class level who have at least two years remaining in school and graduate school students with two years of school remaining may apply. Candidates selected will attend a six-week summer training session prior to enrollment. Two-Year Contract students receive an allowance of $50 per month. Applications are accepted by the Professor of Naval Science between January 1 and March 15.

Upon successful completion of the required courses in Naval Science, together with the University requirements for a baccalaureate degree, NROTC students are appointed Ensigns and serve on active duty with the Fleet as commissioned officers. Qualified students who so desire may pursue Marine Corps professional studies during the last two years of attendance. Upon completion they may be appointed Second Lieutenants.

Regular Midshipmen must complete three summer cruises with Fleet units. Contract students must complete one such cruise, normally between their junior and senior years.

Executive Head: Robert L. Thomas (Colonel, USMC), Commanding Officer
Executive Officer: John F. Kurfess (Commander, USN)
Professor: Robert L. Thomas (Colonel, USMC)
Associate Professor: John F. Kurfess (Commander, USN)
REQUIREMENTS FOR COMMISSIONING

1. All NROTC students must complete the entire sequence of Naval Science courses offered.

2. Regular NROTC Midshipmen must satisfactorily complete one year of college physics, including laboratory, by the end of their second year. Contract students should complete this requirement if their schedule permits.

3. Regular NROTC Midshipmen must satisfactorily complete one year of college mathematics by the end of their second year. Four-Year Contract students must complete mathematics through trigonometry (in secondary school or college) prior to the end of their second year.

4. Regular NROTC and Four-Year Contract students must satisfactorily complete Psychology 1, Psychology 122, or Industrial Engineering 100 by the end of their sophomore year.

5. All NROTC students must take such instruction in swimming as is necessary to achieve proficiency equal to that of a First Class swimmer prior to graduation.

6. All NROTC students majoring in engineering who have completed Engineering 41, 41A, 42 and 42A and one of the following: Engineering 31, Chemistry 173, or Physics 170, are exempt from Naval Science 411 and 412.

COURSES

Naval Science courses are three-quarter courses. The third digit of the course number determines the quarter in which it is given (1-autumn; 2-winter; 3-spring). Courses with A as a suffix are for candidates for a Marine Corps commission. Course numbers are assigned by the Navy Department and do not correspond to the general University plan for numbering, i.e., none are graduate courses. Prerequisite: consent of instructor for enrollment of non-NROTC students.

111. Naval Orientation — Mission, ideals, standards, traditions, and customs of the Naval Service. Introduction to seamanship, naval warfare, and naval leadership.  
3 units, Aut (Mattson) MWF 8 or 12; lab. Th 8 or 12

112. Evolution of Sea Power I — Develop understanding of significant principles of sea power. These are examined in terms of the influence of sea power on historical development throughout the world.  
3 units, Win (Mattson) MWF 8 or 12; lab. Th 8 or 12

113. Evolution of Sea Power II — Continuation of 112.  
3 units, Spr (Mattson) MWF 8 or 12; lab. Th 8 or 12

211. Naval Weapons I — Develops understanding of naval weapons and weapons systems and their application to maintain control of the sea. Stress is placed on basic scientific concepts underlying determination of weapons systems requirements, design, and employment and upon the general principles of conventional anti-surface, anti-air, and anti-submarine warfare.  
3 units, Aut (Staff) MWF 8 or 2:15; lab. Th 8 or 2:15

213. Naval Weapons II — Continuation of 211. Jet and rocket propulsion, aerodynamics, principles of guided missiles, space technology, and nuclear physics.  
3 units, Spr (Staff) MWF 8 or 2:15; lab. Th 8 or 2:15

3 units, Aut (Masterson) MWF 10 or 12; lab. Th 10 or 12

3 units, Win (Staff) MWF 10 or 12; lab. Th 10 or 12

3 units, Spr (Staff) MWF 10 or 12; lab. Th 10 or 12

311A. Evolution of the Art of War I — Development of the art of warfare through consideration of historical examples of evolution.
tionary and technical trends in strategy and tactics.

3 units, Aut (Varney) MWF 10 or 2:15; lab. Th 10 or 2:15

312A. Evolution of the Art of War II—Continuation of 311A.

3 units, Win (Varney) MWF 10 or 2:15; lab. Th 10 or 2:15

313A. Modern Basic Strategy and Tactics—Rationale of basic strategic concepts. Offensive, defensive combat in light of past and present U.S. and foreign military policies.

3 units, Spr (Varney) MWF 10 or 2:15; lab. Th 10 or 2:15

411. Naval Engineering—Application of thermodynamics to design, installation and operation of naval propulsion plants. Introduction to principles of nuclear reactors, problems of radiation shielding and instrumentation. Principles of stability, experimental determination of righting moment, metacentric height, list and trim.

3 units, Aut (Scully) MWF 11 or 1:15; lab. Th 11 or 1:15

412. Naval Engineering and Introduction to Naval Leadership—Continuation of 411. Stress on preparation of Midshipmen for immediate assumption of command responsibilities upon graduation and commissioning.

3 units, Win (Scully) MWF 11 or 1:15; lab. Th 11 or 1:15

412E. Introduction to Naval Leadership—Stress on preparation of Midshipmen for immediate assumption of command responsibilities upon graduation and commissioning. (Open to Engineering majors only.)

1 unit, Win (Scully) by arrangement

413. Naval Leadership—Management principles governing the administration of large complex organizations. Purposes and administration of UCMJ. Psychological, sociological, and anthropological factors underlying leadership in the naval environment.

3 units, Spr (Scully) MWF 11 or 1:15; lab. Th 11 or 1:15

412A. Amphibious Warfare II—Continuation of 411A.

3 units, Win (Varney) MWF 11 or 1:15; lab. Th 11 or 1:15


3 units, Spr (Varney) MWF 11 or 1:15; lab. Th 11 or 1:15

Naval Science Laboratory—Two hours a week of Naval Science Laboratory required of all NROTC students. Monday session held on Drill Field at 3:15 p.m. Thursday session practical work conducted in regular classroom.

PHILOSOPHY

Executive Head: Patrick Suppes

Director of Graduate Study: David S. Nivison

Director of Undergraduate Study: Michael Tooley


Associate Professors: Dagfinn Follesdal, Jeffrey Smith. Visiting: Frithjof H. Bergmann

Assistant Professors: Harvey Friedman, Robert Howell, Joseph D. Sneed, Michael Tooley

OFFERINGS AND FACILITIES

Courses in philosophy give the student a knowledge of major philosophical ideas as they have developed historically and in terms of their contemporary analysis. The historical courses listed below emphasize change and development of philosophical ideas over a period of time, whether in the form of a widespread movement or the intellectual history of an individual philosopher. Other courses, such as those in systematic philosophy (cf. the listing which follows), or, in some instances, in the single work of a philosopher, emphasize the analysis, clarification, and elaboration of ideas. In
recognition of the fact that philosophy gains significance as it draws from and contributes to other fields of human interest and knowledge, the programs of all philosophy majors will be planned to include courses outside the Department.

The Tanner Memorial Library of Philosophy, situated in the Philosophy Building, contains an excellent working library and ideal conditions for study.

The Philosophy Colloquium, to which guest speakers are invited, meets once a month during the academic year. The Hume Society, the undergraduate and graduate philosophical group, holds frequent meetings at which student speakers or their guests discuss philosophical issues.

A number of scholarships for undergraduate majors in Philosophy are available. In addition to general university scholarships, undergraduate majors in the Department may apply for tuition scholarships available from the Crossett fund.

**Programs of Study**

**Bachelor of Arts**

The following Departmental requirements are in addition to the University's basic requirements for the Bachelor's degree:

The major program shall consist of 48 units within the Department including, in the case of qualified and interested students, 9 to 24 units of tutorial work as described below and 24 to 39 units of regular course work. The course work shall include at least one course from each of the following groups of courses: Group A: 3, 157, 160, 161, 181; Group B: 2, 170, 172, 174, 177, 179; Group C: 164, 168, 178, 180, 182, 184, 189; and Group D: 100, 101, 102, 103, 104. Majors who do not take senior tutorial will select, in consultation with their Departmental advisers, a program of courses emphasizing one of the major areas of philosophy indicated by the four groups of courses. All majors will select, in consultation with their Departmental advisers, programs of courses outside the Department which will complement their major programs or enable them to further an interest in some other area of knowledge.

Philosophy courses taken in fulfillment of General Studies requirements may also be counted in fulfillment of Departmental requirements. Majors in philosophy must maintain at least a C average in their work in the Department.

**Tutorial Work**

The Honors Program in Philosophy is an integral part of a Tutorial Program. Both juniors and seniors may apply for individual tutorial with a member of the Department. Junior Tutorial will occupy 12 units (4 units each quarter) of the student's academic program and will be devoted to a course of study and research designed in consultation with his instructor. Juniors may, if this is a preferred type of instruction, apply for group tutorial to be conducted by a member of the Department.

Tutorial in the senior year will occupy 15 units (5 units each quarter) of the student's academic program, and will be devoted to research on a topic resulting in a Senior Tutorial Essay. All students accepted for Senior Tutorial automatically become candidates for Departmental Honors. To achieve Departmental Honors, the Senior Essay must be distinguished. Failing to attain Departmental Honors, a student may nevertheless qualify for Senior Tutorial credit.

**Combined Major in Classics and Philosophy**

Students may, with the consent of the Heads of departments concerned, offer for the degree of Bachelor of Arts a combined major in Classics (Latin and/or Greek) and Philosophy. Students interested in such a major should consult the Heads of each of the departments concerned.

**Honors Program in Humanities**

An Honors Program in Humanities is offered for philosophy majors who wish to supplement their Departmental work for the A.B. degree by a related carefully guided program of studies. See the section "Humanities Special Programs" for a description of the Honors Program.

**Advanced Degrees**

The members of the Department are prepared to direct and supervise individual study and research to supplement instruction offered in courses listed below. In addition, advanced seminars, unlisted in the catalog, are frequently organized in response to
student interest. Candidates for advanced degrees are urged to discuss their entire program of study with their Departmental adviser as early as possible.

Applicants for admission to graduate standing in the Department of Philosophy should apply to the Director of Admissions. Applicants are requested to take, in their senior year or later, the Graduate Record Aptitude Test and the Graduate Record Advanced Test in Philosophy.

The Department will not ordinarily admit students who wish to become candidates for the Master's degree only.

**MASTER OF ARTS**

The University's basic requirements for the Master's degree (residence, thesis, etc.) are discussed in the section "Degrees" in this bulletin. The following are Departmental requirements:

1. Completion of a total of at least 36 units of graduate work in the Department with grades no lower than C and an average grade of B or better. Course work shall include one or two quarters in Philosophy 250.

2. Completion of a thesis acceptable to the Department. Credit will be allowed for the thesis to a maximum of 9 units toward the 36 units required for the degree.

3. Satisfactory performance on the preliminary examinations described below under "Doctor of Philosophy."

**MINOR IN PHILOSOPHY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY**

Each student shall take 30 units of work within the Department to be chosen according to the student's interests in consultation with a Departmental adviser. Departmental approval of the program of studies is required. One hour of the doctoral oral examination is ordinarily devoted to the minor subject.

**DOCTOR OF PHILOSOPHY**

The University's basic requirements for the doctorate (residence, dissertation, examination, etc.) are discussed in the section "Degrees" of this bulletin. The following are Departmental requirements:

**Courses**—There are no fixed course requirements, but the Department reserves the right to prescribe the courses a student takes in preparation for the preliminary examinations. The program of courses for this purpose will depend on the preparation of the individual student and is decided in consultation with his Departmental adviser.

**GENERAL GRADUATE PROGRAM**

**Preliminary Examinations**

1. All first-year graduate students will take a three-hour written examination during the winter quarter of their first year of graduate study at Stanford. It is expected that this examination will ordinarily be given in the last week in January. A student is required to pass this examination in order to continue as a second-year student in the Department.

2. Written preliminary examinations are set for all students in the middle of their second year of graduate study. These examinations are offered in the following four areas: logic and philosophy of science, epistemology and metaphysics, ethics and the theory of value, the history of philosophy. The examinations must be passed as a group, subject to the modification described in the next paragraph. It is expected that a student must pass these examinations in order to continue as a graduate student. In special circumstances a student may be permitted to take these examinations a second time. The second-year examinations will ordinarily be set in the middle of February. If they so desire, first-year students may ask the Department for the option of taking the second-year examinations.

A student may substitute a group of courses for at most one of the four examinations. Such a group consists of at least four courses in each of which the student has a mark of B or better. Courses taken at another university cannot be included. The following groups of courses satisfy the present requirement:

- Logic and Philosophy of Science: 157A, 157B, 164, and 166.
- Epistemology and Metaphysics: 184 plus three additional courses from the following: 181, 182, 189, and 202.
- Ethics and the Theory of Value: 148, 156, 170, and two of the following: 172, 174, 177.
- History of Philosophy: 100, 101, 102, 103.
In each area, more advanced courses or seminars may be substituted for the recommended courses with Departmental permission.

On or before February 1 of the first year in which a student plans to take the preliminary examinations he must file with the Department secretary a declaration of his intention to take the examinations. This should include a statement of the examination (if any) for which courses are to be substituted, and a list of the courses the student wishes to substitute. If this list differs from that given above, it must be approved by the Department. Courses may not be offered in lieu of an examination in an area in which the student has already taken the preliminary examination but failed, and the area in which exemption is requested cannot be changed if the examinations are taken a second time. The four courses offered in substitution for one examination must be completed before the student's formal candidacy for the Ph.D. degree is accepted, and generally no later than the end of the second year of graduate work. The courses need not be completed prior to taking the written preliminary examinations.

**Language Requirements**—Candidates for the Ph.D. must demonstrate a reading knowledge of French and German. When it is relevant to a proposed dissertation topic, the department will give permission to substitute other modern languages, or ancient languages, for one or both of the required languages.

**Dissertation**—Upon passing the preliminary examinations the candidate will submit a brief written statement of his dissertation topic to the Department, and a committee will be appointed to direct the research for and writing of the dissertation. Departmental approval of the dissertation topic is required for formal admission to candidacy for the doctoral degree.

The dissertation must be submitted to the committee in substantially final form at least four weeks before the University deadline in the quarter during which the candidate expects to receive his degree.

Dissertations must be completed and approved within five years from the date of that application. A candidate taking more than five years will be required to reinspect his candidacy by repassing the preliminary examinations.

**Oral Examination**—The University oral examination is taken after completion of the dissertation. The oral examination is to be considered primarily as a defense of the dissertation, but it may range over related topics as well.

**Special Graduate Programs in Logic, Philosophy of Language, and Philosophy of Science**

Recognizing the interests of students in more technical areas of Philosophy, the Department offers programs allowing the student to concentrate in one of three fields. The difference between these special programs and the general graduate program in Philosophy lies in the course requirements and the written preliminary examination. The student need not declare his intention to participate in a specialized program until February 1 of the first year in which he plans to take the preliminary examination. Even at that time he does not have to commit himself to the particular field but must do so before he takes the second part of the examination as explained below.

**Courses**—All students in these programs are required to take 160A,B (Symbolic Logic), 161 (Introduction to Set Theory), 164 (Philosophy of Science), 166 (Probability and Induction), 181 (Philosophy of Language), 184 (Theory of Knowledge). In addition a student is required to take one course or seminar in the general area of history of philosophy and one course or seminar in the general area of ethics and value theory (the courses are to be chosen in consultation with the student's adviser). These course requirements must be completed by the end of the third year of the student's residence in graduate school. In lieu of these courses equivalent or more advanced course work may be offered subject to Department approval. A program of advanced courses in the student's specialty will depend on the preparation of the individual student and is decided in consultation with his departmental adviser.

**Preliminary Examinations**

1. All first-year graduate students will take the three-hour written examination administered to all first-year students in Philosophy (see above).
2. Ph.D. candidates in these programs will take two written preliminary examinations, each lasting three hours. The first examination, of a general nature, will be taken by all students, and will be given in February of the second year. The second examination will be devoted to one of the three specialties chosen by the student and will be given at the beginning of the third year of graduate study. The student must declare his choice prior to the examination at a time to be specified by the Department. It is expected that the student will pass these examinations in order to continue as a graduate student. When circumstances warrant, however, a student may be permitted to take the examination a second time.

**GRADUATE PROGRAM IN HUMANITIES**

The Department of Philosophy also participates in the Graduate Program in Humanities leading to the joint Ph.D. degree in Philosophy and Humanities. For a description of that program, and fellowships offered in connection with it, see the section "Humanities Special Programs."

**GRADUATE FELLOWSHIPS AND ASSISTANTSHIPS**

A number of fellowships, including those provided by the Weiss and Locke funds which are reserved for students of philosophy, are available to graduate students.

In addition, the department has six teaching assistantships which may be held separately or combined with additional scholarship funds. Teaching assistants are expected to devote about half their time to their teaching duties. There are sections taught by teaching assistants in Philosophy 2, 3, 5, 6A and 6B.

Application forms for fellowships and teaching assistantships may be secured by writing the Office of Financial Aids; applicants for teaching assistantships should in addition address a specific request to the Director of Graduate Studies in Philosophy. In general, teaching assistantships are not offered to first-year graduate students. Students who do not intend to become candidates for the doctor's degree are ineligible for graduate fellowships and teaching assistantships.

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**ELEMENTARY COURSES**

**#2. Introduction to Ethics**—This is a systematic treatment of the major problems of ethical theory as these problems arise in the works of classical and contemporary moralists. Several ethical positions are surveyed critically, including intuitionism, utilitarianism, the emotive theory, and various forms of relativism, subjectivism, and absolutism. Among the topics discussed are: How are moral judgments related to scientific judgments? How are moral judgments justified? Are all human acts fundamentally selfish? Can morality be based on some conception of what is natural? What is the relation between value in general, the highest good, and obligation? Are the notions of freedom and responsibility meaningful if human actions are determined? What is the relation between personal value and social value? There are four lectures a week; a fifth hour is given to discussion sections.

5 units, Win (——) MTWTh 2:15 and Th or F section

**#3. Introduction to Logic**—An introduction to the methods and principles of formal logic. Exploration of modern techniques of deduction. Applications to philosophy and the exact sciences. This course is not a General Studies Humanities course.

5 units, Aut (Suppes) MTWTh 1:15 and Th or F section

Spr (Friedman) MTWTh 2:15 and Th or F section

Sum (——) MTWThF 11 and Th or F section

**#5. Introduction to Philosophy**—This is a general introduction to the problems with which philosophers are and always have been concerned, the conflicts in point of view that have arisen in the attempts that have been made to solve these problems, and the practical consequences of adopting any of these points of view. The course also strives to enlarge the intellectual horizon of students by making them familiar with concepts which everyone needs if he is to deal adequately with fundamental beliefs, and to clarify the often highly ambiguous terminology that is associated with these concepts. The course meets five times a week.

5 units, Aut (Mothershead) MTWThF 10

Sum (——) MTWThF 1:15 and one hour by arrangement
#6A, B. Problems of Good and Evil—The problem posed in the Book of Job is taken as central, and various attitudes toward this problem are considered in chronological order. In the first quarter the works covered include the Old Testament, several Greek tragedies, selections from Plato, Aristotle, the Stoics, Lucretius, New Testament, and Dante’s Divine Comedy. In the second quarter, authors covered include Montaigne, Shakespeare, Leibniz, Hume, Marx, Mill, Dostoevsky, and Camus. The course will be given as a continuous course over two quarters, but the first quarter (6A) may be taken for credit without the second. The course is open to freshmen. 6A is prerequisite for 6B.

6A. 3 units, Win (Rhinelander) MWF 10, alternate years, given 1969–70

6B. 3 units, Spr (Rhinelander) MWF 10, alternate years, given 1969–70

#8. Philosophy of Art — Nature and function of artistic creation and expression. Unique and common characteristics of various arts. Relation of arts to other human interests.

4 units, Aut (Smith) MWF 9

#10. Introduction to Philosophical Analysis — An analysis of selected philosophical problems. Readings will include important historical texts as well as contemporary writers.

5 units, Spr (———) TTh 11:00–12:30, alternate years, given 1969–70


3 units, Win (———) W 4:15–6:05, alternate years, given 1969–70

#27. Sophomore Seminar in Philosophy of Religion—Critical examination of some central problems in philosophy of religion. Attention will center upon (1) the traditional arguments for the existence of God; (2) the problem of evil as an argument for atheism; (3) psychological accounts of religious belief; (4) the relevance of evidence to religious belief; (5) the distinction between theology and philosophy of religion. Enrollment limited to 15.

3 units, Aut (Tooley) T 4:15–6:05

#29. Sophomore Seminar in Problems of Ethics—An introduction to the problems of ethics. Examination will be made of theories of right and wrong, and good and evil. Enrollment limited to 15.

3 units, Spr (———) W 4:15–6:05

#31. Sophomore Seminar on Law, Justice, and Civil Disobedience—An introduction to philosophical problems concerning the nature of justice, the relation between law and morality, and the moral justification of civil disobedience.

3 units, Aut (Rhinelander) M 2:15–4:05

COURSES FOR ADVANCED UNDERGRADUATE AND GRADUATE STUDENTS

I. HISTORY OF PHILOSOPHY FROM ANCIENT TIMES TO THE PRESENT

100. Greek Philosophy — Characterization of historical situation in which Western science and philosophy began. Rise of critical thought. Early metaphysical speculation. Sophists and Socrates. Post-Socratic ethical schools. Philosophies of Plato, Aristotle, the Epicureans, the Stoics, the Skeptics, and Neo-Platonism. Prerequisite: some general course in philosophy, such as 2, 5, 6A, or 10.

4 units, Aut (Mothershead) MTWTh 11


4 units, Aut (Mothershead) MTWTh 11

102. Modern Philosophy (Seventeenth and Eighteenth Centuries) — Francis Bacon and the new scientific empiricism. Materialism of Thomas Hobbes. Philosophic systems of Descartes, Spinoza, Leibniz, Locke, Berkeley, Hume, and the philosophy of the Enlightenment. Philosophy of Immanuel Kant. Prerequisite: a total of two philosophy courses; 101 is recommended.

4 or 5 units, Spr (Mothershead) MTWTh 11
103. Philosophy in the Nineteenth and Early Twentieth Centuries—Trends in philosophy during the period considered as a background for understanding of ideas influential today. Philosophers to be studied include Fichte, Hegel, Schopenhauer, Marx and Engels, Comte, J. S. Mill, Spencer, Bradley, Nietzsche, Bergson, James, and Dewey. Prerequisites: two philosophy courses; 102 is recommended.

4 or 5 units, Win (Mothershead) MTWTh 9

104. Contemporary Philosophy — Some principal developments in contemporary philosophical thinking. Prerequisite: a total of two philosophy courses.

4 units, Spr (Goheen) MTWTh 9, given 1969–70

106. Introduction to Philosophy—For graduate students. Lectures same as Philosophy 5.

4 units, Aut (Mothershead) MTWTh 10 and Th or F Section
4 units, Sum (——) MTWTh F 1:15 and Th or F Section

110. History of Scientific Concepts—A survey of the historical development of selected concepts in the physical sciences oriented toward consideration of philosophical problems associated with them and general questions about concept formation in science.

4 units, Win (Sneed) TTh 3:15–5:05

#120. Ancient Chinese Philosophy—Examination of the major Chinese philosophers and schools of thought from the sixth century through the third century b.c., in the context of the history of the late Chou Dynasty. (This course replaces Philosophy 4.)

4 units, Aut (Nivison) MTWTh 11

121. Buddhism — The historical development of Buddhist philosophy and religious thought.

4 units, Spr (Nivison) alternate years, given 1969–70

122. Chinese Philosophy Since Classical Times—The major philosophers since the third century b.c. with emphasis on the period from Sung through middle Ch'ing. Buddhism will be reviewed but not treated in depth in this course. Prerequisite: 4, 120, or equivalent.

4 units, Spr (Nivison) MTWTh 11

II. COURSES IN THE PHILOSOPHY OF A PERIOD AND IN INDIVIDUAL PHILOSOPHERS

The following courses will be offered in 1968–69 or 1969–70. Others will be announced in subsequent years or announced from quarter to quarter depending on the interests of students and instructors. Prerequisite: permission of instructor.

136. Seminar in the Philosophy of Aristotle.

3 units, Win (——) M 4:15–6:05, given 1969–70

137. Seminar in the Philosophy of Plato—A study of selected dialogues. Prerequisite: 100 or equivalent.

3 units, Win (Goheen) WF 4:15–6:05, given 1969–70

140. The Philosophy of St. Thomas Aquinas.

4 units, Spr (——) MTWTh 2:15, given 1969–70

142. Seminar in the Philosophy of Descartes—Prerequisite: 102 or equivalent.

3 units, Aut (Howell) M 4:15–6:05

144. Seminar in the Philosophy of Spinoza—A study of the basic works of Spinoza.

4 units, Spr (Rhinelander) MW 2:15–4:05

145. Seminar in the Philosophy of David Hume—Prerequisite: 102 or equivalent.

4 units, Win (Howell) M 4:15–6:05

147. The Philosophy of Kant—A selection of representative problems in Kant’s philosophy are discussed in the light of recent developments.

3 units, Spr (Hintikka) M 4:15–6:05

148. Seminar in Kant’s Ethics — Reading and discussion of the Critique of Practical Reason and other ethical writings of Kant with a view to their relevance to philosophy today.

3 units, Spr (Mothershead) T 2:15–4:05


3 units, Aut (——) by arrangement, given 1969–70

III. SYSTEMATIC PHILOSOPHY

Unless otherwise specified the prerequisite for the following courses is one course in philosophy or permission of the instructor.
156. Introduction to Ethics—For graduate students. Lectures same as Philosophy 2. Special section for graduate students.
4 units, Win (—) MTWTh 2:15 and Th or F section

157A. Introduction to Logic—For graduate students. Lectures same as Philosophy 3.
5 units, Aut (Suppes) MTWTh 1:15 and Th or F section
Spr (Friedman) MTWTh 2:15 and Th or F section
Sum (—) MTWThF 11 and Th or F section

3 units, Win (—) MWF 11:00

160A,B. Symbolic Logic—Thorough treatment of validity, provability, consistency, completeness, definability and decision problems for logical calculi, and axiomatic theories.
160A. 3 units, Win (Friedman) TTh 11:00-12:15
160B. 3 units, Spr (Friedman) TTh 11:00-12:15

161. Introduction to Set Theory—Intuitive justification of the axioms. Operations on sets, relations and functions. Equivalence and ordering relations. Equipollence of sets and cardinal arithmetic. Topics on ordinal numbers and axiom of choice as time permits. Prerequisite: 157B or 160A or equivalent.
3 units, Spr (—) MWF 2:15

162. Theory of Automata—An introduction to finite automata. Comparison of different notions of computability. Relationship to programming languages and theories of grammars.
3 units, Aut (Friedman) TTh 11:00-12:15

163A. Fundamental Concepts of Intuitionistic Logic — Constructive operations applied to concrete and abstract objects, examples of intensional and extensional constructions, notion of free choice sequence, the concept of idealized mathematician. Role of Church's thesis. Derivation of formal laws from analysis of basic notions. Prerequisite: 157B or 160A or equivalent.
3 units, Spr (Kreisel) by arrangement

163B. Modal Logic — Semantics and axiomatizations for several model propositional and predicate calculi. Discussion of deontic and tense logics. 163A is not prerequisite to 163B. Prerequisite: 157B or 160A or equivalent.
3 units, Spr (Scott) MWF 1:15, given 1969-70

164. Philosophy of Science—Detailed analysis of the structure and methods of empirical science with emphasis on set-theoretical models, probability, induction, causality and the testing of theories.
4 units, Win (Suppes) MWF 2:15 and one hour by arrangement

165. Philosophy of Logic—Some or all of the following topics will be discussed from a semi-formal point of view: Platonism versus nominalism, relation between logic and mathematics, epistemological implications of Gödel's and Church's theorems, counterfactuals, necessity and possibility, extensional and intensional contexts, synonymy, intuitionism, constructivity.
3 units, Spr (Kreisel) TTh 4:15-5:30

166. Probability and Induction—The most important approaches to induction and to probability are discussed and compared, with emphasis on the theories of inductive probability.
3 units, Spr (Kreisel) TTh 4:15-5:30

168. Philosophy of History — Nature and limits of our knowledge of the past, the categories of explanation used by historians, and the aims of historical inquiry; relation of these problems to speculation about the "meaning" of history and the structure of historical process.
4 units, Win (Smith) MWF 9, given 1969-70

169. Nature of Religious Belief—A critical survey of central problems in the philosophy of religion. Among the topics considered will be (1) the relevance of evidence to religious belief; (2) traditional arguments for the existence of God; (3) arguments for atheism, with particular emphasis upon the problem of evil; (4) the positivistic critique of theological statements; (5) the relationship between religion and morality; (6) mysticism:
its interpretation and epistemological value; (7) psychological and sociological accounts of religion; (8) human immortality; and (9) philosophy of religion versus theology.

4 units, Win (Tooley) MWF 1:15

170. Theory of Value—Definitions of "value"; psychological and social conditions of different values; function of value judgments; nature of standards and their role in criticism in art, science, morals. Foundations of the normative disciplines, i.e., logic, ethics, aesthetics. Prerequisite: 2 or permission of instructor.

4 units, Win (——) MTWTh 10


4 units, Aut (Howell) MTWTh 9

177. Political Philosophy — An analysis of fundamental political conceptions and problems: State, law, natural law, rights, natural rights, political obligations, and others.

4 units, Aut (Sneed) MTWTh 2:15


3 units, Sum (Follesdal) MWF 10

179. Philosophy of Law — The nature and function of law, the relation of law to ethics, and the judicial process.

3 units, Win (Rhinelander) MWF 10

180. Philosophy of Religion—Critical enquiry into the nature and validity of religious experience, its unity and variety, its relation to other human interests.

4 units, Spr (Smith) MWF 9, given 1969-70

181. Philosophy of Language—Nature and uses of language. Concepts of meaning, reference, truth, name, syntax, metaphor, ambiguity, vagueness, definition. Comparison and study of scientific, poetic, philosophic, legal, other uses of language. Applications in the fields of psychology, linguistics, anthropology, literary criticism. Prerequisite: 3 or permission of instructor.

4 units, Aut (——) MTWTh 2:15

182. Metaphysics—This course will undertake to examine and clarify the traditional metaphysical distinction between particulars and universals, or substances and attributes, or subjects and predicates. Some traditional and some contemporary positions bearing on this distinction will be considered critically; for example, some theses of Aristotle, Plato, Leibniz, and Hume, in the former instance, and some theses of Frege, Wittgenstein, Russell, and Strawson in the latter instance.

4 units, Win (Howell) MTWTh 9

184. Theory of Knowledge—A survey of the classical problems in the theory of knowledge ranging from the problem of induction to the nature of sense data.

4 units, Aut (Tooley) MTWTh 1:15

188. Induction and the Theory of Rational Behavior—Subjective probability and utility; foundations of statistical decision theory; relation between subjective probability and frequency probability.

3 units, Win (Sneed) TTh 3:15 and one hour by arrangement

189. The Concept of Mind—This course will attempt to give an account of the concepts of action and behavior and to investigate the logical relations in which these concepts stand to those of belief, desire, sensation, and perception.

4 units, Spr (Howell) MTWTh 11


4 units, each quarter (Tooley) by arrangement

192. Philosophy in Literature—A study of the philosophic content of literary works by Dostoevsky, Kafka, Gide, Hesse, Sartre, Camus, and others. (For juniors and seniors.)

3 units, Win (Bergmann) MWF 3:15

193. Formal Aspects of Social Decision Making—The following topics to be discussed: Relation between individual values and social policy. Critique of logical basis of democracy. Relations between political theory and recent work in welfare economics. Political and social values in light of general theory of value. Prerequisite: 3 or permission of the instructor.

3 units, Spr (Sneed) TTh 2:15 and one hour by arrangement
196. Tutorial—Senior year.  
5 units, each quarter (Staff)  
by arrangement

197. Individual Work for Undergraduates.  
Each quarter (Staff) by arrangement

199. Seminar in Recent Philosophical Literature—Open to junior and senior students with consent of instructor.  
Topic: Historical Explanation.  
3 units, Win (Nivison) Th 4:15-6:05  
Topic: Philosophy of Religion.  
3 units, Spr (Tooley) T 4:15-6:05

**COURSES INTENDED PRIMARILY FOR GRADUATE STUDENTS**

3 units, Win (——) T 8–10 p.m., given 1969–70

203. Seminar in Ethical Theory—Analysis of selected writings in contemporary ethical theory. Emphasis will be placed on the possibility of constructing a naturalistic theory that will provide guidance in decision-making (first person) and standards enabling justification or lack of justification for the decisions and actions of others (third person). Prerequisite: 2, 170, or permission of the instructor.  
3 units, Spr (Mothershead) T 2:15–4:05

205. Philosophical Foundations of Quantum Mechanics — The course will center around problems in the foundations of quantum mechanics which have been considered philosophically important, such as the uncertainty principle, the status of causality, complementarity principle, the role of probability concepts and the need for a multivalued logic. Various axiomatic formulations of classical quantum mechanics will also be discussed.  
3 units, Spr (Sneed) W 8 p.m.

206. Mathematical Models in Behavioral Sciences: Measurement and Utility Theory —After a general introduction to the theory of models in the empirical sciences, the course will concentrate on the general theory of measurement and scaling. The last part of the course will deal with utility theory and related topics like subjective probability and decision criteria.  
3 units, Aut (Suppes) TTh 2:15

207. Mathematical Models in Behavioral Sciences: Behavior Theory—Stimulus sampling and linear models for learning will receive the main emphasis. Modification of the basic models to deal with concept formation, perceptual problems and linguistic structures will be discussed.  
3 units, Win (Suppes) TTh 2:15

220. Epistemology—A survey of the central problems of epistemology emphasizing the uses of modern techniques in clarifying classical epistemological issues.  
4 units, Spr (Hintikka) MTWTh 3:15

230. Seminar in the Philosophy of Aristotle —Reading (in English translation) and class discussion of a number of basic philosophical writings of Aristotle. Prerequisite: 100 or equivalent.  
3 units, Win (Hintikka) M 4:15–6:05

232. Seminar in the Philosophy of Kant — Detailed analysis of the critique of pure reason.  
3 units, Spr (Howell) M 4:15–6:05

240. Individual Work for Graduates.  
Each quarter (Staff) by arrangement

242A,B,C. Seminar in the Philosophy of Science.  
242A. 3 units, Aut (——) T 4:15–6:05, alternate years, given 1969–70  
242B. 3 units, Win (Suppes) T 3:15–5:05, alternate years, given 1969–70  
242C. 3 units, Spr (Suppes) M 3:15–4:05, alternate years, given 1969–70

244. Seminar in Metaphysics.  
3 units, Win (——) T 4:15–6:00

245. Seminar in Foundations of Psycholinguistics—Theories of language learning will be examined with particular attention to current theories of performance and competence. Critique of stimulus-response theories and of purely linguistic theories of language learning. Implications of psycholinguistics for the philosophy of language.  
3 units, Spr (Suppes) T 3:15–5:05

Each quarter (Staff) by arrangement
PHYSICAL SCIENCES

291A,B,C. Set Theory — (Enroll in Mathematics 291A,B,C.)
   *Given 1969–70*

292A,B,C. Metamathematics — (Enroll in Mathematics 292A,B,C.)

293A,B,C. Recursion Theory — (Enroll in Mathematics 293A,B,C.)

   3 units, alternate years, given 1968–69

295. Advanced Automata Theory—(Enroll in Electrical Engineering 484.)

299. Advanced Seminar in Recent Philosophical Literature.
   Topic: Recent Continental Philosophy.
   3 units, Win (Bergmann) M 4:15–6:05

   Topic: Some Philosophical Problems in Logic.
   3 units, Sum (Follesdal) by arrangement


   391A. Aut (Feferman) Th 4:15–6:05, units by arrangement

   391B. Win (———) T 4:15–6:05, units by arrangement

   391C. Spr (Kreisel) T 4:15–6:05, units by arrangement

PHYSICAL SCIENCES
(GENERAL PROGRAM)

Professor: Claudio Alvarez-Tostado
Associate Professor: Julien A. Ripley, Jr.
Lecturer: William A. Perkins

Physical Sciences Subcommittee: Richard H. Eastman (Chairman), Robert R. Compton, Paul DeH. Hurd, Donald Kennedy, James L. McGregor, Mason R. Yearian

The general program in Physical Sciences is designed to give students an acquaintance with all the principal fields of physical science without requiring specialization in any one. It provides training suitable especially for students who are preparing to teach science courses in secondary schools.

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

The following requirements are in addition to the University’s basic requirements for the Bachelor’s degree:

Chemistry 1, 2, 3, Mathematics 41, 42, 43, Geology 1, 2, Physics 21, 23, 29, or equivalents.

Forty-five additional units of work in chemistry, physics, mathematics, geology, or related fields.

A reading knowledge of a modern foreign language, preferably French or German. This will normally mean the completion of a course numbered 23 in one of the modern languages.

Programs of study must be approved by an adviser appointed by the chairman of the Physical Sciences Subcommittee. The average grade for the science and mathematics courses specified above must be at least C.

MASTER OF SCIENCE

Candidates for the degree of Master of Science in Physical Sciences (General Program) are expected to complete, in addition to the general residence and other requirements of the University for that degree, a program of study approved by an adviser assigned by the chairman of the Physical Sciences Subcommittee. A reading knowledge of French or German is required. The program of study will include (1) an acceptable thesis; (2) the satisfactory completion of at least 30 units of advanced work in physics, chemistry, mathematics, geology, or related fields; and (3) such other advanced work in the University, making a total of at least 45 units, as may be approved by the adviser.

COURSES

#1, 2, 3. Physical Science—Survey of physical sciences as an expanding field of knowledge. Lectures, demonstrations, laboratorv work in astronomy, chemistry, physics, geology, to give a concept of the genera
rather than emphasize its divisions. Primarily for freshmen. No credit will be given for Physical Science 3 following Geology 1.

1. 3 units, Aut (Alvarez-Tostado) TTh 8 or 9; lab. by arrangement
2. 3 units, Win (Alvarez-Tostado) TTh 8 or 9; lab. by arrangement
3. 3 units, Spr (Alvarez-Tostado) TTh 8 or 9; lab. by arrangement

#5, 6, 7. Physical Science—Survey of physical sciences as an expanding field of knowledge. Similar to Physical Science 1, 2, 3, but no laboratory work; lectures have greater emphasis on history of science.

5. 2 to 3 units, Aut (Ripley) TTh 11
6. 3 units, Win (Ripley) MWF 11
7. 3 units, Spr (Ripley) MWF 11

#50. Modern Astronomy—A review of current concepts and ideas regarding the nature of the solar system, galaxy, and extragalactic systems; essentially nonmathematical discussion of the basis for these concepts. Telescopic observations if possible.

3 units, Spr (Perkins) MWF 11

#100. Physical Science and Modern Life—Review of important conclusions, theories of modern physical science; discussion of methods, values, limitations of scientific inquiry; survey of relations of science to technology, economics, sociology, philosophy, religion. Prerequisite: junior or senior standing.

3 units, Win (Ripley) MWF 8

140. Electron Tubes in Research—Elementary study of electron tubes, their characteristics and application to control, measurement. Emphasis on applications, particular attention to photo tube, d.c. amplifier circuits. Prerequisite: Physics 23, or equivalent.

3 units, Aut (Alvarez-Tostado) alternate years, given 1968–69

   Any quarter (Staff)

PHYSICS

Emeriti: Paul H. Kirkpatrick, David L. Webster (Professors)

Executive Head: Arthur L. Schawlow


Associate Professors: Alexander L. Fetter, David M. Ritson, H. Alan Schwettman, Stanley G. Wojcicki, Mason R. Yearian


OFFERINGS AND FACILITIES

The Russell H. Varian Laboratory of Physics, the adjacent Physics Lecture Hall, and the nearby W. W. Hansen Laboratories of Physics (High Energy Physics Laboratory, Microwave Laboratory, and Biophysics Laboratory) form a closely related complex housing a range of physics activities from general courses through advanced research, and including several accelerators up to 1.2 Bev in size. Separated from this group is the Stanford Linear Accelerator Center (SLAC), a very high energy physics laboratory which will contain as its principal tool a two-mile-long 45-Bev electron accelerator. The initial stage with a 20-Bev beam began operation in 1966. Professor Robert Hofstadter is the Director of the High Energy Physics Laboratory; Professors Fairbank, Mozley, Ritson, Schwettman, and Yearian are on the staff of the Laboratory. The staffs of the other branches of the W. W. Hansen Laboratories of Physics and of the Stanford Linear Accelerator Center are mentioned elsewhere in this catalog (see Applied Physics Division, Biophysics Laboratory, Stanford Linear Accelerator Center).

One of the most important facilities is the Physics Library, which includes current subscriptions and back sets of important journals, together with textbooks, scholarly treatises in English, French, German, and Russian and the collected works of the most eminent physicists. It is a center for reading and study of physics at all levels.

In addition to course work providing a sound foundation in classical and modern physics, undergraduates are offered laboratory work at several levels. Both series of introductory courses include laboratories in
which students carry out individual experiments. The Intermediate and Advanced Physics Laboratories offer facilities for increasingly complex individual work, including independent investigations.

Graduate students find opportunities for research in the fields of theoretical physics, low temperature physics, electron and nuclear resonance, nuclear physics including the Mossbauer effect, high energy physics, coherent optical radiation, and solid state physics. The fields of microwave physics, plasma physics, ferrites, biophysics, and others of a similar nature are offered in the Applied Physics Division and in the Biophysics Laboratory. The number of graduate students admitted to the Physics Department is strictly limited. Students should complete application by January 15, 1969, for the following autumn. Graduate students may normally enter the Department only at the beginning of autumn quarter.

PROGRAMS OF STUDY

The study of physics is undertaken by three principal classes of undergraduates: those including physics as part of a general education, those preparing for careers in professional fields that require a knowledge of physics, such as medicine or engineering, and those preparing for teaching or research careers in physics itself. In this Department the courses numbered below 200 are planned to serve all three of these groups. The courses numbered above 200 meet the needs mainly of the third group, but also of some students majoring in other branches of science and in engineering.

BACHELOR OF SCIENCE

Department requirements for the degree of Bachelor of Science are as follows: Physics 51, 53, 54, 61, 100, 101, 110, 111, 120, 121, 122, 130, 131, 132, 170, 171, 200, 201; 9 units of a sequence, to be decided with the concurrence of the Department adviser, in a science other than physics or mathematics (in the event that the chemistry background of the student is judged inadequate, the Department will require that this sequence be Chemistry 4 and 5); Language, completion of French 3, German 3, or Russian 3 (or placement in more advanced courses). Another language may be substituted by petition at the discretion of the Department. The mean grade for all courses taken in physics and chemistry must be C or higher.

Students may reach the level of the 200-series courses via a normal sequence or an accelerated sequence. Exceptionally able students with an especially good preparation in physics will find the accelerated sequence advantageous. It requires fewer courses and provides more opportunity for electives in either physics or other fields. Admission to the accelerated sequence requires A grades in 51 and 53 or permission of the Physics Department Undergraduate Study Committee.

Sample programs under the two sequences are shown below. The sequence of courses during the first two years is relatively inflexible, but considerable freedom exists during the upper-class years. The sample programs emphasize mathematics and physics electives only as one possibility. The arrangement of language, chemistry, and general studies courses is also rather arbitrary. Students are urged to work out, in consultation with their advisers, a program which will best fulfill their individual aims. The office of the Physics Department has more detailed information on how to obtain a Bachelor's Degree in Physics. This should be carefully studied by prospective majors, especially if they intend to make use of Stanford's programs abroad. Under some circumstances the Department will permit, by petition, flexibility in the requirements so that the student may fit a period abroad into his program.

NORMAL SEQUENCE

| First Year | |
|---|---|---|---|---|
| Course No. | Subject | A | W | Sp |
| Physics 51-53. Mechanics, Electricity | — | 4 | 4 |
| Physics 54. Electricity Laboratory | — | — | 1 |
| Math. 41, 42, 43. Analytic Geometry and Calculus | 5 | 5 | 5 |
| History 1, 2, 3. History of Western Civilization | 4 | 4 | 4 |
| English 1, 2, 3. Freshman English | 3 | 3 | 3 |
| Social Science | 5 | — | — |
| Total units | 17 | 16 | 17 |

| Second Year | |
|---|---|---|---|---|
| Course No. | Subject | A | W | Sp |
| Physics 55, 57, 61. Light and Heat, Atomic Physics, Optics and Wave Motion | 4 | 3 | 3 |
| Physics 56. Light and Heat Laboratory | 1 | — | — |
| Physics 110, 111. Intermediate Mechanics | — | 3 | 3 |
Math. 44, 45, 46. Advanced Calculus  3  3 (3)*
Math. 130, 131, 132. Ordinary Differential
Equations, Partial Differential
Equations  3  3 (3)*
Chem. 4, 5. General Chemistry  4  4 —
Total units ........................... 15 16 12

**Third Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 105, 100, 101. Introductory Electronics, Intermediate Physics Laboratory</td>
<td>(3)*</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Physics 120, 121, 122. Intermediate Electricity and Magnetism</td>
<td>3</td>
<td>3</td>
<td>3</td>
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</tr>
<tr>
<td>Physics 130, 131, 132. Atomic and Nuclear Structure</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Math. 113, 114 or 120. Linear Algebra and Matrix Theory, or Modern Algebra</td>
<td>(3) 3* —</td>
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<tr>
<td>German 1, 2, 3. First-Year German</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Social Science — — — 5</td>
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<tr>
<td>Total units ........................... 16 15 17</td>
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**Fourth Year**

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<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
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</thead>
<tbody>
<tr>
<td>Physics 170, 171, 172. Thermodynamics, Kinetic Theory and Introduction to Statistical Mechanics, Physics of Solids</td>
<td>3</td>
<td>3 (3)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics 200, 201, 202. Advanced Physics Laboratory</td>
<td>2</td>
<td>2 (3)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics 210, 211, 212. Introductory Theoretical Physics</td>
<td>(3) 3 3*</td>
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<tr>
<td>Math. 106. Complex Variable</td>
<td>(3)* — —</td>
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<tr>
<td>Humanities 4 4 —</td>
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<tr>
<td>Total units ........................... 15 12 9</td>
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</tbody>
</table>

Grand total of units 177†

* Not required for degree in physics.
† Additional elective units must be added to bring this total to 180 as required by the University.

**ACCELERATED SEQUENCE**

**First Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 51, 53. Mechanics, Electricity — — 4</td>
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<tr>
<td>Physics 54. Electricity Laboratory — — 1</td>
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<tr>
<td>Math. 43, 44. Analytic Geometry, Calculus, and Advanced Calculus</td>
<td>5</td>
<td>3 —</td>
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<tr>
<td>History 1, 2, 3. History of Western Civilization</td>
<td>4</td>
<td>4 4</td>
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<td>English 1, 2, 3. Freshman English</td>
<td>3</td>
<td>3 3</td>
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<tr>
<td>Social Science 5 — —</td>
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<tr>
<td>Total units ........................... 17 14 12</td>
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**Second Year**

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<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
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</thead>
<tbody>
<tr>
<td>Physics 61. Optics and Wave Motion — — 3</td>
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<tr>
<td>Physics 110, 111. Intermediate Mechanics — 3 3</td>
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<tr>
<td>Physics 100, 101, 105. Introductory Electronics, Intermediate Physics Laboratory (3)*</td>
<td>2</td>
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<tr>
<td>Physics 120, 121, 122. Intermediate Electricity and Magnetism 3 3 3</td>
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<td>Math. 45, 46. Advanced Calculus (3)* —</td>
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<td>Math. 130, 131, 132. Ordinary Differential Equations, Partial Differential Equations 3 3 (3)*</td>
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<tr>
<td>Chem. 4, 5. General Chemistry 4 4 —</td>
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<tr>
<td>Total units ........................... 16 18 14</td>
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<td>Physics 130, 131, 132. Atomic and Nuclear Structure</td>
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<td>Physics 170, 171, 172. Thermodynamics, Kinetic Theory and Introduction to Statistical Mechanics, Physics of Solids</td>
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<td>4</td>
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<tr>
<td>Social Science — — — 5</td>
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<tr>
<td>Total units ........................... 16 16 18</td>
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</table>

**Fourth Year**

<table>
<thead>
<tr>
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<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 200, 201, 202. Advanced Physics Laboratory</td>
<td>2</td>
<td>2 (3)*</td>
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<tr>
<td>Physics 220, 221, 222. Classical Electrodynamics</td>
<td>(3) 3 3*</td>
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<tr>
<td>Physics 230, 231, 232. Quantum Mechanics</td>
<td>(3) 3 3*</td>
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</table>

Grand total of units 177†

* Not required for degree in physics.
† Additional elective units must be added to bring this total to 180 as required by the University.

**MASTER OF SCIENCE**

The Physics Department does not offer a separate program for the Master of Science degree, but this degree may be awarded for a portion of the Doctor's degree work. University requirements for the Master's degree are discussed in the "Degrees" section of this bulletin. Among the Departmental requirements are a B average in courses 130, 131, 132, 170, 171, 202, 210, 211, 212, 240, 241, and, if no thesis is submitted, at least 9 additional units of course work above the 200 level (not including 290 or 390).

A reading knowledge of German, French, Italian, or Russian is also required, and must be demonstrated by an examination admin-
istered by a member of the Department faculty.

**Doctor of Philosophy**

The University's basic requirements for the doctorate (residence, dissertation, examination, etc.) are discussed in the section "Degrees" in this bulletin. The following are Departmental requirements:

Minimum subject matter requirements for the Ph.D. degree in Physics consist of 130, 131, 132, 170, 171, 172, two quarters of Advanced Laboratory (202, 203), 210, 211, 212, 220, 221, 222, 230, 231, 232, 240, 241, 242. All Ph.D. candidates must also take the following mathematics courses or have taken their equivalent previously: 106, 113, 114, 130, 131, 132. A minimum grade average of B during the last five quarters is required in the courses taken toward the Ph.D. degree.

Each candidate for the Ph.D. is required to pass a written comprehensive examination on undergraduate-level physics, given annually in the winter quarter, and a Departmental oral examination on graduate-level physics prior to his applying for Ph.D. candidacy and taking the University oral examination. Also prior to applying for candidacy and taking the University oral, each candidate is required to demonstrate to a Physics Department faculty member a good reading knowledge of any one of four languages: French, German, Italian, or Russian.

Each student must either choose a minor subject or request a waiver of this requirement from his adviser. In the latter case, he must take nine units of graduate (200-series) courses in one of the following fields: mathematics, chemistry, or electrical engineering. Other fields may be substituted only on petition to the Physics Department Graduate Study Committee. The courses taken must be passed with a B average. No course listed by the Physics Department or Applied Physics Division may be counted to fulfill the requirements necessary for the waiver of a minor.

The Physics Department strongly encourages all graduate students to engage in teaching before receiving their degrees.

(The student interested in applied physics and biophysics research should also be aware of the Ph.D. granted independently by the Applied Physics Division and by the Biophysics Laboratory. See elsewhere in this bulletin.

**Minors in physics** must take either Physics 210, 211, and 212 or Physics 130, 131, and 132 or Physics 170, 171, and 172, with the appropriate prerequisites. All physics minors must pass the comprehensive examination given to physics majors, but need take this examination only when they feel prepared for it.

The office of the Physics Department has more detailed information on how to obtain an advanced degree in Physics. This should be consulted by prospective candidates for advanced degrees.

**Teaching Credentials and Master of Arts in Teaching**

In its capacity as agent for the State Board of Education, the University grants credentials for teaching in California in junior and senior high schools and junior colleges. Applicants for these credentials should consult the Credential Secretary of the School of Education for details of the requirements in connection with the teaching of physics.

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and wish further to strengthen their academic preparation. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education. A suggested minimum program in the teaching field of physics would be Physics 57, 100, 101, 110, 111, 120, 121, and Mathematics 130, 131. Up to 6 units of equivalent course work, taken elsewhere as a graduate student, can be transferred. Detailed requirements for the course are outlined in the "School of Education" section.

**Fellowships and Assistantships**

Besides the University fellowships open to all graduates, there are available in the Department a few special fellowships and several assistantships involving teaching or research. Applications for fellowships, scholarships, and assistantships are made to the Financial Aids Office; they must be completed by January 15, 1969.
COURSES

Of the two series into which beginning courses are divided, the Twenty series (21, 23, 29) includes courses prescribed or recommended for general students and for students preparing for medicine or biology; the Fifty series (51, 53, 54, 55, 56, 57) includes courses for students of engineering, chemistry, geology, and physics.

The two series are similar in content and objectives. Both comprise demonstration lectures on fundamental principles of physics, problem work on application of these principles to actual cases, and laboratory experiments closely correlated with the lectures. Their objectives are not only to give information on particular subjects, but also to provide training in the use of the scientific method. The primary difference between the two series of courses lies in the fact that topics are discussed more thoroughly and are treated with greater mathematical rigor in the Fifty series.

Courses beyond 61 are numbered in accordance with the following three-digit code. The first digit indicates the approximate level of the course: sophomore and junior courses (1), senior and first-year graduate courses (2), more advanced courses (3). The second digit indicates the general subject matter: laboratory (0) mathematical physics and mechanics (1), electricity (2), atomic and quantum physics (3), nuclear physics (4), microwaves (5), structure of matter (7), independent study and research (9). Graduate courses in microwave physics, plasma physics, solid state physics and biophysics are offered in the Applied Physics Division and the Biophysics Laboratory.

#21. Mechanics and Heat — Equilibrium, uniform and accelerated motion, force, work, momentum and energy; heat, temperature, properties of matter. Prerequisite: working knowledge of elementary algebra, geometry, i.e., ability to pass examination in these subjects.

4 units, Aut (Schwartz) lec. and lab.

#23. Electricity and Optics — Electric charges and currents, magnetism, induced currents, wave motion, interference, diffraction, geometrical optics. Prerequisite: 21.

4 units, Win (White) lec. and lab.

#29. Modern Physics — Basis of modern atomic theory, structure and properties of atoms, the nucleus, radioactivity. Prerequisite: 23.

4 units, Spr (Hanna) lec. and lab.

#51. Mechanics — Vectors, particle kinematics and dynamics, work, energy, momentum, angular momentum; conservation laws; rigid bodies; oscillations; fluids. Discussions based on use of calculus. Prerequisites: Mathematics 41 or 11 and continuation in Mathematics 42, or permission of instructor.

4 units, Win (——) lec.; (——) discussions

#53. Electricity — Electric charges and currents, magnetism, induced currents, electric oscillations; atomic origin of electromagnetic phenomena. Prerequisites: 51 and Mathematics 42 or 21, or permission of instructor.

4 units, Spr (Little) lec.; (——) discussions

#54. Electricity Laboratory — Concurrent registration in Physics 53 is required.

1 unit, Spr (Ritson)

#55. Light and Heat — Reflection and refraction of light, lens systems; light as electromagnetic waves; temperature, properties of matter, introduction to kinetic theory of matter. Prerequisites: 53 and Mathematics 43 or 23, or permission of instructor.

4 units, Aut (Ritson) lec.; (——) discussions

#56. Light and Heat Laboratory — Concurrent registration in Physics 55 is required.

1 unit, Aut (Wojcicki)

#57. Atomic Physics — Experimental basis of quantum theory; atoms, nuclei, X rays, atomic structure, radioactivity. Prerequisite: 55.

3 units, Win (Hofstadter)

TTTh 11:00-12:15

3 units, Sum (——) MTWF 8

#58. Modern Physics Laboratory — Concurrent registration in Physics 57 is required.

1 unit, Win (——) first given 1969–70

61. Optics and Wave Motion — Theory of wave motions from point of view of Huygens' principle, superposition; interference, diffraction phenomena. Prerequisites: 55 or admission to Accelerated Sequence, Math
PHYSICS 333

matics 42, and concurrent or prior registration in 43.

3 units, Spr (Schawlow) TTh 11:00-12:15

100, 101. Intermediate Physics Laboratory —Fundamental experiments in mechanics, heat, electricity and magnetism, optics, and atomic physics. One set of apparatus for each experiment is available so that one or two students will perform a given experiment during a particular laboratory session. Students will work one or two weeks per experiment, completing ten to fifteen during two quarters. Prerequisites: 111 and concurrent or prior registration in 121 and 122.

100. 2 units, Win (Wojcicki, Yearian) by arrangement
101. 2 units, Spr (Wojcicki, Yearian) by arrangement

105. Introductory Electronics — Practical electronics for the research physicist with the emphasis on circuits, covering both vacuum tubes and transistors. Topics include basic amplifier principles, frequency considerations, feedback, power supplies, oscillators, and pulse and digital circuits. Laboratory work is covered in 100, 101. Prerequisite: 53; concurrent or prior registration in 120 is recommended.

3 units, Aut (——) TTh 2:15-3:30


110. 3 units, Win (——) MWF 11
111. 3 units, Spr (——) MWF 11

120, 121, 122. Intermediate Electricity and Magnetism — Electrostatics, dielectrics; magnetostatics; solutions of Laplace and Poisson equations; passive d.c., a.c. circuits; Maxwell's equations; propagation of electromagnetic waves; motion of charged particles in electromagnetic fields; introduction to special relativity. Prerequisite: 53. Concurrent or prior registration in Mathematics 130 and 131 with Physics 120 and 121, respectively, is required.

120. 3 units, Aut (——) MWF 10
121. 3 units, Win (——) MWF 10
122. 3 units, Spr (——) MWF 10

130, 131, 132. Atomic and Nuclear Structure — Fundamental concepts of quantum mechanics and its physical basis. Elementary properties of the Schrödinger equation. Some applications to atoms, molecules, and atomic nuclei. Prerequisites: 57 or admission to Accelerated Sequence, 61, and 111. Concurrent or prior registration in Physics 120, 121, 122, or equivalent, and in Mathematics 130 and 131 is required.

130. 3 units, Aut (Wojcicki) MWF 11
131. 3 units, Win (Wojcicki) MWF 11
132. 3 units, Spr (Hamilton) MWF 11

170. Thermodynamics—Derivation of laws of thermodynamics from basic postulates. Macroscopic properties of matter as consequences of these laws. Prerequisites: 55 or admission to Accelerated Sequence and Mathematics 130.

3 units, Aut (——) TTh 11:00-12:15

171. Kinetic Theory and Introduction to Statistical Mechanics — Kinetic theory of gases; introduction to statistical concepts from Boltzmann point of view, including quantum statistics, applications. Prerequisites: 130 and 170, or equivalent.

3 units, Win (Bloch) TTh 11:00-12:15

172. Physics of Solids—Introduction to the principal types of solids, with emphasis on their electrical and magnetic properties. Elementary treatment of electrons in metals, energy bands, semiconductors, rectification, and ferromagnetism. Prerequisites: 171, or 57 and Electrical Engineering 328A.

3 units, Spr (White) TTh 11:00-12:15

190. Independent Study and Senior Thesis —Experimental or theoretical physics under supervision of a faculty member. Prerequisites: superior work as an undergraduate physics major, approval of the instructor, and of the Undergraduate Study Committee of the Department of Physics.

Any quarter (Staff) by arrangement

200, 201, 202, 203. Advanced Physics Laboratory—Experiments in atomic physics, nuclear physics, solid state physics, low temperature physics, and cosmic rays, including Zeeman effect, isotope shift, gyromagnetic ratio of the electron, β spectra, α-particle scattering, Compton effect, π-μ decay, X rays, nuclear magnetic resonance, lasers, Mössbauer effect, superconductivity, and others. Experiments in electronic circuits,
including amplifiers, oscillators, transmission lines, etc. Physics 200 and 201 consist of a selection of fundamental experiments chosen mainly from the field of atomic and nuclear physics. Physics 202 and 203 consist of experiments chosen by the student who wishes to do more advanced work in one or more special areas. Prerequisites: for Physics 200 and 201: 100, 101, 121, and 131; for Physics 202: 201 or consent of instructor; for Physics 203: 202. (Note: Any of these courses may be taken in any of the three quarters. Furthermore, a student may take 200 alone or simultaneously with 201.)

200. 2 units, Aut, Win, Spr (Hanna, ———) by arrangement

201. 2 units, Aut, Win, Spr (Hanna, ———) by arrangement

202. 3 units, Aut, Win, Spr (Hanna, ———) by arrangement

203. 3 units, Aut, Win, Spr (Hanna, ———) by arrangement


210. 3 units, Aut (Fetter) MWF 10

211. 3 units, Win (Fetter) MWF 10

212. 3 units, Spr (Fetter) MWF 10

220, 221, 222. Classical Electrodynamics — Vector fields, statics, boundary value problems and Green’s functions. Maxwell’s equations, integration of the wave equations. Special relativity, covariant formulation of electrodynamics, radiation and diffraction, relativistic particle motion, radiation reaction and electromagnetic mass. Prerequisites: 122 or equivalent, and Mathematics 132 and Physics 212 or consent of instructor.

220. 3 units, Aut (Henry) MWF 9

221. 3 units, Win (Henry) MWF 9

222. 3 units, Spr (Henry) MWF 9


230. 3 units, Aut (Schiff) TTh 8–10

231. 3 units, Win (Schiff) TTh 8–10

232. 3 units, Spr (Schiff) TTh 8–10


240. 3 units, Aut (Meyerhof) MWF 11

241. 3 units, Win (Meyerhof) MWF 11


3 units, Spr (Hofstadter) MWF 11

270. Statistical Mechanics — Development of concepts, methods of classical and quantum-statistical mechanics from ensemble viewpoint; microscopic basis for thermodynamics. Prerequisite: 171. Concurrent or prior enrollment in Physics 232 and Mathematics 106 is required.

3 units, Spr (Bloch) TTh 11:00–12:15

290. Literature of Physics—Intensive study of literature of any special topic. Chiefly preparation, presentation of reports upon topics studied. Prerequisites: 25 units of college physics and permission of instructor.

Any quarter (Staff) by arrangement

330, 331, 332. Advanced Quantum Mechanics—Lorentz group. Relativistic one-particle quantum mechanics of spin 0 and spin \( \frac{1}{2} \) (Dirac) particles. Electromagnetic interactions, hydrogen atom, Feynman propagators, S-matrix, perturbation theory, Feynman diagrams, applications. Lagrangian field theory: quantization of free fields, interactions, covariant perturbation theory. Quantum electrodynamics: applications, renormalization, radiative corrections to scattering, Lamb shift. Prerequisites: 222 and 232.
330. 3 units, Aut (——) TTh 9–11
331. 3 units, Win (——) TTh 9–11
332. 3 units, Spr (——) TTh 9–11


3 units, Win (Schatvlow) alternate years, given 1969–70

336. Advanced Topics in Theoretical Physics — Discussion of selected topics of current interest in theoretical physics. Prerequisite: 330.

3 units, Spr (Walecka) by arrangement


3 units, Aut (——) alternate years, given 1969–70

341, 342. Nuclear Theory — Theory of nuclear structure, including nuclear forces, nuclear matter, electromagnetic properties of nuclei, nuclear spectra, nuclear models, weak interactions, and nuclear reactions. Prerequisites: 222, 232, and 241.

341. 3 units, Win (——) alternate years, given 1969–70
342. 3 units, Spr (——) alternate years, given 1969–70


3 units, Spr (——) alternate years, given 1968–69

370, 371. Structure of Condensed Matter — Topics such as the following from solid state and low temperature physics: liquid helium 3, helium 4, superconductivity, superfluidity, long-range order in momentum space, including quantized flux and rotation and the many-body Bose and Fermi systems. The first quarter will emphasize the macroscopic properties and theories of these systems. The second quarter will emphasize microscopic theories. Prerequisites: 172 and 230.

370. 3 units, Aut, alternate years, given 1969–70
371. 3 units, Win, alternate years, given 1969–70

390. Research — All work in experimental or theoretical problems in research, as distinguished from independent study of non-research character listed as Physics 190 and 290. Written report of work required at end of quarter. Open only to graduate physics major students, with permission of instructor.

Any quarter (Staff) by arrangement

POLITICAL SCIENCE

Emeriti: Thomas S. Barclay, Philip W. Buck, Christina P. Harris, Anthony E. Sokol, Graham H. Stuart (Professors)

Executive Head: Gabriel A. Almond


Associate Professors: Richard A. Brody, Richard R. Fagen, Yosal Rogat, Raymond E. Wolfinger (on leave autumn quarter)

Assistant Professors: David B. Abernethy (on leave 1968–69), Robert A. Packenham, Hans N. Weiler (on leave spring quarter).

Acting: Edward S. Greenberg, Joseph E. Paff

Lecturers: Milorad M. Drachkovitch, Robert M. Rosenzweig
OFFERINGS AND FACILITIES

The purpose of instruction in the Department of Political Science is (1) to offer all students courses designed to introduce them to the political aspects of society, to train them in the analysis of political problems, and to equip them for the exercise of their duties as citizens, (2) to provide undergraduate majors with a program of study leading to the A.B. degree in political science as a foundation for a liberal education, (3) to prepare students for postgraduate executive management programs in government and industry, (4) to give candidates for graduate degrees training preparatory to careers in government, research, teaching, or private enterprise where a knowledge of domestic politics and foreign affairs is in demand, and (5) to prepare students for a career in the foreign service.

The University Library has excellent resources for study and research in all fields of political science. Special collections are also found in the Hoover Institution and the Library of the Law School. The West Memorial Library which is housed in the same building with the Department's offices is maintained as a working collection serving political science students. Through participation in the Inter-University Consortium for Political Research, the faculty and students of the Department of Political Science have access to an extensive pool of data on political behavior in a great variety of institutional settings as well as to the research facilities and training programs in survey research and analysis sponsored by the Consortium at the Survey Research Center of the University of Michigan. Professor Eulau serves as coordinator of the program.

During the summer quarter the Political Science Department offers courses and seminars in three fields: Comparative Politics, International Relations, and American Politics. The specific offerings depend on the summer quarter faculty.

PROGRAMS OF STUDY

BACHELOR OF ARTS

The minimum requirements for recommendation for the degree of Bachelor of Arts with political science as the major subject are:

1. Registration as a major student in the department for at least one quarter, a C average or better in all requirements for the major, and a minimum of 15 units of work offered by this Department.

2. The completion of 45 units of political science, including:
   a) Any combination of two of the following courses: Political Science 10A, Political Science 20, Political Science 15A, and Political Science 15B, except the combination of Political Science 15B and Political Science 20.
   b) Political Science 150.
   c) An advanced course or a seminar in at least three of the following fields: administration, comparative politics, international relations, political theory, politics, and public law. Political Science 150 may be counted as an advanced course in the field of political theory.
   d) At least one seminar, which may be counted toward completion of requirement (c) above.

HONORS PROGRAM IN POLITICAL SCIENCE

The Honors Program provides well qualified students with special opportunities for intensive training and research. The honors candidate will enjoy a close relationship with members of the Department through his participation in seminars, tutorials, and research projects.

Application for admission to the Honors Program normally should be made no later than the spring quarter of the sophomore year. Applicants must have achieved a 3.00 average or better in all University work, and a 3.30 average or better in political science courses.

Honors candidates will complete all requirements for a major in political science and will also participate in Political Science 198A,B, a two-quarter Junior Honors Seminar offering 10 units of credit. The aim of the seminar is to provide students an encounter in depth with the central intellectual problems of the discipline and with the process of political analysis. The seminar will be taught by several members of the Department and will combine group meetings with small tutorial sessions. In the Senior year the
honors candidate writes a thesis, (Political Science 199), which will be awarded a maximum of 15 units. Following his selection of a thesis topic, the candidate will be assigned an adviser who will supervise his thesis research and writing.

Graduation with Honors in Political Science will require: 1) a 3.00 average or better in all University work; 2) a 3.30 average or better in political science; 3) 55 units of political science, including Political Science 198 and 199; and 4) submission of an acceptable honors thesis. Students who successfully complete the program will graduate “With Honors in Political Science.” Interested students should consult the chairman of the Honors Program Committee in their sophomore year.

GRADUATE STUDY

ADMISSION TO GRADUATE STANDING

All applicants for admission to graduate work are required to take the Aptitude Test of the Graduate Record Examination. This examination may be taken at most American colleges and by arrangement may be taken in nearly all foreign countries. For details concerning this test see the Information Bulletin. Overseas applicants, who may not receive the Information Bulletin promptly, should write directly to the Educational Testing Service, 20 Nassau Street, Princeton, New Jersey. Preference is given to those applying by January 15; normally applications will not be considered after April 1. Ordinarily graduate students enter the Department at the beginning of the academic year.

Except in unusual circumstances, the Department will not admit graduate students who will not be able to take a full-time program. That is, students will be expected to carry a full course load except for time devoted to teaching or research assistantships.

Ordinarily graduate applicants over the age of 40 will not be accepted.

MASTER OF ARTS

A candidate for the Master’s degree must have a creditable record (with average grade of B or better) of undergraduate work in political science and other social science subjects. Applications from students who plan to terminate their graduate study at the Master’s level are not ordinarily encouraged; preference is given to applicants who seek the doctorate.

The faculty of the Department recommends a candidate for this degree if he has satisfactorily completed, in the judgment of the Department, at least one full academic year as a graduate student, with 45 units of work in political science of which at least 25 units must be taken in graduate seminars. By special permission, work done in related departments may be accepted in lieu of a portion of the work in political science. Normally, grades below the level of B in graduate seminars will not be considered acceptable for A.M. candidates.

The University’s basic requirements for the Master’s degree are discussed in the section “Degrees” in this bulletin.

(The Master’s degree may also be awarded to doctoral candidates who have completed the above requirements.)

MASTER OF ARTS IN THE TEACHING OF POLITICAL SCIENCE

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and wish further to strengthen their academic preparation. The program consists of a minimum of 25 units in political science courses and 12 units in the School of Education. Detailed requirements for the course are outlined in the section “School of Education” in this bulletin.

DOCTOR OF PHILOSOPHY

a. The candidate for the Ph.D. degree will prepare for and submit himself to examination in three of the following fields of political science: American politics, comparative politics, international relations, political analysis, political theory, public administration, and public law. The normal expectation is that the candidate will take these examinations at the end of his second full year in residence at Stanford.

b. In addition, the candidate is normally required to take Political Science 400A,B, and C, “Introduction to Political Analysis,” during his first year in residence.

c. The Ph.D. candidate is required to demonstrate one of the following:

1. A reading knowledge of two Western languages (e.g., French and German); or
2. A reading knowledge of one non-Western language (e.g., Arabic, Chinese, or Japanese) or of Russian; or
3. A reading knowledge of and conversational ability in one language (e.g., French, German, Spanish, Portuguese, Italian); or
4. A reading knowledge of one language and knowledge of statistics and/or related skills.

d. The skill requirement may be fulfilled as follows:

1. By successfully completing a program of at least 15 quarter units of selected courses; or
2. By successfully passing a written examination offered by the Department.

The language or skill alternatives shall be those most likely to be useful in connection with the student's program. (The native language of a foreign student may be accepted in fulfillment of the requirement.) The Department decides on the language or skill program proposed by the candidate.

e. If the candidate has not completed at least one year of previous undergraduate instruction, or 5 quarter units of previous graduate instruction, in political theory, he will take 5 quarter units of graduate instruction in political theory.

f. Not later than the end of the third week of his third quarter in residence, the candidate will submit to the Department a statement of: (a) the three fields of political science in which he is to be examined, (b) his program for fulfilling the language and/or skill requirements, and (c) the proposed field of investigation for his dissertation. This statement will be the subject of an interview of the candidate by a faculty committee. After this interview and an evaluation of the proposed program, the faculty decides whether the candidate will be permitted to proceed toward the Ph.D. degree in the Department. Upon approval, a date for the written Departmental examination will be set in the light of the candidate's total program.

g. After the candidate has completed his preparation in all his fields, and after he has fulfilled the language and/or skill requirements, he takes the written Departmental examinations. These examinations are scheduled in the autumn and spring quarters. Upon successful completion of the written examinations a date for the University oral examination is set by his dissertation committee in consultation with the student.

h. Doctoral candidates who apply for the A.M. degree will be awarded that degree upon completion of the requirements outlined in the description of the Master of Arts program.

MINOR AND TEACHER'S CREDENTIAL

Minor in Political Science—Candidates in other departments, offering a minor in political science, select two fields in political science in consultation with the Graduate Student Adviser. They are then interviewed, prior to admission, by a committee of the faculty. The same committee determines the required preparation in the two fields, but no candidate shall take less than 10 units, including at least one graduate seminar in each field. Candidates will be examined in their fields in the general oral examination.

Teacher's Recommendation—For the recommendation for the Stanford Junior College Teacher's Credential with political science as a major, the applicant should have completed, in a manner satisfactory to the Department, at least 40 units in political science, including courses listed under 2a. For a minor, the applicant should have completed 24 units, including course 10 or 15A.

ASSISTANTSHIPS, SCHOLARSHIPS, AND PRIZES

The Department has teaching assistantships in Political Science 1, 10, 15, and 150 and graduate assistantships in connection with its other courses. These customarily are granted to applicants only after they have been at Stanford for at least one quarter.

A number of scholarships and fellowships are also available. Graduate students, specializing in comparative politics, may apply for fellowships under the National Defense Education Act. The attention of undergraduate students is called to the annual Edwin A. Cottrell Memorial Prize for the best student in Political Science 1, the Arnaud B. Leavelle Memorial Prize for the best student in Political Science 150, the Lindsay Peters, Jr., Memorial Prize for the year's outstanding student in Political Science 10.
I. INTRODUCTORY COURSES

#1. Major Issues of American Public Policy—Alternative public policies in selected areas, including control of monopoly, labor relations, civil rights, social welfare, foreign policy. Political process; influence of cultural, economic, political factors on determination of public policy. Prerequisites: History 1 and 2.

5 units, Aut (——) MTWThF 10
Win (——) MTWThF 11
Spr (——) MTWThF 1:15

10A. American Government — How and why citizens, politicians, groups and parties behave politically as they do. Socialization, recruitment and participation; roles, rules and relationships in different institutional settings — Presidency, Congress and Supreme Court; decision-making and influence in the American political system; political behavior and political ethics.

5 units, Win (Eulau) MTWThF 11

10. American Government—What the informed citizen should know about the organization and operation of American national government. The Constitution and what it means today; Congress, political parties, pressure groups; growth of the Presidency and bureaucracy; Supreme Court, judicial review; separation of powers; federalism.

5 units, Spr (Horn) MTWThF 11

15A. Introduction to Political Science — Basic concepts and problems in political science. Social and psychological factors affecting political beliefs and behavior.

5 units, Aut (Verba, Staff) lec. MW 10 plus section

15B. Introduction to Political Science — Comparative analysis of the formation and development of political systems.

5 units, Win (——, Staff) lec. MW 10 plus section

15C. Introduction to Political Science — The international system.

5 units, Spr (North) lec. MW 2:15 plus section

20. Introduction to Comparative Government and Politics — Governmental institutions and political processes in selected foreign political systems, such as England, the Soviet Union, Japan, and Brazil.

4 to 5 units, Win (Steiner) MTWThF 9

II. ADVANCED COURSES AND UNDERGRADUATE SEMINARS

Advanced undergraduate courses are open to undergraduates who have the necessary prerequisites and also graduates where advisable. Undergraduate seminars are open, with the consent of the instructor, to juniors and seniors and to graduates where advisable. Enrollments will be limited. Some graduate seminars also may be open with consent of instructor to seniors.

ADMINISTRATION

100. Introduction to Public Administration — Introduction to the study of organizations with particular reference to public administrative agencies. Emphasis on the analysis of organizational structure and the interaction between the organization and its environment. Prerequisite: 10 or consent of instructor.

5 units, Aut (——) MTWThF 9

104. Local Government Laboratory—Field course in municipal affairs offered in cooperation with Coro Foundation (San Francisco).

2 units, Spr (——) T 2:00-4:30

106. Organizational Analysis and Public Administration — Advanced course in the study of public administration based upon the analysis of public agencies as organizations. Emphasis upon recent empirical research on organizational behavior. Prerequisite: 100, or Sociology 105, or equivalent background in organization theory, with consent of instructor.

5 units, Spr (——) MTWThF 9

Seminars

107. Seminar in Government and Natural Resources—Political, economic, administra-
ativ factors affecting public policy for river basin development, soil conservation, management of public domain, related problems. Pressure groups, legislative bodies, administrative agencies in the decision-making process. Prerequisite: 100. Economics 1 is desirable.

5 units, Win (Marshall) given 1969-70

108. Seminar in Administrative Responsibility — Conflicting loyalties, accountabilities of administrative officials in decision-making processes; responsibility to public at large, pressure groups, chief executive, legislature, profession. Case study method used. Prerequisite: 100.

5 units, Aut (Marshall) given 1969-70

109. Directed Reading in Administration — Advanced individual study in public administration. Prerequisite: 100.

Any quarter (Staff) by arrangement

110. Administrative Behavior — Environment of administrative action; political, social, psychological factors in management; problem of incentives.

5 units, Win (Walker) MTWThF 11

For graduate courses in Administration, see Part III.

COMPARATIVE POLITICS

111A. European Politics: The British Political System — The development of the British political system treated in terms of state- and nation-building, participation and welfare; the contemporary functioning of the British political system treated in terms of political socialization and recruitment, the functioning of interest groups, political parties, media of communication, parliament, cabinet, and bureaucracy. Desirable prerequisites: 15A, or 15B, or 20.

4 to 5 units, Win (Almond) given 1969-70

111B. European Politics: Government and Politics in Germany — Governmental institutions and the political process in the Federal Republic of Germany as they have emerged after World War II; determinants of domestic and foreign policies; the development of a separate political system in East Germany. Desirable prerequisites: 15A, or 15B, or 20.

4 to 5 units, Spr (Weiler) given 1969-70

112. Government and Politics in Asia — Survey of governmental institutions and the political process in Asian countries. Desirable prerequisites: 20, or equivalent, or previous study of the area.

4 to 5 units, Aut (———) MTWThF 1:15

113. Latin American Politics — Historical, cultural, and socioeconomic context of contemporary politics in Latin America; comparison of political systems of Argentina, Brazil, and Mexico; and analysis of selected problems in Latin American politics.

4 to 5 units, Spr (Packenham) MTWThF 9

114. Government and Politics in Japan — Governmental institutions and the political process in prewar and postwar Japan; the influence of tradition and social change; the impact of the occupation. Desirable prerequisite: 15A, or 15B, or 20, or 112.

4 to 5 units, Win (Steiner) MTWThF 11

115. Government and Politics in China — Governmental institutions and the political process in the Chinese People's Republic; analysis of elites, policy formulation, techniques for eliciting mass response, and constraints upon the exercise of central power. Desirable prerequisites: 20 or equivalent or 112; History 190, 191, 192, or 193; or Anthropology 117.

4 to 5 units, Win (Lewis) MTWThF 11

116. Comparative Politics of Ruling and Non-Ruling Communist Parties — Examination of selected communist parties (Soviet, Yugoslav, Czechoslovak, Italian, etc.) in terms of their development, recruitment, membership, style, function, and structure patterns. Emphasis is on the distinctions among these parties, their causes and consequences.

4 to 5 units, Win (Triska) MWF 2:15

117. Government and Politics in Africa South of the Sahara — The transition from the colonial situation to independent statehood; emerging and changing functions of political parties; ethnic, economic, and educational issues in African politics; the politics of interstate relations in Africa.

4 to 5 units, Aut (Weiler) MTWThF 10
Seminars

120. Introductory Seminar in Comparative Politics. Prerequisite: 20 or equivalent.
5 units, Win (Steiner) given 1969-70

120A. Seminar in Comparative Politics: Japan — (Graduate students register for 220A.)
5 units, Win (——) Th 4:15-6:05

121. Seminar in Comparative Politics: Party Systems.
5 units, Aut (——) T 2:15-4:05

122. Seminar in Comparative Politics: Patterns of Politics in Non-Western Countries. Prerequisite: 112.
5 units, Win (——) M 2:15-4:05

123. Seminar in Comparative Politics: Brazil — See 223.

123A. Seminar in Comparative Politics: Mexico — See 223A.

124. Seminar in Comparative Politics: Local Government — Survey of local government structures; theories of local government and politics; functions of the local community in the political system (political socialization and recruitment, communication, etc.) with emphasis on the relations between local government and democracy. (Graduate students register for 224.)
5 units, Win (Steiner) given 1969-70

125. Seminar in Comparative Politics: Communist China — Focus on domestic problems. (Graduate students register for 225.) Permission of instructor required.
5 units, Aut (Lewis) Th 2:15-4:05

126. Seminar in Comparative Politics: Eastern Europe and the Soviet Model — Analysis of the major contemporary determinants of Soviet and East European domestic political decisions.
5 units, Aut (Triska) T 2:15

127A. Undergraduate Seminar in Education and Politics in Developing Countries — Interaction of educational and political systems, as seen in school crises over language and religion, pressure to expand educational facilities, and efforts to cope with unemployment among school-leavers.
5 units, Win (Abernethy) given 1969-70

127B. Undergraduate Seminar in Education and Politics in Europe — The politics of educational innovation in selected countries of Western and Southern Europe, including the influence of international organizations such as OECD, EEC, etc. Desirable prerequisite: Reading knowledge of a European language other than English.
5 units, Spr (Weiler) given 1969-70

128. Seminar on the Politics of Development Planning — Examines the political and administrative setting in which planning for economic development takes place; the political implications of economic dependence on the outside world; and the consequences of successful and unsuccessful development projects. Attention will be focused on selected countries of Asia, Africa, and Latin America.
5 units, Spr (Abernethy) given 1969-70

129. Directed Reading in Comparative Politics — Advanced individual study in comparative politics. Prerequisites: 15A and 15B, or 10 and 20.
Any quarter (Staff) by arrangement

For graduate courses in Comparative Politics, see Part III.

INTERNATIONAL LAW AND RELATIONS

130. Introduction to International Law — A broad overview of theories, development, present state and propensities of international law as a process in various critical arenas of international interaction.
4 to 5 units, Spr (Triska) MWF 2:15

131. Control of American Foreign Policy — How American foreign policy is made; problems of administrative coordination, public opinion, decision-making process. Special attention to State Department and the Foreign Service. Prerequisite: 10 or equivalent.
4 to 5 units, Spr (Brody) MTWThF 11

132. Principles and Problems of American Foreign Policy — The great traditions and their contemporary application; neutrality, freedom of the seas, Monroe Doctrine, Pan-Americanism, pacific settlement, international cooperation, etc.
4 to 5 units, Spr (Watkins) MTWThF 10

4 to 5 units, Spr (Weiler) given 1969-70
135. **International Relations**—Introductory survey of the national state system, its characteristic forms and the principal forces making for conflict and adjustment. Nationalism, imperialism, economic relations, war, diplomacy, international organization given special attention.

4 to 5 units, Win (Watkins) MTWThF 10

136. **Soviet Foreign Policy**—Contemporary Soviet foreign policy decision-making, instruments of Soviet foreign policy. Soviet interaction with the communist party-states, the developing nations, the West, and the U.S. Testing of hypotheses concerning Soviet and communist international organizations; diplomacy, negotiation and risk-taking; agreements; and conference behavior.

4 to 5 units, Ant (Triska) MWF 2:15

136B. **Analysis of the Socialist and Communist Internationals (1864–1956)**—Emphasis on the ideological bases, operational devices and historical meaning of the First, Second, and Third Internationals, including the Cominform period.

4 to 5 units, Aut (Drachkovitch) given 1969–70


4 to 5 units, Spr (Watkins) MTWThF 10

138. **Problems of Arms Control and Disarmament**—General international politics; international law and relations, stressing problems of arms control, proliferation of nuclear weaponry, inclusion of China in disarmament agreements, on-site inspection and verification of disarmament.

4 to 5 units, Spr (Lewis) MTWThF 11

**Seminars**

140. **Introductory Seminar in International Relations**—May be repeated for credit.

5 units, Aut (Watkins) Th 2:15–4:05

140A. **Seminar in History of International Relations Thought.**

5 units, Win (Watkins) given 1969–70

141. **International Relations: An Introductory Seminar in Scope and Method.**

5 units, Win (Brody) given 1969–70

146. **Seminar in International Law: International Treaties.**

5 units, Win (Triska) T 2:15–4:05

146B. **Seminar on De-Stalinization**—Aspects and problems of the post-1953 political and economic decompression in the Soviet Union and in East-Central Europe. Graduate students register for 246B.

5 units, Win (Drachkovitch) given 1969–70

147. **Seminar on Soviet-Chinese Relations.**

5 units, Win (North) T 4:15–6:05

148. **Introductory Seminar in International Organization**—Prerequisite: 137 or equivalent.

5 units, Win (Watkins) T 2:15–4:05

149. **Directed Reading in International Law and Relations**—Advanced individual study in international law and relations.

Any quarter (Staff) by arrangement

For graduate courses in International Law and Relations, see Part III.

**POLITICAL THEORY**

150. **Introduction to the History of Political Thought**—The first half of the course will be primarily devoted to Greek philosophy. Medieval and modern political and legal theorists will be discussed in terms of four conceptions of the nature and conditions of political freedom. Prerequisite: third-year standing or consent of the instructor.

4 to 5 units, Aut (Drekmeier) MTWThF 11

151. **Roman, Medieval, and Early Modern Political Thought**—The search for a principle of authority consistent with spiritual ideals, with new forms of social integration, and with the private goals of the individual. Prerequisite: third-year standing or consent of the instructor.

5 units, Win (Drekmeier) given 1969–70

152. **Modern Political Thought**—Philosophy and ideology of the Enlightenment, the nineteenth and early twentieth centuries, with particular attention to the critique of
liberalism and the development of democratic and socialist theory.

5 units, Win (Drekmeier) given 1970-71

154. Political Theory of China and Japan
—Leading thinkers and schools of thought from Confucius to Mao Tse-tung. Prerequisite: third-year standing or consent of the instructor.

4 to 5 units, Spr (———) MTWThF 1:15

155. Comparative Marxist Theory
—A critical examination of the chief theories developed by Marx, Engels, Lenin, Stalin, Mao Tse-tung and certain revisionists. Special emphasis on Soviet and Chinese Communist ideologies. Prerequisite: third-year standing or consent of instructor.

4 to 5 units, Aut (North) given 1969-70

157. American Political Thought: 1865 to the Present
—The American political tradition since the Civil War. Special reference to the contributions of clergymen, businessmen, politicians, lawyers, economists, reformers and agitators.

4 to 5 units, Win (———) given 1969-70

158. Theoretical Foundations of Political Sociology
—The major contributions of social and political theorists to our understanding of social and psychological phenomena and their impact on political behavior, roles, institutions, and values. Critics and analysts such as Marx, Weber, Freud, Michels and Parsons will be discussed.

5 units, Spr (Drekmeier) given 1969-70

160A,B. "Modernisms"—"Modern" thought characteristically seeks insight into its own roots. The seminar will consider how such increased awareness of subjectivity affects subsequent action or expression. This is a two-quarter course.

160A. 5 units, Win (Rogat) M 4:15-6:05

160B. 5 units, Spr (Rogat) M 4:15-6:05

161. Modern Political Theory
—Development of political thought from Machiavelli to Rousseau: perspectives on politics of realism, Utopianism, science, art, and common sense.

4 to 5 units, Win (Paff) MWF 11

169. Directed Reading in Political Theory
—Advanced individual study in political theory. Prerequisite: 150.

Any quarter (Staff) by arrangement
For graduate courses in Political Theory, see Part III.

PUBLIC LAW

170. The Supreme Court and the Constitution
—Theory and practice of constitutional government in the United States. Formation of the Constitution; federal court system; separation of powers; judicial review; Congressional and Presidential authority; exclusive national and concurrent state powers; emphasis on nature of legal reasoning and judicial process. Prerequisite: third-year standing. (Graduate students register for 270.)

5 units, Aut (Horn) MTWThF 1:15

172. The Constitution and Economic Justice
—Changing concepts of private property rights and governmental powers over the economy in American constitutional law; Supreme Court interpretation of the contract and due process clauses versus state police powers; expansion of congressional currency, commerce, taxing and spending, and war powers used to regulate property and the economy. Prerequisite: third-year standing; 170 desirable. (Graduate students register for 272.)

5 units, Win (Horn) MTWThF 1:15

173. Civil Liberties in the United States
—Civil liberties in contemporary American culture; theory, history underlying them. Free speech, press in era of mass communications; freedom of association for religious, political, economic groups; rights of ethnic minorities; fair trial, rights of accused persons. Prerequisite: third-year standing. (Graduate students register for 273.)

5 units, Spr (Horn) MTWThF 1:15

179. Directed Reading in Public Law —
Advanced individual study in public law.

Each quarter by arrangement with
Public Law faculty

For graduate courses in Public Law, see Part III.
POLITICS

181. Attitude Formation and Voting Behavior—The formation of opinions, perceptions of political events, political participation, voting behavior; the significance for democratic government of findings in these areas. Prerequisites: third-year standing and 10 or equivalent.

5 units, Aut (—) MTWThF 11

184. Legislative Behavior — Congressional elections, constituent relations, policy making and leadership, relations between Congress and administrative and executive agencies; the committee system, seniority and procedure; Congress as an element in the party system. Prerequisites: third-year standing and 10 or equivalent.

5 units, Win (Wolfinger) MTWThF 10

185. Political Parties — Conventions, nominations, primary elections and voting; types of party organizations; money in politics; party reform and responsible parties. Prerequisites: third-year standing and 10 or equivalent.

5 units, Spr (Greenberg) MTWThF 10

Seminars

187. Introductory Seminar in Politics—Historical, social and ideological factors affecting American politics, emergent patterns in the party system; analysis of the nature of public opinion and voting behavior.

5 units, Aut (Rosenzweig) T 2:15-4:05

189. Directed Reading in Politics — Advanced individual study in politics. Prerequisite: 10 or equivalent.

Any quarter (Staff) by arrangement

For graduate courses in Politics, see Part III.

UNDERGRADUATE HONORS

198A,B. Honors Seminar—Open to honors candidates in their junior year.

198A. 5 units, Aut (Greenberg, Paff, Staff) by arrangement

198B. 5 units, Win (Greenberg, Paff, Staff) by arrangement

199. Senior Honors Thesis.

Each quarter (Staff) by arrangement

III. GRADUATE COURSES

Conducted as seminars or reading and discussion groups. Courses numbered 200-299 are limited to graduates and, with the consent of the instructor, to qualified seniors. Courses numbered 300 and above are limited to graduates. All students should consult the instructor before enrolling in any graduate course.

201. Introductory Seminar in Organizational Theory and Research.

5 units, Win (—) Th 4:15-6:05

207. Seminar in Government and Natural Resources—See 107.


209. Directed Reading in Public Administration.

Any quarter (Staff) by arrangement

210. Administrative Behavior—See 110.

211. Seminar in the Theories of Comparative Politics—Introduction to various systematic approaches to the study of comparative politics.

5 units, Aut (Fagen) M 7:30-9:30 p.m.

213. Seminar in Comparative Politics: Latin America — Problems in Latin American politics. Reading knowledge of Spanish or Portuguese recommended but not required. Not to be taken in conjunction with 313.

5 units, Spr (Fagen, Packenham) M 2:15-4:05

218. Seminar in Political Anthropology — (Same as Anthropology 245.) An examination of political processes in traditional and modernizing societies, both simple and complex, and in their various subsystems. Analysis will proceed in connection with a rethinking of relevant theory from political science, anthropology, sociology, and related disciplines.

5 units, given 1969-70

220A. Seminar in Comparative Politics: Japan—See 120A.

223. Seminar in Comparative Politics: Brazil — Advanced undergraduates admitted with permission of the instructor. Reading knowledge of Portuguese strongly recommended but not required.

5 units, Aut (Packenham) given 1969-70
223A. Seminar in Comparative Politics: Mexico—Advanced undergraduates admitted with special permission of the instructor. Reading knowledge of Spanish strongly recommended.
5 units, Win (Fagen) W 2:15–4:05

224. Seminar in Comparative Politics: Local Government—See 124.

225. Seminar in Comparative Politics: Communist China—See 125.


227. Seminar in Comparative Politics: Africa.
5 units, Win (Weiler) M 2:15–4:05


229. Directed Reading in Comparative Politics.
Any quarter (Staff) by arrangement

231A. Seminar on Social Science and Public Policy—Definition, description and explanation of utilities and limitations of social science and social scientists for public policy and public policy makers. Uses both theoretical and empirical studies. Advanced undergraduates admitted with permission of instructor.
5 units, Win (Packenham) given 1969–70

233. Research Seminar in International Relations Theory: Systems Analysis
5 units, Win (——) given 1969–70

234. Seminar in International Politics—A survey of central concepts.
5 units, Aut (Brody) Th 2:15–4:05

241. International Relations—See 141.


246B. Seminar on De-Stalinization — See 146B.

249. Directed Reading in International Law and Relations.
Any quarter (Staff) by arrangement

251. Seminar in Roman, Medieval, and Early Modern Political Thought—See 151.

254. Essentials of Political Theory.
5 units, Aut (Drekmeier) T 4:15–6:05

258. Seminar in the Theoretical Foundations of Political Sociology—See 158.


5 units, Win (Paff) M 4:15–6:05

269. Directed Reading in Political Theory.
Any quarter (Staff) by arrangement

270. The Supreme Court and the Constitution—See 170.


5 units, Win (Horn) TTh 4:15–5:45

279. Directed Reading in Public Law.
Any quarter (Staff) by arrangement

281A,B. Seminar in Political Behavior: Empirical Political Theory—This is a two-quarter course.
281A. 5 units, Win (Eulau) given 1969–70
281B. 5 units, Spr (Eulau) given 1969–70

289. Directed Reading in Politics.
Any quarter (Staff) by arrangement

300. Thesis.
Each quarter (Staff) by arrangement

301. Advanced Seminar in Organizational Theory and Research—Prerequisite: 201 or equivalent, with consent of instructor.
5 units, Spr (——) Th 4:15–6:05

302. Research Seminar in Public Administration.
5 units, Win (Staff) by arrangement

5 units, Win (Lau, Lewis, Skinner) by arrangement
312. Research Seminar on Comparative Politics—Problems in the politics of development.

5 units, Spr (——) given 1969-70

313. Research Seminar in Comparative Politics: Latin America—Limited to students prepared to undertake advanced research. Reading knowledge of Spanish or Portuguese required. Not to be taken in conjunction with 213.

5 units, Spr (Fagen, Packenham)
W 2:15-4:05

322A,B. Research Seminar in Political Development: Comparative Studies in Historical Political Development.

322A. 5 units, Win (Almond) Th 10-12
322B. 5 units, Spr (Almond) Th 10-12

323. Research Seminar on Western European Political Systems—Comparative studies of the development and performance of the political systems of Western Europe; implication for theories of political development and political development policy.

5 units, Spr (Almond) given 1969-70

325. Advanced Seminar in Reform and Revolution in Twentieth Century China and Japan.

5 units, Spr (——) F 4:15-6:05

326. Advanced Seminar on Japanese Politics—Emphasis will be on empirical studies, leadership, voting and public opinion. Reading knowledge of Japanese required.

5 units, Spr (——) T 2:15-4:05

328. Research Seminar in the Cuban Revolution—Research will be based on the Cuban collection held in the Hoover Library. Reading knowledge of Spanish required. Exceptionally qualified undergraduates admitted with special permission of the instructor.

5 units, Spr (Fagen) Th 8-10

331. Advanced Seminar in International Political Theory.

5 units, Spr (North) T 4:15-6:05

333. Research Seminar in International Relations Theory: Decision Making—An examination of alternative models of decision processes; the role of individual, organizational, and situational factors in decision making.

5 units, Win (Brody) Th 2:15-4:05

334A,B. Advanced Seminar on Force and Diplomacy.

334A. Readings and discussion of theories and practice of deterrence and coercion in recent world politics, and problems encountered in efforts to use force as an instrument of policy.

5 units, Win (George) T 2:15-4:05
334B. Student research on historical cases and policy problems.

5 units, Spr (George) T 2:15-4:05

336. Research Seminar in the World Communist System—Studies focusing on the volume, intensity and quality of international interaction among and comparison between the various units within the communist system.

5 units, Spr (Triska) T 2:15

360. Advanced Seminar in Power and Authority.

5 units, Spr (Drekmeier) given 1969-70

381A,B. Advanced Seminar on Political Leadership.

381A. Readings and discussion of approaches to the study of political leadership focusing on interplay of personality, role, and other constraints on the policies and decision-making of political leaders.

5 units, Aut (George) F 2:15-4:05
381B. Student research on some aspect of leadership.

5 units, Win (George) F 2:15-4:05

382A,B. Research Seminar in American Politics: Public Opinion and Voting Behavior—Survey of current findings on attitude formation, political participation, and voting behavior; student research on numerous aspects of individual political behavior using data from the Inter-University Consortium for Political Research. This is a two-quarter course.

382A. 5 units, Aut (——) W 2:15-4:05
382B. 5 units, Spr (——) W 2:15-4:05

383A,B. Seminar in Political Behavior: Modes of Empirical Analysis — This is a two-quarter course.

383A. 5 units, Win (Eulau) W 7:30-9:30 p.m.
383B. 5 units, Spr (Eulau) W 7:30-9:30 p.m.

384A,B. Seminar in American Politics: Public Policy Formation—Analysis of various
aspects of policy-making in American national government. Students must take both 384A and 384B.

384A. 5 units, Win (Wolfinger)
       W 2:15-4:05
384B. 5 units, Spr (Wolfinger)
       W 2:15-4:05

385A,B. Seminar on Political Behavior: Political Socialization

385A. 5 units, Win (Greenberg)
       M 2:15-4:05
385B. 5 units, Spr (Greenberg)
       M 2:15-4:05

400A,B,C. Introduction to Political Analysis—Required of all Ph.D. candidates in Political Science. To be taken during first year of residence. Not open to A.M. candidates or students registered in other departments.

15 units, Aut, Win, Spr (Staff) M 4:15-6:05 or T 7:30-9:30 p.m.

See also Senior Colloquia.

INTERNATIONAL RELATIONS
Program

Director: James T. Watkins IV

The Program in International Relations is designed to serve two purposes: (1) to provide an undergraduate major for students interested in the whole field of international relations; and (2) to provide professional preparation for students expecting to enter one of the fields of work in international relations. Professional occupations exist in governmental service, in international agencies, in business and commercial activities, in the work of foundations and charitable institutions, and in teaching.

The program leads to the degree of Bachelor of Arts, Political Science: International Relations. Candidates for the degree of Bachelor of Arts, with professional interests, are especially urged to consult promptly with the faculty advisers to whom they will be assigned.

Attention of officers in the Institute of International Relations is directed to the opportunities available in Political Science 99.

BACHELOR OF ARTS IN POLITICAL SCIENCE:
INTERNATIONAL RELATIONS

The minimum requirements for recommendation for the degree of Bachelor of Arts with Political Science: International Relations as the major subject are:

1. Registration in this major for at least one quarter, and a minimum of 25 units taken at Stanford in fulfillment of the major requirements.
2. Completion of the following requirements with a C average.
   a) The required courses:
      Economics 1. Elementary Economics
      History 31. Europe in the Nineteenth Century
      History 32. Twentieth Century Europe
      History 154. American Diplomatic History to 1898
      or
      History 155. American Diplomatic History Since 1898
      Political Science 10. American Government
      Political Science 20. Introduction to Comparative Government and Politics
      Political Science 100. Introduction to Public Administration
      Political Science 137. The United Nations and Its Antecedents
      Political Science 150. Introduction to the History of Political Thought
      (each to be taken for 5 units)
   b) Twenty additional units (of which ten must be in political science) of appropriate courses or seminars in anthropology, communication, economics, geography, history, modern European languages, political science, or other fields.

PSYCHOLOGY

Emeriti: Paul R. Farnsworth, Maud Merrill James, Quinn McNemar, Lois Meek Stolz
(Professors)

Executive Head: Albert H. Hastorf

Associate Professors: Edith M. Dowley (Director, The Bing Nursery School), Jonathan L. Freedman, Leo Ganz, Leonard M. Horowitz
Assistant Professors: J. Merrill Carlsmith, P. James Geiwitz, Charles R. Hamilton, Thomas K. Landauer, William C. Ward

LABORATORIES
Aside from lecture and seminar rooms and offices, the Department has well-equipped laboratories comprising some 50 rooms which are adapted to research and laboratory course work. Special facilities are available, in addition to the general laboratory, for experimentation with animals.

THE BING NURSERY SCHOOL
The Department maintains a nursery school in the Escondido married students' housing area. This provides a laboratory for child observation, for training in nursery school practice, and for research.

SUMMER SESSION
The courses announced for the Summer Session are those regularly scheduled in the Department curriculum. Additional courses may be announced in the Summer Session Bulletin, to be issued in February, 1969.

PROGRAMS OF STUDY

BACHELOR OF ARTS
For the Bachelor's degree, 45 units of psychology are required, including courses 1, 60, and one laboratory course from among 103A, 103B, 103C, 103D, and 103E. The following courses in other fields allied to psychology may be counted as fulfilling up to 10 of the nonlaboratory units for the degree.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropology 126.</td>
<td>Cultural Changes</td>
<td>4</td>
</tr>
<tr>
<td>Anthropology 158.</td>
<td>Culture and Personality</td>
<td>4</td>
</tr>
<tr>
<td>Biology 153.</td>
<td>The Physiological Basis of Behavior</td>
<td>3</td>
</tr>
<tr>
<td>Communication 70.</td>
<td>Introduction to Survey Research</td>
<td>3</td>
</tr>
<tr>
<td>Computer Science. Any course(s); up to a total of 6 units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statistics 27.</td>
<td>Introduction to Probability Theory</td>
<td>3</td>
</tr>
<tr>
<td>Statistics 116 (Math. 123 or Econ. 270). Theory of Probability</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Philosophy 3.</td>
<td>Introduction to Logic</td>
<td>5</td>
</tr>
<tr>
<td>Sociology 103.</td>
<td>Introduction to Social Psychology</td>
<td>5</td>
</tr>
<tr>
<td>Sociology 104.</td>
<td>Interpersonal Behavior</td>
<td>5</td>
</tr>
</tbody>
</table>

A student must have an average grade of C or better for his work in psychology and have taken at least 15 units in the department in order to receive the Departmental recommendation for graduation.

A Psychology Honors Program is designed for those exceptionally able students who wish, in their major, to pursue an intensive and somewhat independent study of psychology, and to engage in psychological research. It is directed toward the integrating of a substantial body of theoretical and factual information, and the development of creative scholarly skills, by independent study, small seminars, and extended research experience. Particular emphasis is laid on the planning of an individual program for the student that will combine his specialized interests with the body of basic general psychology essential for all students who are undertaking their first two years of concentrated study in the field. The plan will include arrangements for continuous supervised research activity from the beginning of the student's junior year until the end of the winter quarter of his senior year, at which time he will submit a written report of his work as a thesis.

ADVANCED DEGREES
An applicant for admission to graduate work must file a report of his scores (aptitude and advanced psychology) on the Graduate Record Examination as part of his application. This examination may be taken at most American colleges (see your registrar for further information). Admission to the training program is strictly limited. Except for students also enrolled in the Medical School or the Graduate School of Business, no student will be accepted who does not plan to continue through to the doctorate. The taking of the degree of Master of Arts is optional. It is contrary to the policy of the Department to accept candidates for an advanced degree who have reached the age of 40. A Stanford graduate is ordinarily not accepted for an advanced degree in the Department of Psychology unless he is also registered in the Medical School or the Graduate School of Business.

MASTER OF ARTS
For the degree of Master of Arts, at least 27 units in psychology beyond the equivalent of an undergraduate major are required
as well as sufficient additional units outside of psychology to make up a program totaling 45 or more units. In partial fulfillment of this unit requirement Psychology 151, 152, and 207 must be elected as well as two other courses from the content areas, one to be selected from 208, 209, and 210, and one to be selected from 211, 212, and 213. The student is normally expected to spend one-half of his time in research and must present a thesis based on a portion of his research. He will normally take no more than 9 units of course work each quarter.

Doctor of Philosophy

In addition to fulfilling the residence requirement for the degree, the following requirements are stipulated:

1. The course requirements mentioned above, in connection with the Master's degree, must be met by all candidates for the doctorate. These requirements should normally be met by all graduate students during their first year of graduate work. If a student already has a Master's degree in psychology from another institution, he must present evidence of his competence in these course areas during his first year at Stanford. This may be done either by examination or by taking the courses.

2. A written examination must be completed by the end of the second year of graduate work. Part or all of this examination may, at the student's option, be taken at the end of the first year. The written examination shall include a special field examination which will normally be one of the following: developmental psychology, learning, perception, personality and psychopathology, physiological psychology, and social psychology. The student will also select three others of the above to be covered in a more general examination.

3. Completion of a university minor, or its equivalent, satisfactory to the University Committee on the Graduate Division. Candidates for the Ph.D. degree may have the minor waived by selecting 12 approved units outside the Department and additional work in general psychology.

4. Demonstrated reading knowledge of a foreign language, preferably Russian, German, or French. Upon petition to the Department faculty another modern language may be substituted for one of these.

5. Passing of the University oral examination which will cover the relevant literature to the student's doctoral research and a defense of the dissertation proposal.

6. A dissertation satisfactory to a Departmental reading committee. The minimum membership of this committee is to be (1) the principal dissertation adviser; (2) a second member from within the Department; and (3) a third member chosen from either Psychology or another department.

Ph.D. candidacy expires five years after admission to candidacy by the University Committee on the Graduate Division. Re-application will require Departmental re-examination.

Minor for the Degree of Doctor of Philosophy—Candidates for the degree of Doctor of Philosophy in other departments who elect a minor in psychology will be expected to complete the equivalent of an A.B. in psychology, of which at least 15 units must be taken as a graduate student at Stanford. Of these 15 units in the Department at least two courses must be from those numbered 200 or above. The program to be followed will be adapted to the needs of each candidate and will be under the direction of the Department's Committee on Minors.

The Doctoral Training Program

As indicated by the examination requirements described above, a student may concentrate in any one of several areas within psychology. Regardless of area, however, the training program places emphasis on the development of research competence, and students are encouraged to develop those skills and attitudes which are appropriate to a career of continuing research productivity.

Two kinds of experience are necessary for this purpose. One involves the learning of substantial amounts of technical information. A number of courses, seminars, and reading lists are provided to assist in this learning, and a student is expected to work out a program, with his adviser, that will permit him to secure such knowledge in the most stimulating and economical fashion. Beyond the first-year graduate courses mentioned above, there are no required courses for any of the areas of concentration. The
curriculum has been designed to offer as much help as possible for such learning, of course, and a glance at the list of courses and seminars available will suggest some of the help that may be gained in preparation for the doctoral examinations.

A second aspect of training is one that cannot be gained from reading or seminars. This is the firsthand knowledge of, and practical experience with, the methods of psychological investigation and study. These methods do not exist in the abstract; they are ways of behaving with the people or animals who are being studied. They are skills, and they require guided practice for their perfection. Again, however, as with formal courses, there are no specific requirements; students are provided with whatever opportunities they need to reach those levels of competence representative of doctoral standing. Continuing research programs, sponsored by members of the faculty, offer direct opportunities for experience in the fields represented by the faculty’s several research interests.

Each student will achieve competence in somewhat unique ways and at a somewhat unique rate. Each student and his adviser share in planning a program which will lead to the objectives discussed.

**Fellowships and Assistantships**

The Dr. C. Annette Buckel Foundation, supplemented by additional support from the Board of Trustees of the University, has provided a teaching assistantship in child psychology and the University provides several fellowships and scholarships. The Thomas Welton Stanford Fellowship in Psychic Research is a postdoctoral fellowship for research in psychic phenomena, established by the Trustees, in 1913, from the "Psychic Fund" created by Thomas Welton Stanford. There are teaching assistantships in general and experimental psychology, statistics, social psychology, personality and psychopathology, developmental psychology, and the nursery school. A number of research assistantships are available in connection with faculty research. United States Public Health Service, National Science Foundation, and National Defense Education Act stipends, and Veterans Administration assistantships are available.

**Courses Open to All Students**

### #1. General Psychology — Introduction, survey.

- 5 units, Aut (Carlsmith, Landauer)  
  MWF 11 and sections
- Win (Hilgard, Pribram)  
  MWF 5 and sections
- Spr (Atkinson) MWF 10 and sections

4 to 5 units, Sum (——) MWF 9

### #60. Statistical Methods.

- 5 units, Aut (Horowitz) MWF 10
- Win (——) MWF 11
- Spr (Lawrence) MWF 9

4 to 5 units, Sum (——) MWF 9

### 103B. Experimental Psychology: Perception—Prerequisites: 1 and 60.

- 4 units, Spr (——) MWF 3:15 and three hours by arrangement

### 103C. Experimental Psychology: Learning—Prerequisites: 1 and 60.

- 4 units, Aut (Lawrence) MWF 3:15 and three hours by arrangement

### 103D. Experimental Psychology: Personality and Interpersonal Processes—Prerequisites: 1 and 60.

- 4 units, Aut (Geiwitz) MWF 11 and three hours by arrangement

### 103E. Experimental Psychology: Social—Prerequisites: 1 and 60, and prior or concurrent enrollment in 121.

- 2 to 3 units, Win (Carlsmith, Freedman)
  T 11 and Th 2:15-4:05

### 104. Special Laboratory Projects — Prerequisites: 103A, 103B, 103C, 103D, or 103E, and consent of instructor.

- 3 to 6 units, each quarter (Staff)
  by arrangement

### 111. Developmental Psychology—Prerequisite: 1 or equivalent.

- 4 units, Aut (Maccoby) MWF 9

### 112. Development in Middle Childhood—(Enroll in Education 116.) Prerequisite: 111.

- 4 units, Win (——) MWF 9 and one 3-hour block by arrangement

### 113. Adolescent Development — Prerequisite: 1 or equivalent.

- 3 units, Sum (——) MWF 1:15
114. Exceptional Children — The study of children with deviant patterns of development; includes gifted, retarded, sensory defects, emotional problems. Prerequisite: 111.
3 units, Spr (Ward) MWF 2:15

117. Observation of Children—Enrollment limited to 16. Prerequisites: 111 or equivalent, and permission of instructor.
3 to 5 units, Aut, Win (Dowley)
Th 2:15-4:05 and by arrangement

118. Nursery School Practice — Supervised experience with the nursery school child. Prerequisites: 111, 117, and permission of instructor.
3 to 5 units, Win, Spr (Dowley)
T 2:15-4:05 and by arrangement

119. The Psychology of Human Nature — Considers whether and what generalizations concerning the nature of man can be made with evidence from the study of human evolution, comparative psychology, cross-cultural comparisons, and basic findings of experimental psychology.
3 units, Spr (Landauer) by arrangement

121. Social Psychology—Prerequisite: 1 or equivalent.
4 units, Win (Freedman, Carlsmith)
MWF 11

131. Abnormal Psychology—Psychopathology and behavior deviations. Concepts and theories regarding these conditions. Prerequisites: 1 and at least second-year standing.
4 units, Aut (——) MWF 11
Spr (Mischel) MWF 1:15

132. Personality—Prerequisite: 1 or equivalent.
4 units, Win (Sanford) MWF 10 and by arrangement

134. Dynamic Psychology — Emphasis on psychoanalytic theories and their derivatives. Prerequisites: 131 and senior or graduate standing.
4 units, Spr (Hilgard) TTh 9-11

141. History of Psychology—Prerequisites: three courses in psychology and junior standing.
3 units, Spr (Hastorf) TTh 11:00-12:20

145. Psychological Foundations of Education — (Same as Education 215.) Introductory course in application of psychological principles to educational practices. Prerequisite: 1 or equivalent.
4 units, Aut (Gage) MTWTh 9
Sum (——) MTWTh 9 and by arrangement

146. Language and Thought—Prerequisite: 1 or equivalent.
3 units, Aut (Ward) MWF 1:15

147. Comparative Psychology — Prerequisite: 1 or equivalent.
3 units, Aut (Hamilton) MWF 10

148. Physiological Psychology — Prerequisites: 1 and a course in zoology or physiology.
3 units, Win (Pribram) MWF 9

151. Statistical Methodology—Prerequisite: 60 or equivalent.
3 units, Win (Horowitz) MWF 10

152. Analysis of Data—Prerequisite: 151 or permission of instructor.
3 units, Spr (Carlsmith) MWF 10

155. Human Abilities—(Same as Education 255.) The nature, development, and measurement of intellectual abilities. Prerequisites: 1 and 60.
3 units, Spr (Cronbach) by arrangement, alternate years, given 1969–70

162. Mathematical Learning Theory I — Prerequisites: 1 and 60 or equivalent.
3 units, Aut (Bower) MWF 11

163. Mathematical Learning Theory II — Prerequisites: 1 and 60 or equivalent.
3 units, Win (Atkinson) MWF 11

164. Mathematical Psychology — Prerequisites: 1 and 60, or equivalent.
3 units, Spr (——) MWF 11

181. Honors Seminar (Junior)—Limited to students in the Psychology Honors Program.
3 units, Aut, Win, Spr (Freedman) by arrangement

182. Honors Seminar (Senior)—Limited to students in the Psychology Honors Program.
3 units, Aut, Win, Spr (Freedman) by arrangement

188. Reading and Special Work — Independent study. Prerequisite: permission of instructor.
1 to 3 units, each quarter (Staff) by arrangement
190. Undergraduate Seminar in Psycholinguistics—Primarily intended for majors in psychology. Prerequisite: permission of instructor.

3 units, Aut (——) by arrangement

191. Undergraduate Seminar in Behavior Change—Application of social learning principles to the modification of prosocial and deviant behavior. Primarily intended for majors in psychology. Prerequisite: permission of instructor.

3 units, Spr (Bandura) M 2:15-4:05

192. Undergraduate Seminar in the Physiological Basis of Perception—Primarily intended for majors in psychology. Prerequisite: permission of instructor.

3 units, Win (Ganz) by arrangement

193. Undergraduate Seminar in Social Psychology—Primarily intended for majors in psychology. Prerequisite: permission of instructor.

3 units, Spr (——) by arrangement

194. Undergraduate Seminar in Developmental Psychology—Primarily intended for majors in psychology. Prerequisite: permission of instructor.

3 units, Spr (Maccoby) by arrangement

195. Undergraduate Seminar in Personality—Primarily intended for majors in psychology. Prerequisite: permission of instructor.

3 units, Win (Geiwitz) by arrangement

196. Undergraduate Seminar in Psychological Psychology—See 268A and 268B.

197. Undergraduate Seminar in Learning—Primarily intended for majors in psychology. Prerequisite: permission of instructor.

3 units, Win (Ganz) by arrangement

198. Undergraduate Seminar in Research in Hypnosis—Primarily intended for majors in psychology. Prerequisite: permission of instructor.

3 units, Spr (——) by arrangement

See also Senior Colloquia.

COURSES PRIMARILY FOR GRADUATE STUDENTS

Undergraduate students may be admitted only by special permission.

207. Contemporary Viewpoints in Psychology—A survey of major issues in contemporary psychology with their historical backgrounds. Required of and limited to first-year graduate students in psychology.

2 to 3 units, Aut (Hilgard, Hastorf) TTh 11:00-12:20

208. Advanced Physiological Psychology—Lectures in psychobiology with optional laboratory work. Prerequisites: graduate standing in psychology, or undergraduates having completed 148 or Biology 153.

2 to 4 units, Spr (Hamilton, Landauer) by arrangement

209. Advanced Perception—Prerequisite: graduate standing in psychology or permission of instructor.

2 to 3 units, Aut (Ganz) by arrangement

210. Advanced Learning—Prerequisite: graduate standing in psychology or permission of instructor.

2 to 3 units, Win (Lawrence) by arrangement

211. Advanced Developmental Psychology—Prerequisite: graduate standing in psychology or permission of instructor.

2 to 3 units, Win (Maccoby, Ward) by arrangement

212. Advanced Social Psychology—Prerequisite: graduate standing in psychology or permission of instructor.

2 to 3 units, Spr (Freedman) by arrangement

213. Advanced Personality—Prerequisite: graduate standing in psychology or permission of instructor.

2 to 3 units, Aut (Mischel) by arrangement

220. Human Motivation—Limited to graduate students in psychology and related fields.

2 to 3 units, Win (Hilgard) TTh 11

221A. Small Groups I: Group Theory—(Enroll in Business 475.) Prerequisite: permission of instructor.

4 units, Aut (Leavitt) by arrangement

221B. Small Groups II: Experimental Small Group Research—(Enroll in Business 476.) Prerequisite: permission of instructor.

4 units, Win (Bavelas) by arrangement

222. Mathematical Theories of Perception—Prerequisite: permission of instructor.

3 units, Spr (——) by arrangement
224. Computer Simulation of Cognitive Processes—(Enroll in Computer Science 224.) Information-processing models of learning, problem solving, pattern recognition, etc., using computer simulation methods and list-processing languages. Prerequisite: 238, or demonstrable knowledge of LISP language obtained through LISP short courses or otherwise.

3 units, Win (Colby, Feigenbaum) by arrangement

226. Seminar in Stress and Behavior—Prerequisites: 208 or 148, and permission of instructor.

2 to 3 units, Spr (Levine) by arrangement

246. Methods in Developmental Research—Prerequisite: permission of instructors.

4 units, Spr (Sears, Maccoby, Dowley, Landauer, Ward) by arrangement

248. Introduction to Test Theory—(Enroll in Education 252.)

3 to 4 units, Aut (Johnson) MW 2:15–4:05, alternate years, given 1969–70

249. Problems in Measurement—(Enroll in Education 353.) For prospective research workers. Survey of alternative mathematical models used in test construction and analysis covering such topics as profile analysis, measurement of gains, factor analysis, theory of personal decisions. Prerequisites: Education 250B and 252, or equivalent.

3 to 4 units, Aut (Cronbach) MW 2:15–4:05, alternate years, given 1968–69

251. Seminar in Personality Theory and Assessment—Prerequisite: graduate standing in psychology or permission of instructor.

2 to 3 units, Win (Mischel) by arrangement

252. Interpersonal Processes—Prerequisite: graduate standing in psychology or permission of instructor.

2 to 3 units, Spr (Geiwitz) by arrangement

253. Psychopathology—Prerequisite: graduate standing in psychology or permission of instructor.

3 units, Win (Bandura, Mischel) by arrangement

254. Principles of Personality Change I—Prerequisite: graduate standing in psychology or permission of instructor.

3 units, Aut (Bandura) M 10–12

255. Principles of Personality Change II—Prerequisites: graduate standing and permission of instructor.

3 units, Win (Bandura) M 2:15–4:05

256. Personality Development—Prerequisites: graduate standing and permission of instructor.

2 to 3 units, Spr (Sears) by arrangement

257. Individually Supervised Practicum—Prerequisites: graduate standing and permission of instructor.

3 to 5 units, Aut, Win, Spr (——) by arrangement

258. Child Research Practicum—Prerequisites: 117 and permission of instructor.

3 to 4 units, Win (Dowley) TTh 1:15, given 1969–70

261. Seminar in Social Psychology—Prerequisite: permission of instructor.

2 to 3 units, Win (Carlsmith, Freedman) by arrangement

262. Seminar in Verbal Behavior—Prerequisite: permission of instructor.

2 to 3 units, Spr (Horowitz) TTh 10

263. Seminar in Perception—Prerequisite: permission of instructor.

2 to 3 units, Spr (Ganz) by arrangement

264. Seminar in Learning Theory—Prerequisite: permission of instructor.

2 to 3 units, Win (Bower) by arrangement

265A. Seminar in Mathematical Psychology I—Prerequisite: permission of instructor.

2 to 3 units, Aut (Atkinson) by arrangement

265B. Seminar in Mathematical Psychology II—Prerequisite: permission of instructor.

2 to 3 units, Win (——) by arrangement

265C. Seminar in Mathematical Psychology III—Prerequisite: permission of instructor.

2 to 3 units, Spr (Bower) by arrangement

266. Seminar in Developmental Psychology—Prerequisite: permission of instructor.

2 to 3 units, Spr (Ward) by arrangement
267. Seminar in Person Perception — Pre-requisite: permission of instructor.
    2 to 3 units, Win (Hastorf) by arrangement

268A. Seminar in Physiological Psychology I — Advanced topics. Graduate or undergraduate standing. Prerequisites: 208 or 148, and permission of instructor.
    2 to 3 units, Aut (Landauer) by arrangement

268B. Seminar in Physiological Psychology II—Special topics. Graduate or undergraduate standing. Prerequisites: 208 or 148, and permission of instructor.
    2 to 3 units, Win (Hamilton) by arrangement

269. Seminar in Personality—Prerequisite: permission of instructor.
    2 to 3 units, Aut (——) by arrangement

275. Research — Research of intermediate nature, whether or not to be used toward Master's thesis, may be undertaken with members of Department faculty.
    (Staff) by arrangement

276. Internship in Psychology — As part of training for advanced degrees in personality and experimental psychopathology, developmental psychology, arrangements are made for residence service in hospitals, penal institutions, and schools.
    5 to 15 units, each quarter (Staff) by arrangement

    (Staff) by arrangement

303. Research Seminar in Hypnosis — Primarily for graduate students doing research within hypnosis and related areas. Prerequisite: permission of instructor.
    1 to 3 units, Aut, Win, Spr (E. Hilgard, J. Hilgard) F 4:15-5:30

304. Research Seminar in Neuropsychology — Prerequisite: permission of instructor.
    1 to 3 units, Aut, Win, Spr (Pribram) Th 12-2

Seminar in Educational Psychology — See Education 415.

The Biochemistry of Behavior—See Psychiatry 9.
In addition to the 35 units mentioned above, students not enrolled in the Honors program in Humanities (for a description see "Humanities Special Programs" in this bulletin) are to select with the help of their adviser a minimum of three general courses (9 units) in support of their major program.

**Master of Arts: Russian**

No student is accepted for candidacy for the degree of Master of Arts unless he has completed the equivalent of the training represented by the requirements for the A.B. degree. Students intending to work toward the Ph.D. degree are required to pass the reading examination in either French or German during their first year of graduate studies. There are no examinations for the Master of Arts degree; a thesis, however, is required.

**Requirements:**

1. The following courses (or their equivalents) are part of the basic Master of Arts program: Phonology, Syntax and Lexicology (196, 197); Old Church Slavonic (211, 212); History of Russian Language (213); Russian Literature to the Nineteenth Century (189); Studies in Russian Fiction (193, 194); Graduate Seminar (300); Thesis (299).

2. Each student shall, in addition, choose with the approval of his adviser a number of electives sufficient to bring the total to 44 units.

**Doctor of Philosophy: Slavic**

Candidates are not obliged to present a minor but they are urged to offer one. A minor in a second language is strongly recommended. If it is in French, German, or Spanish, it should be equivalent to the course requirements for the degree of Master of Arts.

**Candidacy**—Candidates should read carefully the general regulations governing the conferring of this degree, as described in the section "Degrees" in this bulletin. For specific Departmental requirements and recommendations, the student should consult with his adviser. No student is accepted as a candidate until he has completed the equivalent of the training represented by the requirements for the Master of Arts degree as described above.

**General Requirements**—All candidates, regardless of their field of specialization, are expected to fulfill these requirements:

1. Have a reading knowledge of French and German, to be demonstrated by passing an examination.

2. Write a dissertation that embodies such results of research as would merit publication.

3. Pass written and oral examinations along the following lines:
   a) The principles of general and descriptive linguistics and the outlines of the history of the Russian language in its relationship to the development of the other Slavic languages.
   b) The history of Russian literature including its relationship to the development of other Slavic literatures, or of European literature; or to Russian intellectual history.
   c) The essentials of the political and cultural history of the Slavic world.

4. Prove, by examination, that they can write and speak Russian correctly.

**Specialization**—Candidates in Slavic Languages and Literatures specialize either in linguistics or literature. Once the basic requirements for the Master of Arts degree have been satisfied, candidates may draw up individual programs of study and research in consultation with the graduate adviser. Minimal language requirements (along with others) will thus vary according to the nature of the specialized program requested.

**Course Work**—Candidates for the Ph.D. degree should arrange their course work in such a way as to fulfill all requirements for their major and minor within nine quarters after receiving the A.B. degree. This can be done by enrolling for a minimum of 12 units per quarter. Candidates who enroll for less must expect a corresponding delay.

**General Courses (A)**

When registering, students are advised to prefix the identifying letter A to the course number.


4 units, Aut (Nordby) MWF 10
#146. Russian Literature of the Twentieth Century—Major emphasis on the novel. Readings in English.
4 units, Win (Whittaker) MWF 10

#149. Introduction to the Culture and Literature of the Slavic Peoples.—No foreign language required.
4 units, Aut (Stahlberger) alternate years, given 1969–70

#151. Dostoevsky—A reading of the major works in English translation. Open to all students except freshmen.
4 units, Aut (Fanger) alternate years, given 1969–70

#152. Balzac, Dickens, Dostoevsky.
4 units, Win (Fanger) alternate years, given 1969–70

#153. Leo Tolstoy—Chief works of fiction in English translation. Open to all students except freshmen.
4 units, Win (Stahlberger) every three years, given 1969–70

SLAVIC AND RUSSIAN COURSES
FIRST- AND SECOND-YEAR
(Under the direction of Joseph A. Van Campen)

POLISH
15. Elementary Polish—An intensive grammar course, with emphasis on rapid acquisition of the essentials for a reading knowledge of the language.
4 units, Aut (Szwede) MTWThF 8

16. Intermediate Polish — Introduction to the reading of prose texts. Prerequisite: 15 or equivalent.
4 units, Win (Szwede) MTWThF 8

17. Advanced Polish — Reading of prose texts. Prerequisite: 16 or equivalent.
4 units, Spr (Szwede) MTWThF 8

SERBO-CROATIAN
18. Beginning Serbo-Croatian — An intensive grammar course, with emphasis on rapid acquisition of the essentials for a reading knowledge of the language.
4 units, Aut (——) alternate years, given 1969–70

19. Intermediate Serbo-Croatian — Introduction to the reading of prose texts. Prerequisite: 18 or equivalent.
4 units, Win (——) alternate years, given 1969–70

20. Advanced Serbo-Croatian—Reading of prose texts. Prerequisite: 19 or equivalent.
4 units, Spr (——) alternate years, given 1969–70

RUSSIAN

#1. First-Year Russian.
5 units, Aut (Staff)

#2. First-Year Russian—Continuation of 1.
5 units, Win (Staff)

#3. First-Year Russian—Continuation of 2.
5 units, Spr (Staff)

5. Intensive First-Year Russian — Equivalent to 1, 2, and 3 combined. Enrollment limited. Consent of instructor necessary.
12 units, Sum (Staff) MTWThF 8:00–9:30, 10:30–12:00, and W 2:15–4:05

10. Elementary Russian — Accelerated course for beginners, particularly for those seeking to fulfill the University requirement of a reading knowledge for the Ph.D. degree. Open to senior, graduate students only. No auditors permitted.
4 units, Win (Skarginsky) MTWTh 8
Sum (Staff) MTWThF 8

11. Readings in Russian — Training in the reading and translation of texts. May be repeated for credit. Prerequisite: 10 or equivalent. No auditors permitted.
3 units, Aut, Spr (Skarginsky) TWTh 8

35. Intensive Second-Year Russian.
12 units, Sum (Staff) MTWThF 8:00–9:30, 10:30–12:00, and W 2:15–4:05

#52. Second-Year Russian.
5 units, Aut (Staff) MTWThF 12:00 or 1:15

#53. Second-Year Russian — Continuation of 52. Satisfies General Studies requirement under C. Prerequisite: 52.
5 units, Win (Staff) MTWThF 12:00 or 1:15

#54. Second-Year Russian — Continuation of 53. Prerequisite: 53.
5 units, Spr (Staff) MTWThF 12:00 or 1:15
THIRD YEAR

111. Third-Year Russian Conversation and Composition — Prerequisite: 54 or equivalent.
   3 units, Aut (Whittaker) MWF 9

112. Third-Year Russian Conversation and Composition — Continuation of 111.
   3 units, Win (Whittaker) MWF 9

113. Third-Year Russian Conversation and Composition — Continuation of 112.
   3 units, Spr (Whittaker) MWF 9

#147. Russian Nineteenth-Century Prose — Discussion of selected problems, based on readings in Russian. This course must be taken concurrently with General Course 145.
   1 unit, Aut (Nordby) by arrangement

#148. Russian Twentieth-Century Prose — Discussion of selected problems, based on readings in Russian. This course must be taken concurrently with General Course 146.
   1 unit, Win (Whittaker) by arrangement

ADVANCED AND GRADUATE

#184. The Russian Short Story — Conducted in Russian. Prerequisite: 113 or equivalent.
   4 units, Aut (Pashin) MTWTh 1:15

#185. The Russian Novella — Conducted in Russian. Prerequisite: 113 or equivalent.
   4 units, Win (Pashin) TTh 3:45–5:05

#186. The Russian Drama — Conducted in Russian. Prerequisite: 113 or equivalent.
   4 units, Spr (Nordby) TTh 3:45–5:05

#187. Russian Poetry of the Nineteenth Century — A survey of the major figures and movements.
   4 units, Win (Stahlberger) MWF 1:15

#188. Russian Poetry of the Twentieth Century — A survey of the major figures and movements.
   4 units, Spr (Stahlberger) MWF 1:15

#189. Russian Literature from the Eleventh to the Eighteenth Century.
   4 units, Spr (Stahlberger) MTWTh 9

#191. Russian Literary Criticism — Emphasis will be on major nineteenth-century texts. Lectures in Russian; written work may be in English.
   3 units, Aut (Pashin) TTh 2:15–3:35

#192. Russian Literary Criticism — Continuation of 191.
   3 units, Win (Pashin) given 1969–70

#193. Studies in Russian Fiction: The Age of Realism — The development of realism over the first two-thirds of the nineteenth century, with special attention to the evolution of the literary language and problems of genre, as well as to social and philosophical background, both Russian and European.
   4 units, Aut (Whittaker) MWF 11

   4 units, Spr (Fanger) given 1969–70

#195. Russian Pronunciation — Problems of theoretical and applied phonology. Prerequisite: 54 or equivalent.
   3 units, Aut (Pashin) TTh 3:45–5:05

#196. Russian Syntax and Lexicology — Introduction to problems of advanced grammar and usage.
   3 units, Spr (Pashin) TTh 2:15–3:35

#197. Russian Poetry of the Twentieth Century — A continuation of 193.
   4 units, Spr (Whittaker) TTh 2:15–3:35

#198. Russian Literary Criticism — Conducted in Russian.
   3 units, Win (Pashin) TTh 2:15–3:35

#199. Individual Work — Open to Russian majors or students working on special projects. May be repeated for credit.
   1 to 5 units, each quarter (Staff) by arrangement

GRADUATE COURSES IN SLAVIC LINGUISTICS AND LITERATURES

#200. Proseminar — Introduction to problems of literary and linguistic analysis and research in the Slavic field. Required of all entering graduate students.
   3 units, Aut (Staff) M 7:30–9:30 p.m.

#201. Synchronic Morphology of Russian (I): Conjugation.
   3 units, Aut (Van Campen) alternate years, given 1969–70

   3 units, Win (Van Campen) alternate years, given 1969–70

#203. Synchronic Morphology of Russian (III): Root Structure; Prefixation and Suffixation.
   3 units, Aut (Van Campen) alternate years, given 1969–70
211. Introduction to Old Church Slavonic.  
3 units, Aut (Van Campen) MWF 2:15

212. Advanced Old Church Slavonic—Pre-requisite: 211.  
3 units, Win (Van Campen) MWF 2:15

213. History of the Russian Language — Prerequisite: 212.  
3 units, Spr (Van Campen) MWF 3:15

228. Divergence of Slavic Languages.  
2 units, Spr (Van Campen) by arrangement

251. Examination of the Structure of Non-Russian Slavic Languages—Topic for 1968-69: Bulgarian.  
3 units, Aut (Van Campen) MWF 3:15

262. The Russian Chronicles.  
3 units, Spr (Stahlberger) every three years, given 1969-70

264. Russian Epic Tradition.  
2 units, Win (——) every three years, given 1969-70

271. Russian Literature of the Seventeenth and Eighteenth Centuries.  
3 units, Win (Stahlberger) MWF 11

272. Russian Symbolism.  
2 units, Aut (——) every three years, given 1969-70

277. Gogol.  
3 units, Win (Fanger) every three years, given 1969-70

278. Tolstoy.  
3 units, Spr (Whittaker) MWF 11

279. Dostoevsky.  
3 units, Spr (Fanger) every three years, given 1969-70

280. Comparative Slavic Literature of the Medieval Period.  
3 units, Aut (Stahlberger) every three years, given 1970-71

3 units, Aut (Stahlberger) MWF 9

289. Problems in the Theory and Practice of Translation — Conducted as a seminar. Prerequisites: 113 or equivalent, and permission of the director.  
2 units, Spr (Fanger, Pashin, Van Campen) alternate years, given 1969-70

290. Problems in the Theory and Practice of Teaching Russian—Conducted as a seminar.  
2 units, Spr (Van Campen and Staff) by arrangement

299. Individual Work — Exclusively for graduate students in Slavic working on thesis or engaged in special work.  
1 to 12 units, any quarter (Staff) by arrangement

300. Graduate Seminar in Literature—Subjects to be announced in Time Schedule.  
3 units, Aut (Stahlberger) by arrangement  
Spr (Nordby) by arrangement

SOCIAL SCIENCES  
(SPECIAL PROGRAM)

HONORS PROGRAM IN SOCIAL THOUGHT AND INSTITUTIONS

Committee in Charge: Charles Drekmeier (Chairman), Richard A. Brody, Robert McA. Brown, Margot Drekmeier, John G. Gurley, Mark Mancall

STATEMENT OF PURPOSE

The Honors Program in Social Thought and Institutions is designed to meet the needs of students wishing special preparation in areas of study which draw on the materials of two or more of the social science disciplines. It aims at a clearer understanding of the contributions the social sciences are able to make to one another and to a specific problem, an awareness of differences and agreements in their theoretical assumptions, and facilitation of communication among these disciplines. It seeks to combine rigorous training with the breadth of knowledge interdisciplinary study provides. The Program is administered by an interdepartmental committee.

ADMISSION TO THE PROGRAM

Students wishing admission to the program should provide evidence of superior academic achievement (at least a 3.00 average). It is recommended that application
be made in the last quarter of the sophomore year. Any member of the committee may be consulted regarding admission. (Mr. Drekmeier's office is in the Department of Political Science.)

Requirements

It is expected that most students will be able to fulfill the conditions of an undergraduate major; in some cases minor modifications of departmental requirements may be necessary. The student is required to take the interdisciplinary seminar series (Social Sciences 101, 102, 103) offered for 4 units each quarter, during his junior year. The seminar meets bi-weekly, at a professor’s home, and is organized around a particular theme or concept each year. In past years topics have included responsibility, freedom, utopia, change, self and community, and false consciousness. Approximately fifteen students are admitted to the junior seminar each year.

Members of the Program submit an honors thesis toward the end of the senior year which demonstrates the ability to synthesize and criticize materials drawn from several disciplines. A credit of from 5 to 15 units will be allowed for the thesis, and no more than 5 units may be taken in any single quarter. The student may also be required to take a senior seminar which will offer the opportunity for the discussion of problems arising in the research projects.

After the student’s plans for an honors thesis have been approved by the administrative committee, he will be assigned an adviser. In most cases the committee will arrange for the appointment of a second adviser in his major field.

Though the Honors Program is intended to supplement a regular departmental major, there may be areas of study which cannot be related to a department in this way. In such instances a major may be offered under the supervision of the committee and requirements for graduation will be determined by the committee in consultation with the student’s advisers. No more than two or three students will be accepted as majors in Social Thought and the usual expectation is that they will complete between seventy and eighty units of social science and philosophy courses by the time of graduation.

SPECIAL COURSES OF INSTRUCTION

101. Interdisciplinary Seminar — Designed to familiarize the student with philosophical and methodological problems of the social sciences.
   4 units, Aut (Staff) by arrangement

102. Interdisciplinary Seminar — Continuation of 101.
   4 units, Win (Staff) by arrangement

103. Interdisciplinary Seminar — Continuation of 102.
   4 units, Spr (Staff) by arrangement

193. Senior Thesis and Directed Reading.
   1 to 5 units, each quarter (+——) by arrangement

SOCIOLoGY

Emeriti: Richard T. LaPiere, Charles N. Reynolds (Professors)

Executive Head: Morris Zelditch, Jr.


Associate Professor: W. Richard Scott

Assistant Professors: C. Norman Alexander, Bo Anderson, J. Victor Baldridge, John W. Meyer

PROGRAMS OF STUDY

BACHELOR OF ARTS

The Bachelor of Arts degree, with a major in Sociology, may be obtained in one of two ways:

1. The Standard Major — If the student elects this program, he must take 45 units of sociology, in addition to basic University requirements. Introduction to Sociology, Introduction to Sociological Research, and Introduction to Sociological Theory are required of all majors, and, in addition, two courses must be selected from the remaining five courses in the Fundamental Program. The two courses from the Fundamental Program used to satisfy this requirement must be taken for 5 units of credit each. These requirements are designed to provide each major with a sound basis for further work in more specialized fields in sociology.
To be recommended for the degree the student must maintain an average grade of C or higher in the major field. Normally, students who expect to graduate as Sociology majors must be registered with the Department two full quarters prior to graduation.

2. The Honors Program — The Honors Program provides specialized training and research experience for those qualified students who wish to pursue independent study of sociology and to engage in sociological research. The Honors candidate will enjoy a close relationship with members of the Department through his participation in seminars and research projects. The program is designed to meet the needs of those students who wish to pursue particular interests in sociology, or those who have the interest and capacity for independent study and research, or those who intend to do graduate work in sociology or related fields. Students interested in the program should direct their inquiries to the undergraduate major advisers.

Honors students are not required to take a fixed number of units in sociology. Each student in the Honors Program will have a special adviser, but he may work with various staff members on individual or group projects during the junior and senior years. He will plan his academic program with the adviser to include Introduction to Sociological Research, a course in sociological theory, and a course in statistics. Honors students are exempt from prerequisites attached to courses at the discretion of the adviser and the course instructor, and may be admitted to graduate level courses. They are urged to take courses in related fields, such as anthropology, psychology, and philosophy.

Intensive work in the Honors Program will begin in the junior year, when the student will participate in Honors seminars. These seminars are devoted to an examination of basic problems in sociology. Late in the junior year or early in the senior year, each student in the Program will select a problem in sociology for intensive study. The problem selected should be tailored to the student's own interests and needs: it may entail the conducting of a basic scientific investigation with the gathering and analysis of empirical data; it may involve the re-analysis of materials collected in connection with some earlier study; it may involve a case study applying sociological principles to some particular social phenomenon; or it may be concerned with the investigation and refinement of some set of concepts or the work of some selected social theorist.

The student will be granted 2 units of credit for each quarter's participation in the seminar in the junior year and 10 units for the satisfactory completion of a thesis describing his investigations during the senior year.

To remain in the Honors Program, the student must maintain an average grade of B or better in all sociology courses. In the last quarter of the senior year, Honors students must pass a Comprehensive Examination in Sociology.

Master of Arts

Although it is desirable to have had undergraduate preparation in sociology, under special circumstances the Department will admit candidates for advanced degrees without such preparation. The Master of Arts degree is granted as a step toward eventual fulfillment of requirements for the Doctor of Philosophy degree. Ordinarily, the Department prefers not to admit students who are candidates solely for the A.M. degree.

To be recommended for the degree, the candidate must complete forty-five units of approved work, no units will count which do not have a grade of C or higher, and the student must receive an average grade of B or better. At least 30 of the 45 units must be received in courses offered by the Department.

Twelve of the required 45 units may be obtained by (1) completing a Master's Thesis, or (2) by participating in one of the formal research programs being conducted by a faculty member, collaborating in associated publications, or (3) by replicating a previous research study. For the latter two alternatives, the candidate is required to present to the Department a written report of article length and professional quality. The candidate must satisfactorily complete one of the three alternatives.
Doctor of Philosophy

The goal of training for the Ph.D. is the preparation of persons who may be expected to make significant contributions to the advancement of sociological knowledge. To be recommended to the University Committee on the Graduate Division for admission to candidacy for this degree, the student must satisfy the following requirements: (a) he must have a Master's degree in sociology, or the equivalent thereof in course work; (b) he must demonstrate to appropriate examiners his knowledge of a language other than English, which language is to be approved by the Department. Normally, this requirement will be satisfied no later than during the second year of graduate study.

All sociology graduate students must develop a thorough grounding in both sociological theory and research methods to provide a solid foundation for later specialization. To accomplish this, six graduate courses are required: Theory Construction, Advanced Social Statistics, Research Design, Logic of Social Research, Basic Problems in Sociological Theory, and Problems in Sociological Measurement. In addition, for students entering with a deficiency in statistics, Statistics 107, Psychology 60, Statistics 50 or some equivalent must be taken in the first quarter after entering.

Each candidate must select three fields within sociology as his areas of special competence, in consultation with the Director of Graduate Studies. He must pass written examinations in these fields in order to be certified for the University oral examination. Examples of such fields are Small Groups, Organizational Behavior, Institutional Structure, and the Sociology of Medicine. Sociological Theory or Research Methods may be offered as a field only when the candidate has an exceptional grasp of materials in the area for competence in both fields is assumed for all graduate students. The written examinations will ordinarily be given only within the first seven weeks of autumn and spring quarters.

After passing the University oral examination, the candidate must satisfactorily complete a doctoral dissertation. Members of the faculty are available to assist the candidate at each stage of his research in fulfilling the dissertation requirement.

The Master of Arts in Teaching Degree

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and wish further to strengthen their academic preparations. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education.

Teaching Assistantships and Fellowships

The University has a number of fellowships and scholarships available. Information about these, as well as application blanks, may be secured by writing the Office of Admissions.

In addition, the Department has annual teaching assistantships, traineeships in medical sociology, research assistantships, traineeships in mental health, and National Defense Education Fellowships for the support of its graduate students.

Courses Primarily for Undergraduates

#1. Introduction to Sociology—Basic concepts; theories; emphasizes group aspects of human behavior.

5 units, Aut (Dornbusch) MTWThF 11
Win (Meyer) MTWThF 1:15
Spr (Scott) MTWThF 11
Sum (—) MTWThF 11

7. Introduction to Statistics—(Enroll in Statistics 7.)

5 units, Aut (—) MTWThF 10

50. American Society — Basic institutions and problems of contemporary American society.

5 units, Spr (—) MWF 10

55. The Individual and Social Structure — The social formation of character in families, peer groups, schools, and places of work. The effects of social institutions, and their breakdown, on behavior. Readings in Freud, Mead, Durkheim, and modern empirical studies.

5 units, given 1969-70
100. Introduction to Sociological Research
Aim of this course is to provide the consumer of social research with standards by which to evaluate the findings of sociological studies; to present a critical analysis of some basic notions and theories used in sociological analysis. Lectures and laboratory exercises consider problems of collecting observations, constructing theory, testing hypotheses and generalizing research results. Required of all sociology majors.
5 units, Aut (Cohen) MW 11; lab. T, W, or Th 2:15–5:05

102. Basic Social Institutions — Study of how basic institutions such as the stratification system, the polity, the family, the economy and political order affect one another in Western and non-Western societies.
3 to 5 units, Win (Anderson) MWF 9

103. Introduction to Social Psychology — Review and discussion of current problems, theories, and research in social psychology; social perception, development of self-conceptions, socialization, attitude change.
5 units, Spr (Dornbusch) MWF 11

104. Interpersonal Behavior—An examination of research in such areas as power and prestige structures in small groups; communication networks and processes; deviance, conformity, and social control.
5 units, Aut (Berger) MWF 10

105. Organizational Behavior—An analysis of the structural characteristics of economic, political, educational and other organizations and their impact on individual participants. Prerequisite: 1 or consent of instructor.
3 to 5 units, Win (Scott) MTWThF 10

106. Introduction to Sociological Theory — Critical analysis of some basic notions and theories used in sociological analysis, like Heider’s balance theory, Homan’s theory of social behavior as an exchange process and structural-functional analysis.
5 units, Spr (——) MTWThF 11

108. Class, Status, and Power—Analysis of stratification in simple and complex groups and societies. General theories of stratification are analyzed and evaluated. Emphasis is placed on conditions affecting the stability of stratification.
5 units, Spr (——) MWF 1:15

OTHER COURSES OPEN TO UNDERGRADUATES AND GRADUATES

107. Introduction to Statistics—For graduate students. (Enroll in Statistics 107.)
4 units, Aut (——) MTWThF 10

110. Religious Institutions and Behavior—A sociological approach to organized religion, emphasizing the interaction between the church and its social setting.
5 units, given 1969–70

123. Political Institutions and Behavior—Empirical studies of political life, particularly in modern industrial societies, seen in the light of more general theoretical ideas.
3 or 5 units, Aut (Meyer) MWF 9

129. Family Institutions and Behavior — Social structure of the family in Western and non-Western societies; family pathologies.
5 units, Win (Wallin) MWF 1:15

130. Population Problems—(Same as Food Research 135.) Analysis of U.S. and world population growth. Economic and social causes and consequences of trends in births, deaths, and migration. Population in relation to food and development; population theories and policies; national family planning programs.
5 units, Win (Kirk) by arrangement

131. Advanced Social Psychology: Situational Identity and Social Behavior—A perspective on major problems in social psychology; reviewing and analyzing perspectives on personal behaviors in such areas as social perception, self-conceptions, social definitions of selves and situations, and the normative context of interaction.
5 units, Win (Alexander) TTh 1:15–2:45

137. Advanced Organizational Behavior—An examination of organization structures, of the social processes—specialization, authority, ranking, etc.—which modify them and of the levels at which such processes operate. Prerequisite: 105 or consent of instructor.
5 units, given 1969–70

145. Survey Methods—Training in the use of the questionnaire and the interview schedule for the systematic collection of
146. Field Methods—Training in the use of participant observation, informants' life histories, interview material, etc., for the study of sociological problems. Prerequisite: 100 or consent of instructor.

5 units, given 1969-70

147. Experiments in Social Interaction—Topics considered in this laboratory course include: formulation of an experimental problem, experimental design, problems of conducting and analyzing experiments. Discussion will be in the context of conducting an actual experiment. Prerequisite: 100 or consent of instructor.

5 units, Spr (- - -) by arrangement

149. Advanced Social Statistics—Prerequisite: 7 or consent of instructor.

5 units, Win (- - -) MWF 1:15; lab. by arrangement

151. Undergraduate Colloquium: The Concept of Status Politics—Reading and analysis of a number of interpretations which trace political movements, pressures, and protests to disturbance or change in the status structures of society. Open to graduates and undergraduates by permission of instructor. Prerequisite: concurrent or previous enrollment in 123.

3 or 5 units, Aut (Meyer) F 2-4

152. Undergraduate Colloquium: Practicum in Data Analysis—Students will gain practical experience in developing hypotheses and testing them on existing data in the fields of organization, social psychology, and religion. (Limited to 8 students.)

5 units, Aut (Dornbusch) M 2:15-5:05

153. Undergraduate Colloquium: Organizational Analysis—Open to a limited number of undergraduate students who wish to collectively pursue a topic in organizational analysis to be selected. Prerequisite: 105 or consent of instructor.

5 units, Spr (Scott) by arrangement

154. Undergraduate Colloquium—Consideration of some theoretical conceptions and analysis of some empirical data relating to social class.

5 units, Spr (Wallin) by arrangement

155. Undergraduate Colloquium—Topic to be announced.

5 units, Spr (Anderson) by arrangement

156A. Undergraduate Colloquium: Research on College Drinking Behavior—Readings on the social use of alcohol and formulation of a research problem to be investigated through secondary analysis of data on the drinking behaviors and attitudes toward alcohol of college students.

3 units, Win (Alexander) by arrangement

156B. Continuation of 156A.

3 units, Spr (Alexander) by arrangement

161. Advanced Interpersonal Behavior—A more intensive examination of topics covered in Sociology 104. Prerequisite: 104 or consent of instructor.

3 to 5 units, given 1969-70

162. Comparative Institutional Analysis—Cross-cultural approach to the study of institutions and social systems. Prerequisite: 102 or consent of instructor.

5 units, Spr (- - -) Th 2:15-5:05

165. Advanced Social Stratification—Analysis of stratification structures in complex social systems. Emphasis is placed on the formulation of theory relevant to problems of stability of stratification structures.

5 units, Spr (- - -) MWF 9

175. The Evolution of Underdeveloped Societies—A discussion of social, economic and political development of emergent countries.

5 units, given 1969-70

180. Honors Seminar—Basic readings in sociology and current faculty research.

2 units, Aut (Staff) by arrangement

181. Honors Seminar—Basic readings in sociology and current faculty research.

2 units, Win (Staff) by arrangement

182. Honors Seminar—Basic readings in sociology and current faculty research.

2 units, Spr (Staff) by arrangement

190. Individual Study.

(Staff) by arrangement

192. Senior Thesis.

3 to 10 units (Staff) by arrangement
COURSES PRIMARILY FOR GRADUATES

200A. Graduate Proseminar — Limited to first-year graduate students in sociology.
   2 units, Aut (Staff) by arrangement

200B. Graduate Proseminar—Continuation of 200A.
   2 units, Win (Staff) by arrangement

200C. Graduate Proseminar—Continuation of 200B.
   2 units, Spr (Staff) by arrangement

201. Introduction to Sociological Research — Graduate students attend lectures in 100, but have special laboratory sessions.
   5 units, Aut (Cohen) MW11, labs. by arrangement

203. Problems in Organizational Analysis.
   3 to 5 units, given 1969-70

204. Field Methods in the Study of Organizations.
   5 units, given 1969-70

210. Social Foundations of Education — (Same as Education 210.) Influence of social structure on schools, school systems; American cultural values and their influence on education; special problems of ethnic groups in American schools; school system as formal organization in mass society; case studies of teachers, administrators.
   4 units, Aut (——) MW 1:15-3:05

211. Research Problems in Sociology of Education—(Same as Education 310.)
   4 units, Spr (E. Cohen) MTWTh 10

217. Problems in Theoretical Analysis — Prerequisite: 253 and consent of instructor.
   5 units, Spr (Berger) T 2:15-5:05

   5 units, Spr (Kirk) MTWTh 9

231. Demography of the Developing Countries—(Same as Food Research 285.) The demographic position of the major regions in relation to their problems of economic and social development. Problems of population policy.
   3 units, Spr (Kirk) by arrangement

249. Research on the Organization and Effects of Educational Institutions — Prerequisite: consent of instructor.
   5 units, Win (Meyer) M 2:15-5:05

250. Basic Problems in Sociological Theory — Prerequisite: consent of instructor.
   5 units, Aut (——) T 2:15-5:05

253. Theory Construction — Prerequisite: consent of instructor.
   5 units, Win (Berger) T 2:15-5:05

255. Logic of Social Research—Practicum in the formulation and critical evaluation of research designs for the study of sociological problems. Prerequisites: 149 and 260.
   5 units, Aut (Wallin) M 2:15-5:05

260. Research Design—Prerequisite: 149.
   5 units, Spr (——) M 2:15-5:05

261. Data Analysis.
   5 units, Spr (Anderson) M 2:15-5:05

264. Seminar in Socialization and Social Control.
   4 to 5 units, given 1969-70

267. Problems of Sociological Measurement—Prerequisite: 149.
   5 units, Spr (Alexander) W 2:15-5:05

GRADUATE INDIVIDUAL STUDY

290. Graduate Individual Study.
   (Staff) by arrangement

296. Special Colloquia—On request of 3 or more students and consent of an instructor, a colloquium can be organized on some particular problem.
   (Staff) by arrangement

300. Graduate Research.
   (Staff) by arrangement

309. Directed Graduate Research.
   (Staff) by arrangement

   (Staff) by arrangement

331. Research in Social Psychology—Analysis and conceptualization of problems in an area of current research concern in social psychology. Formulation of a problem, specification of a design for its investigation, and exploratory data gathering. Prerequisite: 131 or equivalent and consent of instructor.
   5 units, Aut (Alexander) W 2:15-5:05

333. Selected Problems in Social Psychology.
   5 units, Win (Dornbusch) W 2:15-5:05
334. Topic to be announced.
5 units, Aut (Anderson) Th 7:30-10:30 p.m.

335. Authority and Power in Organizations
—Prerequisite: 105 or consent of instructor.
5 units, Aut (Scott) Th 2:15-5:05

336. Apprenticeship Research — Research will be carried out on a selected topic to provide some students with the basis for fulfilling the "apprenticeship" plan.
Spr (Wallin) by arrangement

SPANISH and PORTUGUESE

Emeriti: Juan B. Rael (Professor); Grace Knopp (Assistant Professor)
Executive Head: Bernard Gicovate
Professors: Fernando Alegría, Aurelio M. Espinosa, Bernard Gicovate, Ronald Hilton, Isabel M. Schevill
Assistant Professors: Gustavo Alfaro, Joaquim F. Coelho, Rubén A. Gamboa, Janice T. Geasler, Phillip Petersen, Luis Ponce de León

The Department of Spanish and Portuguese accepts candidates for the degree of Bachelor of Arts, Master of Arts in Spanish, and Doctor of Philosophy in Spanish, and for certification as high school and junior college teachers. Special consideration is given to the needs of those who intend to make teaching their profession.

PROGRAMS OF STUDY

Bachelor of Arts

Candidates are expected to complete a minimum of 42 units from courses in this Department numbered 100 or higher. Courses are to be selected with the guidance of the student's adviser. Language competence equivalent to Spanish 113 is required.

For students in the Honors Program in Humanities, up to six units of that program may be applied toward completion of the Spanish major.

Stanford Spanish Program in Madrid

 Majors in Spanish and allied disciplines may spend two quarters in Spain as participants in the Stanford Program at the University of Madrid. Students reside in residencias de estudiantes and attend courses both at the University and with the faculty supervisor who accompanies the group. Application forms may be obtained from the Department.

Intensive Summer Program

In cooperation with the United States Office of Education, Stanford University offers intensive study at various levels in both Spanish and Portuguese during the summer. Application forms for fellowships for this special program may be obtained from the Department.

Teaching Credentials

For information concerning the requirements for teaching credentials, consult the "School of Education" section of this bulletin and the Credential Secretary, School of Education.

Master of Arts in Teaching

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and who wish further to strengthen their academic preparation. The program consists of a minimum of 45 quarter units of graduate study, 36 of which must be completed at Stanford. A minimum of 25 units of courses taken must be in the teaching field and at least 12 units must consist of graduate courses in the School of Education at Stanford.

For general requirements, see School of Education, page 47.

Specific requirements:

<table>
<thead>
<tr>
<th>Components</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Study: Spanish 164, 165, 166, 170, 201, 202</td>
<td>19 units</td>
</tr>
<tr>
<td>Literature: Chosen from courses in Hispanic Literature or Civilization numbered from 180 up</td>
<td>10 units</td>
</tr>
<tr>
<td>Methods: Spanish 210</td>
<td>4 units</td>
</tr>
<tr>
<td>Courses in Education</td>
<td>12 units</td>
</tr>
<tr>
<td></td>
<td>45 units</td>
</tr>
</tbody>
</table>

Graduate Program in Humanities

The Department of Spanish and Portuguese participates in the Graduate Program in Humanities leading to a joint Ph.D. degree. For a description of that program and fellowships offered in connection with it, see the section "Humanities Special Programs" in this bulletin.
M A S T E R  O F  A R T S  I N  S P A N I S H

To be accepted as a candidate for the degree of Master of Arts in Spanish, a student needs to establish that he has completed creditably either an A.B. degree with a major in Spanish or an equivalent of this work. Stanford University requires a minimum residence of three full quarters before any degree can be granted. A student with graduate work taken at another university, in this country or abroad, is advised that this work will not reduce the three-quarter requirement; it will, however, if he continues his studies, shorten the time needed for completion of the Ph.D. degree. A total of 44 units is required for the Master of Arts degree of which 36 must be taken at Stanford. The Department requires a B average.

Requirements:
1. A reading knowledge of one foreign language other than Spanish or Portuguese.
2. 203. Advanced Grammar and Stylistics (3 units)—Prerequisite: 202 with grade of B or placement test.
3. 248 and 249 (4 units).
4. 7 units to be chosen from the following courses: 190, 197, 204, 205, 260, 261, 263, 264, 266.
5. 26 units of courses in Spanish or Portuguese above 180 chosen with the approval of the student's adviser, of which 6 units may be in related fields dealing with the area.
6. 299. Thesis (4 units) or a three-hour written examination in Hispanic Literature, Linguistics, and Civilization.

D O C T O R  O F  P H I L O S O P H Y  I N  S P A N I S H

Students should read carefully the University regulations governing the conferring of this degree as described in the section "Degrees" in this bulletin.

No student is accepted for candidacy unless he has completed the equivalent of the requirements for the Master of Arts degree in Spanish as described above.

Requirements — All candidates for the Ph.D. degree must fulfill the following requirements:
1. Have a reading knowledge of Latin, Portuguese, and one other foreign language. This knowledge must be demonstrated by examination.
2. Pass the final written examinations in the following fields:
   a) Philology and Linguistics, Medieval Literature and Civilization.
   b) Spanish Literature and Civilization from 1500 to the present.
   c) Spanish American Literature and Civilization.

Portuguese and Brazilian Literature and Civilization may be substituted for either b or c above.
3. Write a dissertation that embodies such results of research as would merit publication.
4. Pass a final University oral examination in defense of the dissertation.
5. Satisfactory teaching experience. Teaching assistantships are available to enable candidates to fulfill this requirement, which will be waived only in the case of students who have teaching experience in other institutions.
6. Ph.D. candidates, except those in the Graduate Humanities Program, are required to present no less than 18 units of graduate work in a related field chosen with the consent of the adviser.

G E N E R A L  C O U R S E S  ( A )

These courses are open to all students. When registering, students are advised to prefix the identifying letter A to the course number.

#75. Don Quixote in Translation—Reading, interpretation of Don Quixote.
   3 units, Win (Alfaro) MWF

150. Unamuno and Ortega — Present-day conflicts in literary works of Unamuno, Ortega y Gasset. Not open to Spanish majors.
   2 to 3 units, alternate years, given 1969-70

   3 units, Spr (Ponce de Leon) MWF

152. Lorca and Other Contemporary Spanish Dramatists in Translation — Modern trends, tensions as reflected in significant Spanish dramatists of present day. Not open to Spanish majors.
   3 units, Aut (Schevill) alternate years, given 1969-70
171, 172, 173. The Civilization of Spain and Latin America—Under the direction of the instructor, students select reading material describing the civilization, in any of its aspects, of Spain and Latin America or of an individual country or area. The course will be taught in English, but students wishing to complete the 4-unit reading requirement of the language sequence may satisfy the University foreign language requirement by reading in Spanish or Portuguese. Since the reading materials will change each quarter, the course may be repeated for credit.

3 units, Aut, Win, Spr (Hilton) MWF 10

SPANISH COURSES
FIRST- AND SECOND-YEAR
(Under the Direction of Professor Phillip Petersen)

Note—Students registering for the first time in a first- or second-year course must take a placement test if they have had any training in Spanish before entering Stanford.

#1. First-Year Spanish.
4 units, Aut, Win (Staff)

#2. First-Year Spanish—Continuation of 1.
4 units, Aut, Win, Spr (Staff)

#3. First-Year Spanish—Continuation of 2.
4 units, Aut, Win, Spr (Staff)

#5. Intensive First-Year Spanish—Offers preparation in comprehension, speaking, reading and writing the language. Since classes are limited to 15, applicants should consult the Division as soon as possible.

12 units, Sum (Staff) MTWThF 8:00-9:30 and 10:30-12:00 and one hour daily in the Language Laboratory by arrangement

10. Elementary Spanish — Accelerated course for beginners, particularly for those seeking to fulfill the University requirement of a reading knowledge for the Ph.D. degree. Open to seniors and graduate students only.
4 units, Spr (Staff) MTWTh 1:15
Sum (Staff) MTWThF 10

#22. Second-Year Spanish—Prerequisite: 3.
3 units, Aut, Win, Spr (Staff)

#23. Second-Year Spanish—Continuation of 22.
3 units, Aut, Win, Spr (Staff)

3 units, Aut, Win, Spr (Staff)

#29. Intensive Second-Year Spanish—Reading, grammar, composition, and conversation. Enrollment is limited.

9 units, Sum (Staff) MTWThF 8 and 11

#54. Second-Year Spanish — Enrollment limited to 15. Satisfies General Studies Requirement under C. Prerequisite: 23.
5 units, Spr (Staff) MTWThF 9

99. Individual Reading — Enrollment only by special permission. Prerequisite: 23.
1 to 4 units, any quarter (Staff) by arrangement

THIRD- AND FOURTH-YEAR

100. Advanced Spanish Conversation — May be repeated for credit. Prerequisite: 24 or equivalent.
3 units, Win (Staff) MWF 1:15

110. Spanish Pronunciation—Prerequisite: 24.
3 units, Spr (Petersen) TTh 11 and one hour by arrangement

111. Third-Year Spanish—Prerequisite: 24.
3 units, Aut (Staff) MWF 8 or (Staff) MWF 10

112. Third-Year Spanish — Continuation of 111.
3 units, Win (Staff) MWF 8 or (Staff) MWF 10

113. Third-Year Spanish — Continuation of 112.
3 units, Spr (Staff) MWF 8 or (Staff) MWF 10

Note: Courses #121 through #189 marked with the symbol # satisfy General Studies Requirement under C.

#121. Hispanic American Cultural Readings—Prerequisite: 23 or equivalent.
4 units, Spr (Ponce de Leon) MWF 1:15 and one hour by arrangement

#125. Spanish Cultural Readings — Training in careful reading of books with significant cultural content. Prerequisite: 23 or equivalent.
3 to 4 units, Aut (Geasler) MWF 9
#126. **Cervantes**—Reading and interpretation of selected passages from Don Quixote. Prerequisite: 23 or equivalent.

*3 to 4 units, Win (Alfaro) MWF 10*

#131. **Masterworks of Spanish Literature I**—From its origins to end of Fifteenth Century. Prerequisite: 23 or equivalent.

*3 to 4 units, alternate years, given 1969–70*

#132. **Masterworks of Spanish Literature II**—Sixteenth and Seventeenth centuries. Prerequisite: 23 or equivalent.

*3 to 4 units, Aut (Alfaro) MWF 11*

#133. **Masterworks of Spanish Literature III**—From 1700 to 1898. Prerequisite: 23 or equivalent.

*3 to 4 units, Win (Ponce de Leon) MWF 2:15*

#134. **Modern and Contemporary Spanish Literature**—Prerequisite: 23 or equivalent.

*3 to 4 units, alternate years, given 1969–70*

#142. **The Spanish Novel of the Nineteenth Century.**

*3 to 4 units, Spr (Ponce de Leon) MWF 2:15*

#151. **Masterworks of Spanish American Literature I**—Prerequisite: 23 or equivalent.

*3 to 4 units, Win (Geasler) MWF 11*

#152. **Masterworks of Spanish American Literature II**—Prerequisite: 23 or equivalent.

*3 to 4 units, Spr (Geasler) MWF 11*

165. **Spanish Conversation**—Discussion in Spanish of present-day problems. Enrollment limited to 15. Students in the short-term program should enroll for 165A for 2 units.

*4 units, Sum (Staff) MTWThF 9*

166. **Spanish Conversation.** Enrollment limited to 15. Students in the short-term program should enroll for 166A for 2 units.

*4 units, Sum (Staff) MTWThF 8*

170. **Spanish Phonetics.**

*2 units, Sum (Petersen) MWF 10*

**ADVANCED AND GRADUATE**

#180. **Lope de Vega, Tirso and Calderón**—Study and interpretation of four or five representative comedies.

*3 to 4 units, alternate years, given 1969–70*

181. **History of Linguistic Thought.**

*3 units, Win (Petersen) TTh 9 and one hour by arrangement*

#182. **Contemporary Spanish Theater.**

*3 to 4 units, alternate years, given 1969–70*

#184. **Spanish Speech and Drama**—Reading and rehearsing of Spanish plays. May be repeated for credit. Prerequisites: 100 and 112 or permission of instructor.

*3 units, alternate years, given 1969–70*

#186. **Spanish American Literature I**—Colonial epoch. Open only to graduate and advanced undergraduate students.

*3 to 4 units, Aut (Geasler) MWF 2:15*

#187. **Spanish American Literature II**—Romanticism. Open only to graduate and advanced undergraduate students.

*3 to 4 units, Win (Geasler) MWF 2:15*

#188. **Spanish American Literature III**—Modernismo. Open only to graduate and advanced undergraduate students.

*3 to 4 units, alternate years, given 1969–70*

#189. **Spanish American Literature IV**—Twentieth Century. Open only to graduate and advanced undergraduate students.

*3 to 4 units, alternate years, given 1969–70*

190. **Spanish Linguistics**—(Same as Education 283.)

*3 units, Spr (Petersen) TTh 9 and one hour by arrangement*

193. **The Problems of Spain in the Literature of the Nineteenth and Twentieth Centuries.**

*3 to 4 units, alternate years, given 1969–70*

195. **Chilean Literature of the Twentieth Century.**

*3 to 4 units, Aut, every third year, given 1970–71*

195A. **Argentine Literature of the Twentieth Century.**

*3 to 4 units, Aut (Alegria) MW 3:15*

197. **Spanish Lexicon.**

*3 units, alternate years, given 1969–70*

198. **Poetry of the Golden Age.**

*3 to 4 units, Spr (Alfaro) TTh 2:15 and one hour by arrangement*

199. **Individual Work**—May be repeated for credit. Open only to majors in Spanish.

*1 to 4 units, any quarter (Staff) by arrangement*
201. Advanced Grammar and Stylistics — Intensive review of structural syntax. Prerequisite: qualifying examination.

3 units, Aut (Staff) (I) MWF 11;  
(Ponce de Leon) (II) MWF 4:15  
Sum (Alfaro) MTWF 2:15

202. Advanced Grammar and Stylistics — Analysis of structural patterns. Translation and free composition. Prerequisite: 201 with grade of B or equivalent.

3 units, Win (Ponce de Leon) (I) MWF 11;  
(Schevill) (II) MWF 3:15  
Sum (Alfaro) MTWF 3:15

203. Advanced Grammar and Stylistics — Prerequisite: 202 with grade of B or equivalent.

3 units, Spr (Schevill) MWF 3:15

204. Modern Spanish I— The phonology of modern Spanish.

3 units, Aut (Espinosa) MWF 9

205. Modern Spanish II — The syntax of modern Spanish.

2 units, alternate years, given 1969–70

207A. Conversations on Contemporary Spanish America—This course will present the cultural life of twentieth century Spanish America.

5 units, Sum (Gamboa) MTWThF 11

210. Methods of Teaching Spanish and Laboratory Technique — Students in the short-term program should enroll for 210A for 2 units.

4 units, Sum (Petersen) MTWThF 11

210A. Methods of Teaching Spanish — (Same as Education 292.)

2 units, Aut (Petersen) TTh 1:15  
Sum (Petersen) MTWThF 11

210B. Language Laboratory Techniques — (Same as Education 295.)

2 units, Sum (Petersen) MTWThF 11

211. Spanish Literature from its Origins to 1500.

4 units, alternate years, given 1969–70

212. Spanish Literature of the Sixteenth and Seventeenth Centuries.

4 units, alternate years, given 1969–70

213. Spanish Literature from 1700 to 1850.

4 units, Aut (Ponce de Leon) W 7:15 p.m.

214. Spanish Literature from 1850 to 1905.

4 units, Win (Schevill) M 7:15 p.m.

215. Spanish Literature from 1905 to the Present.

4 units, Spr (Schevill) M 7:15 p.m.

217. Spanish Theater of the Golden Age.

3 to 4 units, Spr (Alfaro) W 7:15 p.m.

218. Spanish Renaissance Prose.

3 units, alternate years, given 1969–70

220. Cervantes.

4 units, alternate years, given 1969–70

223. The Modern Spanish Novel.

3 to 4 units, alternate years, given 1969–70


3 units, Aut, alternate years, given 1969–70


3 units, alternate years, given 1969–70

228. Contemporary Spanish Poetry.

3 to 4 units, alternate years, given 1969–70

230. Hispanic Folklore.

2 units, every third year, given 1970–71

232. The Spanish Epic Tradition.

3 units, every third year, given 1970–71

240. Spanish Versification.

3 units, Win (Espinosa) MWF 9

248. Proseminar: Problems and Methods of Research in Hispanic Literatures I.

2 units, Win (Gicovate) alternate years, given 1969–70

248A. Proseminar: Problems and Methods of Research in Hispanic Literatures I and II. (Courses 248 and 249 combined into one quarter.)

4 units, Spr (Gicovate) MW 2:15

249. Proseminar: Problems and Methods of Research in Hispanic Literatures II.

2 units, Spr (Gicovate) alternate years, given 1969–70

250. Graduate Seminar in Spanish Literature — Subject to be announced in Time Schedule.

3 units, Sum (Alfaro) T 4:15–6:05
251. Graduate Seminar in Spanish American Literature — Subject to be announced in Time Schedule.
   3 units, Spr (Gicovate) T 7:15 p.m.

255. Contemporary Novelists of Spanish America.
   3 units, Aut (Alegria) M 5–7

260. History of the Spanish Language — Readings in Old Spanish. Prerequisite: Elementary knowledge of Latin and permission of instructor.
   3 units, alternate years, given 1969–70

261. Old Spanish—Elements of phonology, morphology; reading of Old Spanish texts. Prerequisite: Elementary knowledge of Latin and permission of instructor.
   4 units, Aut (Espinosa) MTThF 10

   3 units, Win (Espinosa) MWF 10

264. Historical Spanish Linguistics II.
   3 units, alternate years, given 1969–70

266. Hispanic Dialectology.
   3 units, Spr (Espinosa) TTh 11

299. Individual Work — Exclusively for graduate students in Spanish working on thesis or engaged in special work.
   1 to 12 units, any quarter (Staff) by arrangement

PORTUGUESE COURSES

FIRST- AND SECOND-YEAR

#1. First-Year Portuguese.
   4 units, Aut (Staff) MWFThF 12

#2. First-Year Portuguese — Continuation of 1.
   4 units, Win (Staff) MWFThF 12

#3. First-Year Portuguese — Continuation of 2.
   4 units, Spr (Staff) MWFThF 12

#15. Intensive First-Year Portuguese — Equivalent to 1, 2, and 3 combined. Enrollment limited. Consent of instructor necessary.
   12 units, Sum (Rasmussen) MTWThF 8:00–9:30 and 10:30–12:00

#22. Second-Year Portuguese — Prerequisite: 3.
   3 units, Aut (Staff) MWF 12

#23. Second-Year Portuguese — Continuation of 22.
   3 units, Win (Staff) MWF 12

#54. Second-Year Portuguese—Enrollment limited to 15. Satisfies General Studies Requirement under C. Prerequisite: 23.
   4 units, Spr (Staff) MWF 12

99. Individual Reading — Enrollment only by special permission. Prerequisite: 23.
   1 to 2 units, any quarter (Staff) by arrangement

#131. Masterworks of Portuguese and Brazilian Literature.
   3 to 4 units, Spr (Staff)

ADVANCED UNDERGRADUATE AND GRADUATE

181. Advanced Portuguese.
   3 units, Aut (Coelho) TTh 9

182. Advanced Portuguese — Continuation of 181.
   3 units, Win (Coelho) TTh 10

183. Advanced Portuguese — Continuation of 182.
   3 units, Spr (Coelho) TTh 10

185. Portuguese Linguistics.
   4 units, alternate years, given 1969–70

186. Portuguese Phonetics.
   4 units, alternate years, given 1969–70

191. Portuguese Literature I.
   3 to 4 units, Aut (Coelho) MWF 9

192. Portuguese Literature II.
   3 to 4 units, Win (Coelho) MWF 9

195. Brazilian Literature I.
   3 to 4 units, Aut (Coelho) MWF 1:15

196. Brazilian Literature II.
   3 to 4 units, Win (Coelho) MWF 1:15

199. Individual Work—May be repeated for credit.
   1 to 3 units, any quarter (Staff) by arrangement

250. Graduate Seminar—Subject to be announced in Time Schedule.
   3 units, Spr (Coelho) Th 7:15 p.m.

299. Individual Work.
   1 to 12 units, any quarter (Staff) by arrangement
SPEECH and DRAMA

Emeriti: James G. Emerson (Professor); Helene Blattner, Elisabeth Buckingham (Associate Professors)

Acting Executive Head: Wendell Cole

Professors: Wendell Cole, Norman Philbrick, Eleanor Frosser, H. Donald Winbigler

Associate Professors: Richard Hay, Paul Landry, Douglas A. Russell, Helen W. Schrader, William L. Sharp

Assistant Professors: Clara Bush, Arthur Hastings, Frederick Hunt. Acting: Kenneth E. Mosier

Instructors: John Kulsar. Acting: Marianne E. Crowder

Lecturers: Glenn Cannon, Evelyn Draper, Naomi Wrage

PROGRAMS OF STUDY

BACHELOR OF ARTS

The requirements for the degree of Bachelor of Arts with a major in Speech and Drama are planned to allow the student wide latitude in developing his special aptitudes. Students are encouraged to declare their major in Drama in their sophomore year. A minimum program is required of all students. Every major in Speech and Drama must take:

<table>
<thead>
<tr>
<th>Units</th>
<th>90, 91, 92. Dramatic Literature</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>160A, 160B. Theater Practice</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>164A, 164B, 164C. Acting; Directing</td>
<td>12</td>
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<tr>
<td></td>
<td>173A. Theatrical Makeup</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>174A, 174B, 174C. Introduction to Design and Technical Production</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>195. Theater Criticism</td>
<td>3</td>
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<tr>
<td></td>
<td>Electives in Speech and Drama (Undergraduate and Graduate with consent of instructor)</td>
<td>9</td>
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<tr>
<td>Total</td>
<td></td>
<td>82</td>
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</table>

An additional six units must be taken, to be chosen from:

170A, 170B, 170C. Visual Arts for Theater
Art 5. Survey I
Art 10. Survey II
Art 100A, 100B. Ancient Art: Greek and Roman
Art 103A, 103B, 103C. Mycenaean; Greek Architecture; Archaic Greek Sculpture
Art 105A, 105B, 105C. Medieval Art
Art 110A, 110B, 110C. Renaissance Art
Art 115A, 115B, 115C. Baroque Art
Art 117. European Art of the Eighteenth Century
Art 120A, 120B, 120C. Modern Art
Art 130A, 130B, 130C. American Art

As a major in Speech and Drama, each student is required to take one unit of Speech and Drama 160A or 160B each quarter; at least two units of 160B are required each year. Thirty hours of work per unit each quarter will be required to pass the course. A minimum of 6 units of Speech & Drama 160A and 160B is required. No more than 10 units of 160A and 160B, however, may be counted toward graduation requirements of 180 units.

All students must complete a program of interrelated study in an area other than Drama totaling 12 units. This program is to be chosen with the approval of the student's faculty adviser. A grade average of C must be maintained in all course work.

Special Major Program for the Honors Candidate in Humanities — Students who are planning to take the special Honors Program in Humanities may fulfill the requirements for the major in Speech and Drama by satisfactory completion of the following program:

164A, 164B, 164C. Acting and Directing
90, 91, 92. Dramatic Literature
Six units to be chosen from Speech and Drama 170A, 170B, 170C or Art History
Electives in theater and drama totaling at least nine units at the undergraduate course level, or at the graduate course level with consent of the instructor.

GRADUATE PROGRAM IN HUMANITIES

The Department of Speech and Drama also participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in Speech and Drama and Humanities. For a description of that program and fellowships offered in connection with it, see the section "Humanities Special Programs."

TEACHING CREDENTIALS

The degree of Master of Arts in Teaching of Speech and Drama is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and who wish further to strengthen their academic preparation. The program consists of a minimum of 30 units in the teaching field and 12 units in the School of Education. Detailed requirements for the course are outlined in the School of Education section.
Standard Teaching Credential (Secondary)—Students wishing to obtain the Stanford General Secondary Credential should consult the Credential Secretary of the School of Education for the general requirements, and the teacher training adviser, Professor Helen Schrader, in the Department of Speech and Drama for Departmental requirements.

Advanced Degrees

Any student wishing to enter upon graduate work in the Department of Speech and Drama at Stanford University should apply to the Office of the Director of Admissions. Graduate students, when applying for admission, must furnish their scores on the Aptitude Test of the Graduate Records Examination. Applicants for the doctoral degree must also submit a sample of their best written scholarly work. All graduate students must be degree candidates.

For University regulations governing advanced degrees, see the section “Degrees” in this bulletin.

Master of Fine Arts

An intensive program in theater arts has been inaugurated for the exceptionally gifted student who wishes to train for a professional career in the fields of acting, directing, costume, lighting, stage design, and technical production. Artists-in-residence will serve as teachers in the training program in addition to the regular departmental faculty. The acting program is designed for two years; the curriculum for directors and designers is planned for three years. For students with a strong background in drama, the three-year curriculum could well be reduced to two years. Advanced standing would be based upon special examination.

In addition to regular University requirements for admission, all applicants for the acting and directing programs will be interviewed; design applicants must submit a portfolio of their work. While overall scholastic ability will be a factor in admission, primary emphasis will be placed on evidence of superior potential in theater arts.

The M.F.A. is designed as a terminal degree, but if a candidate successfully completes his work for the M.F.A. and demonstrates strong interest and ability in teaching and research, he will be urged to continue to the Ph.D. degree.

For further details please write to the Executive Head, Department of Speech and Drama.

Note—Certain of the following course sequence requirements can be fulfilled by special examination.

Costume Design Major

Candidates for the M.F.A. degree in costume design are required to complete 101 units of course work beyond the Bachelor’s degree. The course requirements are as follows:

First Year

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>271A, 271B, 271C. Costume I</td>
</tr>
<tr>
<td>297, 298, 299. Theater History</td>
</tr>
<tr>
<td>170A, 170B, 170C. Visual Arts for the Theater</td>
</tr>
<tr>
<td>281A, 281B, 281C. Stage Design I</td>
</tr>
<tr>
<td>260. Crew</td>
</tr>
<tr>
<td>399. Core Seminar</td>
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<tr>
<td>Total</td>
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</table>

Second Year

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>272A, 272B, 272C. Costume II</td>
</tr>
<tr>
<td>291A. Directing I (one quarter)</td>
</tr>
<tr>
<td>251A, 251B, 251C. Lighting I</td>
</tr>
<tr>
<td>260. Crew</td>
</tr>
<tr>
<td>173A, 173B. Theatrical Makeup</td>
</tr>
<tr>
<td>Electives</td>
</tr>
<tr>
<td>399. Core Seminar</td>
</tr>
<tr>
<td>Total</td>
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</tbody>
</table>

Third Year

<table>
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<tr>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>260. Crew</td>
</tr>
<tr>
<td>Electives (to include courses in Art and Architecture)</td>
</tr>
<tr>
<td>399. Core Seminar</td>
</tr>
<tr>
<td>Total</td>
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</tbody>
</table>

Scene Design Major

Candidates for the M.F.A. degree in scene design are required to complete 102 units of course work beyond the Bachelor’s degree. The course requirements are as follows:

First Year

<table>
<thead>
<tr>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>281A, 281B, 281C. Scene Design I</td>
</tr>
<tr>
<td>297, 298, 299. Theater History</td>
</tr>
<tr>
<td>241A, 241B, 241C. Technical Production I</td>
</tr>
<tr>
<td>170A, 170B, 170C. Visual Art for the Theater</td>
</tr>
<tr>
<td>260. Crew</td>
</tr>
<tr>
<td>399. Core Seminar</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
**LIGHTING DESIGN, TECHNICAL PRODUCTION MAJOR**

Candidates for the M.F.A. degree in lighting design and technical production are required to complete 110 units of course work beyond the Bachelor's degree. The course requirements are as follows:

**First Year**

291A, 291B, 291C. Scene Design I 9
297, 298, 299. Theater History 9
170A, 170B, 170C. Visual Art for the Theater 9
241A, 241B, 241C. Technical Production I 9
260. Crew 3
399. Core Seminar 3
Total .......................... 36

**Second Year**

281A, 281B, 281C. Scene Design II 9
271A, 271B, 271C. Costume I 9
291A. Directing I (one quarter) 3
251A, 251B, 251C. Lighting I 9
260. Crew 3
399. Core Seminar 3
Total ................................ 36

**Third Year**

283A, 283B, 283C. Scene Design III Thesis 6
260. Crew 3
Electives (to include courses in Art and Architecture) 12
399. Core Seminar 3
Total ............................. 24

Candidates for the M.F.A. degree in directing are required to complete 97 units of course work beyond the Bachelor's degree. The course requirements are as follows:

**First Year**

291A, 291B, 291C. Directing I 15
297, 298, 299. Theater History 9
281A. Acting I (one quarter) 3
173A, 173B. Theatrical Makeup 2
260. Crew 2
399. Core Seminar 3
Total ................................ 34

**Second Year**

271A, 271B. Costume I (two quarters) 6
244A, 244B. Survey of Lighting and Technical Production (winter and spring quarters) 6
281A. Scene Design I (two quarters) 6
292. Directing II 6
300-series. Dramatic Literature (two quarters autumn and winter) 8
**Two of the following four courses must be taken in spring quarter:**
271C. Costume I 6
281C. Scene Design I 6
300-series. Dramatic Literature 3
399. Core Seminar 3
Total ................................ 22-30

(Nota—If the "directing" candidate is interested in going on to the Ph.D. degree, his electives should specifically be 360A, B, C, and 200, 201, and 306. If these courses are taken, he will need only 12 additional courses (or, normally, 3 quarters' work) to complete the remaining residence requirements for the Ph.D.)

**ACTING MAJOR**

The candidate for the M.F.A. in acting is required to complete 75 units of course work.

**First Year**

261A, 261B, 261C. Acting I 9
174A. Costume Design and Construction 3
260. Crew 1
263A, 263B, 263C. Voice and Movement 6
291A. Directing I 3
264. Rehearsal and Performance (Stanford Repertory Theater) 6
294A, 294B. Projects with M.F.A. Directors (winter and spring quarters) 6
173A, 173B. Theatrical Makeup 2
Electives (winter and spring quarters) to be chosen from courses outside of Speech and Drama 6
399. Core Seminar 3
Total ................................ 45
Second Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>262A, 262B, 262C. Acting II</td>
<td>9</td>
</tr>
<tr>
<td>297, 298, 299. Theater History or Dramatic Literature</td>
<td>9</td>
</tr>
<tr>
<td>263A, 263B, 263C. Voice and Movement</td>
<td>6</td>
</tr>
<tr>
<td>264. Rehearsal and Performance (Stanford Repertory Theater)</td>
<td>6</td>
</tr>
<tr>
<td>399. Core Seminar</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
</tr>
</tbody>
</table>

Doctor of Philosophy

The degree of Master of Arts is eliminated; no interim degree is awarded by the Department of Speech and Drama for Ph.D. candidates. University requirements for the doctorate (residence, dissertation, examinations, etc.) are discussed in the section “Degrees” in this bulletin. The following are Departmental requirements.

General Requirements—A candidate for the Ph.D. degree must complete three years (nine quarters) of full-time work, or their equivalent, in graduate study beyond the Bachelor's degree. He will be expected to offer at least 72 units of graduate courses and seminars in addition to his doctoral dissertation. At least three consecutive quarters of graduate work, and also the last course work in the doctoral program, must be taken at Stanford.

All candidates, regardless of their field of specialization, are expected to fulfill the following general requirements:

1. Language requirement. Before the second year of residence, the candidate must demonstrate advanced reading knowledge of one language by satisfactorily completing a literature course in which readings are in the original language of the literature studied.

2. Course requirements. The candidate is required to take the course sequence in research and criticism (360A, 360B, 360C) and a minimum of four seminars in dramatic literature. Depending on the candidate’s preparation, courses in theater arts and history may be required.

3. Examinations. Before scheduling his comprehensive examination, and normally before the second year of residence, the candidate must pass a written examination on theater arts. The examination is given annually in the fall. When course work is completed, the candidate takes written comprehensive examinations in his four fields of concentration (see below). Upon successful completion of all qualifying examinations, the candidate is admitted to a University oral examination based on his four fields.

4. Dissertation. Immediately preceding completion of his comprehensive examinations, the candidate will file formal application for candidacy as prescribed by the University. The dissertation must be completed and approved within 5 years from the quarter in which candidacy is granted. A candidate taking more than 5 years will be required to reinstate his candidacy by repassing comprehensive examinations on dramatic literature.

Specialization—During the first year of residence, the candidate, in consultation with his adviser, will select four fields of concentration. One of the four fields is designated as the candidate’s major field of specialization so that much preparatory research and study for the dissertation will have been completed before completion of course work.

One field of concentration is to be chosen from each of the following groups:

1. Comparative drama in one literary period. (Examples: Medieval Drama, Renaissance Drama, European Drama in the Eighteenth Century, Modern Drama from 1870 to 1914, etc.)

2. One major playwright.

3. One national drama. (To be chosen from English, American, French, Italian, Spanish, German, Greek.)

4. One dramatic genre, or dramatic criticism. (Examples: Tragicomedy, Farce, Comedy of Manners, Melodrama, etc.)

Only two areas of study in a candidate’s program are permitted to overlap significantly. (Examples: French Drama and Molière; or European Drama of the Nineteenth Century and Melodrama.) At least one area of study must be before 1700.

Fellowships

The Department of Speech and Drama awards a number of fellowships to graduate students in both the M.F.A. and Ph.D. programs. These grants range in amounts from about $1,500 to $3,000. Completed application forms for fellowships should be filed before January 15 at the Office of Financial Aids at the same time as completed
SPEECH AND DRAMA

application forms for admission are filed with the Admissions Office.

Limited opportunities are also available for teaching assistantships, but they are usually awarded to the student who has completed a portion of his work in the program.

SPEECH CORRECTION, HEARING, AND SPEECH SCIENCES

For programs and courses in Speech Correction, Hearing, and the Speech Sciences, please refer to the Program in Speech and Hearing Sciences listed in the section “School of Medicine” in this bulletin.

SUMMER SESSION

A special brochure is available, with full details of courses given in the summer by the Department of Speech and Drama.

COURSES

GENERAL

#30. Oral Interpretation—Basic course in understanding the organization of the logical and emotional content of literature with emphasis on its communication to the listener.

3 units, Aut, Win, Spr (Staff) MWF 9 or 11

101. Voice and Articulation — Analysis of articulatory and vocal usage. Practicum emphasizing these factors as they relate to public performance.

3 units, Win, Spr (Bush) MW 3:15–4:20

PUBLIC ADDRESS AND SMALL GROUP COMMUNICATION

Courses offered in this division provide theory and instruction in the communication of ideas, feelings, and actions as experienced in public address and in small interacting groups.

#20. Public Speaking — Includes preparation and presentation of original speeches, and analysis and written criticism of significant public addresses.

3 units, Aut, Win, Spr (Hastings, Kulsar, Mosier, Wrage) MTW 10, 11, 2:15; TTh 9, 10, 11, 1:15

80A, 80B, 80C. Debate, Forensics, and Symposium—The theory and practice of debate and forensic speaking. Students will have opportunities to participate in campus speaking events, intercollegiate debate and public presentations.

80A. Debate.
2 units, Aut (Mosier) M 7:30–9:30 p.m.

80B. Debate and Forensics.
2 units, Win (Mosier) M 8–10 p.m.

80C. Symposium.
2 units, Spr (Mosier) M 8–10 p.m.

100. Independent Study.
1 to 4 units, any quarter (Staff) by arrangement

120A. Exposition—Focuses on the individual as he experiences the process of communication in an interacting group.

3 units, Aut, Win, Spr (Schrader, Staff) MWF 11 or 1:15

120B. Argumentation — Reasoning processes and their use in analysis and persuasion.

3 units, Aut, Win, Spr (Hastings) MWF 10

120C. Discussion — Focuses on group phenomena which facilitate or inhibit free communication in the solving of problems in an interacting group.

3 units, Win, Spr (Schrader) MWF 10

121. Advanced Public Speaking—Preparation and delivery of platform speeches designed to modify audience behavior. Prerequisite: 20 or equivalent.

3 units, Spr (Mosier) MTW 2:15

130. Persuasion Theory — Philosophical, psychological, and rhetorical principles of persuasion.

4 units, Aut, Win (Hastings) MW 2:15–4:05

132. Group Communication — Decisions, conflict, and communication in small groups. Prerequisite: 120A or 120C.

4 units, Spr (Schrader) TTh 2:15–4:05

134. Language and Communication—Analysis of symbolic processes.

4 units, Spr (Hastings) MW 2:15–4:05

140. Social Protest—The role of American spokesmen in contemporary social controversies.

4 units, Win, Spr (Wrage) TTh 2:15–4:05

Business and Professional Speaking — See Business 386, Graduate School of Business Bulletin.

Aut, Spr (Kulsar)
THEATER AND DRAMA

Undergraduate

#60. Introduction to the Contemporary Theater—Survey of the arts of the theater; lectures and discussion of readings in contemporary drama. May not be offered in support of the major.
3 units, Win (——) MWF 9

#90. Development of Drama (Classical and Medieval)—Survey of masterpieces of Western drama from origins in Greece to the Renaissance. Emphasis on the social and theatrical environments of each play's performance.
4 units, Aut (Sharp) MW 1:15-3:05

#91. Development of Drama (Renaissance and Baroque)—Survey of the art of drama from the Renaissance to Ibsen.
4 units, Win (Sharp) MW 1:15-3:05

#92. Development of Drama (Modern)—Ibsen, subsequent dramatists, English and Continental. Lectures, discussions; critical papers.
4 units, Spr (Sharp) MW 1:15-3:05

160. Theater Practice — Credit for participation by undergraduates in productions in acting or stagecraft. May be repeated. Prerequisite: consent of instructor.
160A. Acting.
1 to 3 units, any quarter (Staff)
by arrangement
160B. Crew.
1 to 3 units, any quarter (Staff)
by arrangement

164. Fundamentals of Acting and Directing — Not open to freshmen. Sophomores with consent of instructor.
164A. Principles of Acting — Actor's resources and methods, basic body movement.
4 units, Aut (Cannon, Crowder)
WF 10-12; lab. M 10-12

4 units, Win (Cannon, Crowder)
WF 10-12; lab. M 10-12

164C. Directing—Techniques of analysis, blocking and composition. Acting projects.
4 units, Spr (Pierce, Crowder) WF 10-12; lab. M 10-12

165A,B,C. Advanced Undergraduate Acting—Prerequisites: 164A, 164B, 164C.
165A. 3 units, Aut (Cannon) TTh 2:15-4:05
165B. 3 units, Win (Cannon) TTh 2:15-4:05
165C. 3 units, Spr (Cannon) TTh 2:15-4:05

170A,B,C. Visual Art for the Theater—Survey of painting, sculpture, as it affects theatrical style. Required of M.F.A. students in design.
170A. 3 units, Aut (Russell) T 10-12 and Th 11
170B. 3 units, Win (Russell) T 10-12 and Th 11
170C. 3 units, Spr (Russell) T 10-12 and Th 11

173A,B. Theatrical Makeup — Laboratory course in the art of stage makeup. 173A required of all undergraduate drama majors; complete sequence required of all M.F.A. acting, directing and costume majors.
173A. 1 unit, Aut (Russell) M 11-1
173B. 1 unit, Win (Russell) M 11-1

174. Introduction to Design and Technical Production—Open to undergraduates and graduates with insufficient background in theater arts.
174A. Costume Design and Construction.
3 units, Aut (Staff) TTh 9 and lab. by arrangement
174B. Stage Lighting Design and Practice.
3 units, Win (Staff) TTh 9 and lab. by arrangement
174C. Scene Design and Construction.
3 units, Spr (Staff) TTh 9 and lab. by arrangement

190. Senior Seminar—Acting and Directing selected Classic and Renaissance plays.
3 units, Aut (——) TTh 10-12

191. Senior Seminar—Acting and Directing selected Restoration and Eighteenth Century plays.
3 units, Win (Sharp) TTh 10-12

192. Senior Seminar—Acting and Directing selected Romantic or Modern plays.
3 units, Spr (Sharp) TTh 10-12

193. Special Research—Individual reading in dramatic literature.
1 to 4 units, any quarter (Staff)
by arrangement
194. Special Projects — Individual projects in theater arts.
   1 to 4 units, any quarter (Staff)
   by arrangement

195. Theater Criticism — Readings in contemporary techniques. Papers based on performances attended in the area.
   3 units, Spr (Prosser) MWF 11

200. Early American Drama.
   3 units, Win (Philbrick) MWF 11

201. Modern American Drama.
   3 units, Spr (Cole) MWF 11

GRADUATE COURSES FOR M.F.A.
Open by permission to unusually qualified undergraduate students

(Note—All courses are year-long and conducted as a combination of class and studio work. These courses are offered as a sequence, autumn, winter, and spring.)

241A,B,C. Technical Production I — Introduction to technical production and scenicographic techniques.
   241A. 3 units, Aut (Hunt) W 10–12 and Th 9–11 and F 10
   241B. 3 units, Win (Hunt) W 10–12 and Th 9–11 and F 10
   241C. 3 units, Spr (Hunt) W 10–12 and Th 9–11 and F 10

   242A. 3 units, Aut (Hunt) by arrangement
   242B. 3 units, Win (Hunt) by arrangement
   242C. 3 units, Spr (Hunt) by arrangement

   243A. 2 units, Aut (Staff) by arrangement
   243B. 2 units, Win (Staff) by arrangement
   243C. 2 units, Spr (Staff) by arrangement

245. Theater Management — Theater organization, production organization, box office procedures, publicity, and business procedures.
   3 units, Aut (Burgess) by arrangement

   246A. 2 units, Aut (Staff) by arrangement
   246B. 2 units, Win (Staff) by arrangement
   246C. 2 units, Spr (Staff) by arrangement

251A,B,C. Lighting I — Introduction to stage lighting.
   251A. 3 units, Aut (Landry) TTh 12
   251B. 3 units, Win (Landry) TTh 12
   251C. 3 units, Spr (Landry) TTh 12

252A,B,C. Lighting II — Advanced stage lighting.
   252A. 3 units, Aut (Landry) by arrangement
   252B. 3 units, Win (Landry) by arrangement
   252C. 3 units, Spr (Landry) by arrangement

   253A. 2 units, Aut (Landry) by arrangement
   253B. 2 units, Win (Landry) by arrangement
   253C. 2 units, Spr (Landry) by arrangement

260. Crew — Credit for participation by graduate students in productions in acting or stagecraft. May be repeated.
   1 unit, any quarter (Staff) by arrangement

261A,B,C. Acting I — Basic, special problems, and projects (contemporary). Open to seniors with consent of instructor.
   261A. 3 units, Aut (Staff) T 10–12 and Th 11
   261B. 3 units, Win (Staff) TTh 10–12
   261C. 3 units, Spr (Staff) TTh 10–12

262A,B,C. Acting II — Projects in Classical, Shakespearean, Restoration, Nineteenth Century, modern acting.
   262A. 3 units, Aut (Staff) TTh 10–12
   262B. 3 units, Win (Staff) TTh 10–12
   262C. 3 units, Spr (Staff) TTh 10–12

263A,B,C. Voice and Movement.
   263A. 2 units, Aut (Draper) by arrangement (Voice); S 10:00–11:30 (Movement)
SCHOOL OF HUMANITIES AND SCIENCES

263B. 2 units, Win (Draper) by arrangement (Voice); S 10:00-11:30 (Movement)

263C. 2 units, Spr (Draper) by arrangement (Voice); S 10:00-11:30 (Movement)


2 units, any quarter (Staff) by arrangement

271A,B,C. Costume I—Introduction to costume history, design and construction.

271A. 3 units, Aut (Russell) T 9 and Th 9-11
271B. 3 units, Win (Russell) T 9 and Th 9-11
271C. 3 units, Spr (Russell) T 9 and Th 9-11

272A,B,C. Costume II—Projects in costume design.

272A. 3 units, Aut (Russell) T 1:15
272B. 3 units, Win (Russell) T 1:15
272C. 3 units, Spr (Russell) T 1:15


273A. 2 units, Aut (Russell) by arrangement
273B. 2 units, Win (Russell) by arrangement
273C. 2 units, Spr (Russell) by arrangement

281A,B,C. Scene Design I — Principles of design and practice.

281A. 3 units, Aut (Hay) M 10-12 and W 10
281B. 3 units, Win (Hay) M 10-12 and W 10
281C. 3 units, Spr (Hay) M 10-12 and W 10

282A,B,C. Scene Design II—Projects in design.

282A. 3 units, Aut (Hay) W 11-1
282B. 3 units, Win (Hay) W 11-1
282C. 3 units, Spr (Hay) W 11-1


283A. 2 units, Aut (Hay) by arrangement
283B. 2 units, Win (Hay) by arrangement
283C. 2 units, Spr (Hay) by arrangement

291A,B,C. Directing I—Principles of directing.

291A. 3 units, Aut (——) MWF 10; lab. by arrangement
291B. 6 units, Win (——) MWF 10; lab. by arrangement
291C. 6 units, Spr (——) MWF 10; lab. by arrangement

292. Directing II—Preparation for production.

6 units, Spr (Staff) by arrangement


293A. 3 units, Aut (Staff) by arrangement
293B. 3 units, Win (Staff) by arrangement
293C. 3 units, Spr (Staff) by arrangement

294A,B. Acting projects with M.F.A. directors.

294A. 3 units, Win (Staff) MWF 10; lab. by arrangement (Directing I)
294B. 3 units, Spr (Staff) by arrangement (Directing II)

297. Theater History (Classical)—Theater buildings, theories of production, and staging methods.

3 units, Aut (Cole) MWF 9

298. Theater History (Baroque)—Theater buildings, theories of production, and staging methods.

3 units, Win (Cole) MWF 9

299. Theater History (Modern)—Theater buildings, theories of production, and staging methods.

3 units, Spr (Cole) MWF 9

300. Comprehensive Research.

1-6 units, any quarter (Staff) by arrangement

PH.D. COURSES

301. Seminar in Classical Drama (Greek and Roman).

3 to 4 units, Aut (——) MW 1:15-3:05, given 1968-69

302. Seminar in Medieval Drama.

3 to 4 units, Aut (Prosser) MW 1:15-3:05
Statistics

Emeritus: Quinn McNemar

Executive Head: Lincoln E. Moses


Associate Professor: Bradley Efron

Assistant Professors: Richard Olshen, David O. Siegmund, Paul Switzer, George G. Woodworth

OFFERINGS AND FACILITIES

The Department’s purposes are to acquaint students with the role played in science and technology by probabilistic and statistical ideas and methods, to provide instruction in the theory and application of techniques that have been found to be commonly useful, and to train research workers in probability and statistics. There are courses for general students as well as for those who plan careers in statistics in government, business, industry, and teaching.

General students with an interest in the principles of statistical inference and the theory of making decisions in the face of uncertainty should take Statistics 50. Statistics 110 covers the most important techniques used in the analysis of experimental data in engineering and science. Statistics 116 provides a general introduction to the theory of probability. The sequence 116, 119, 120 is a basic one-year course in mathematical statistics; the sequence 116, 217A, and 217B is a basic one-year course in probability theory.

Students interested in computing and data processing have access to the Stanford Computation Center.

The requirements for a degree in statistics are flexible, depending on the needs and interests of the student. Among the courses which may be counted toward a degree in Statistics are certain courses offered by the Departments of Mathematics, Economics, Psychology, Electrical Engineering, Industrial Engineering, and the Graduate School of Business.

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

The following Departmental requirements are in addition to the University’s basic requirements for the Bachelor’s degree:

1. Mathematics through Mathematics 45 or equivalent, and Mathematics 113.
2. Computer Science 50A.
3. Statistics 116, 119, 120 (or the Honors sections of these courses), and 4 additional courses chosen from offerings in the Statistics Department (24 units). Students can receive credit toward fulfilling this require-
ment for, at most, 1 of the following 3 courses: Statistics 7, 50, 110.

4. Four additional courses chosen from offerings in the Statistics Department or from authorized courses in other departments.

MASTER OF SCIENCE

In addition to the University's basic requirements for the Master's degree, the Department requires that the student take 45 units of work from offerings in the Statistics Department or from authorized courses in other departments. If advanced statistics courses are included in the program, the total number of units may be reduced.

Programs are ordinarily arranged to provide specialization in mathematical statistics, mathematics in behavioral science, industrial statistics, or data processing and operations research. Each student will normally fulfill the following requirements for the Master of Science degree:

1. Statistics 116, 219, 220 (or the Honors sections of these courses), 217A, 217B.

2. Mathematics 113; and Computer Science 136 or an additional course in Mathematics at the 100 level or above.

3. Three additional courses from offerings in the Statistics Department.

4. Additional units to complete the requirements chosen from offerings in the Statistics Department or from authorized courses in other departments.

Requirements "3" and "4" enable the student to specialize in mathematical statistics, mathematical models in behavioral science, industrial statistics, or data processing and operations research.

Students who are interested in mathematical statistics should concentrate on more advanced courses in the Department.

Students interested in mathematical models in behavioral sciences can take 206, 207, 208, and 209 offered within the Department, as well as authorized courses from other departments.

The program in industrial statistics is directed toward students with graduate training in engineering or science. Such students will usually take 110, 161, 216, and 252 within the Department, as well as authorized courses from other departments.

Students interested in operations research and data processing will normally be interested in the application of quantitative techniques to business and industrial technology. They may take 252, 253, 254, 256, 257, and 258 within the Department, as well as authorized courses from other departments.

DOCTOR OF PHILOSOPHY

Candidates for the degree of Doctor of Philosophy in Statistics will follow such courses as are approved by the Department faculty, subject to general University regulations. Each student's program should be arranged to include work in pure mathematics, mathematical statistics, and the application of statistics to some particular field.

The relative amount of time allotted to study under each of these headings will vary from individual to individual, according to previous training and experience. In any case, the following requirements are stipulated:

1. Mathematics. Four 200-level quarter courses in Mathematics including Mathematics 205A and 206A (or equivalent).

2. Probability and statistics. Statistics 221, 230A,B,C, 236A,B,C. These courses provide familiarity with the mathematical theory of probability and the major divisions of statistical theory. In addition, a Ph.D. candidate must offer six quarter courses from the advanced courses offered in specialized fields such as Decision Theory, Large Sample Theory, Multivariate Analysis, Non-parametric Inference, and Time Series.

3. Two written examinations in statistics—one at the end of the first year, the other at the end of the second year of graduate study. These tests are intended to assess the student's problem-solving ability and mathematical ingenuity; questions are in mathematics, probability, and statistics. Appraisal of performance is undertaken in the light of what course work the student has had.

4. All students working for the Ph.D. are required as a part of their program to obtain experience including any or all of: research, consulting, teaching assistance. These duties are deliberately kept light enough to permit full-time study. In exceptional cases where, by mutual agreement, significantly more work is undertaken for a limited period, additional compensation is given.
Doctor of Philosophy Minor — The general requirements for the minor in statistics are a reasonable knowledge of the principal branches of the theory of statistics and professional competence in those branches of statistical theory commonly applied in the major. Ordinarily a student will be required to take Statistics 116, 219, 220, 217A, and 217B. In addition, five other courses will be chosen from offerings in the Statistics Department or from authorized courses in other departments. A written examination to establish proficiency will be required and must be taken before the University oral examination. This examination for the minor will be given once in the spring quarter.

Fellowships and Assistantships

A variety of fellowships and assistantships are available for doctoral candidates. The duties are variable and may include any or all of, grading papers, teaching sections of undergraduate courses, research and computation assistance to investigators. A smaller number of assistantships are available in Summer Session. All applicants for financial assistance are required to take the Aptitude Test and the Advanced Test in Mathematics of the Graduate Record Examination. For details concerning this test see the Information Bulletin. Overseas applicants, who may not receive the Information Bulletin promptly, should write directly to the Educational Testing Service, 20 Nassau Street, Princeton, New Jersey.

Courses

7. Introduction to Statistics—(Same as Economics 7 and Sociology 7.) Especially designed for students in economics, sociology, and other social sciences.

5 units, Aut (Olkin) MTWThF 9


3 units, Aut (——) MWF 2:15
Spr (Olshen) MWF 2:15

#50. Elementary Statistics — An introduction to statistics for the general student, with emphasis on concepts of decision making in the face of uncertainty.

5 units, Aut (Chernoff) MTWThF 9
Win (Woodworth) MTWThF 2:15
Spr (——) MTWThF 2:15
4 units, Sum (——) MTWThF

104. Sampling from Human Populations (Elementary) — Theory of sampling from finite populations; efficiency of various survey designs; application. Prerequisite: elementary course in statistics.

3 units, Spr (Madow) MWF 11

107. Introduction to Statistics—For graduate students. Lectures same as Statistics 7.

4 units, Aut (Olkin) MTWThF 9

110. Statistical Methods in Engineering and the Physical Sciences — Use of statistical methods in research, production. Measurement errors, comparison of two or more means, curve fitting, correlation, design of engineering experiments. Prerequisite: Calculus.

4 units, Aut (Solomon) TThlO and MW4:15
Win (Chernoff) MTWF 9
Spr (Woodworth) MTWF 10
Sum (——)

116. Theory of Probability—(Same as Economics 270.) This course covers the material of Statistics 27 in more detail and with more emphasis on mathematical technique. Students are expected to have a good working knowledge of calculus, including infinite series and double integrals. The course is designed to provide an adequate background for all courses whose prerequisite is probability theory. Prerequisite: Mathematics 44 or equivalent.

4 units, Aut (——) MTWF 11
Win (Parzen) MTWF 11
Spr (——) MTWF 9
Sum (——) MTWThF

116E. Theory of Probability—A course similar to 116 for engineering students. Prerequisite: Mathematics 45.

3 units, Aut (Siegmund) MWF 2:15
4 units, Aut (Stein) MTWF 10

119. Elementary Statistical Inference—Review of probability; distribution theory; sampling, sampling distributions; univariate, bivariate normal distribution; correlation, regression. Prerequisite: 116 or 27.
4 units, Win (Lieberman) MWF 9

119H. Elementary Statistical Inference—Honors version of 119. Prerequisites: Grade of A in 116 or B in 116H; Mathematics 45.
4 units, Win (Woodworth) MWF 11

120. Statistical Inference—Point estimation; interval estimation; tests of hypothesis; linear hypothesis; distribution free methods; sequential analysis. Prerequisite: 119.
4 units, Spr (Lieberman) MWF 9

120H. Statistical Inference—Honors version of 120.
4 units, Spr (Woodworth) MWF 11

136. Introduction to the Theory of Games—Two person-zero sum games; strategy; minimax solutions; infinite games. Prerequisite: 27 or equivalent.
3 units, Win (Chernoff) MWF 10

137. Special Mathematical Topics Related to Probability and Statistics—Subject matter varies from year to year; topics may be drawn from convexity, geometrical probability, generating functions, Tchebychev inequalities, etc. Prerequisite: 116. May be repeated for credit.
3 units, Win

138. Special Topics in Statistics—Subject matter varies from year to year; topics may be any of Biological assay, Sequential analysis, Non-parametric methods, Analysis of variance, Design of experiments, Regression, Multi-variate statistical methods, Decision theory. Prerequisite: 120. May be repeated for credit.
3 units, Spr

150. Elementary Statistics—For graduate students. Lectures same as Statistics 50.
4 units, Aut (Chernoff) MTWThF 9
Win (Woodworth) MTWThF 2:15
Spr (———) MTWThF 2:15
3 units, Sum (———) MTWThF

152. Introduction to Operations Research I—(Enroll in O.R. 152.) Introduction to deterministic models in operations research. Linear, non-linear, and dynamic programming. Network analysis, inventory theory, simplex method, transportation problem, dual theorem, convex programming, integer programming, structure of deterministic dynamic programming problems, minimax theorem. Matrix notation will be introduced. (Not open to graduate students. See 252.) Prerequisite: Differential Calculus.
3 units, Win (———) MW 4:15–5:30

3 units, Spr (———) MWF 4:15–5:30

161, 162. Theory and Application of Statistics (Non-Mathematical)—This course is intended for the student who has had a single elementary statistics course. Tests of significance and estimation, with emphasis on the application and rationale of the most common methods. Chi-square, Least squares, Regression, Correlation, Non-parametric methods, Analysis of variance, Elementary design of experiments. Prerequisites: 7, 50, or 110, or Psychology 60 within the past 12 months, or permission of the instructor.
161. 3 units, Win (Solomon) MWF 11
162. 3 units, Spr (Solomon) MWF 11

199. Independent Study—For undergraduates. (Staff)

204. Sampling from Human Populations—Theory of simple and complex sample survey designs. Limiting distributions. Estimate theory for finite populations. The sampling of experiments. Prerequisites: Completion of or concurrent registration in 120.
3 units, Spr (Madow) given 1969–70

empirical sciences, the course will concentrate on the general theory of measurement and scaling. The last part of the course will deal with utility theory and related topics like subjective probability and decision criteria.

3 units, Aut (Suppes) TTh 2:15

207. Mathematical Models in Behavioral Sciences: Learning Theory—(Enroll in Philosophy 207.) Stimulus sampling and linear models for learning will receive the main emphasis. Modification of the basic models to deal with concept formation, perceptual problems and linguistic structures will be discussed.

3 units, Win (Suppes) MWF 9

208. Mathematical Models in Behavioral Sciences: Psychometrics—Examination of mathematical models in factor analysis, mental testing, latent structure analysis, scaling theory, and related topics.

3 units, Spr (Suppes) MWF 9


3 units, given 1969–70

216. Statistical Techniques for Industrial Problems—Review of principles of lot-by-lot acceptance inspection; variables inspection; recent results in use of economic costs and Bayesian statistical methods; general principles of sequential sampling plans; sampling plans for continuous production; life testing. Prerequisite: 120 or equivalent.

3 units, given 1969–70

217A. Introduction to Stochastic Processes—The theory and application of stochastic processes as models for empirical phenomena, with special emphasis on the following processes: Wiener, Poisson, stationary, normal, counting, renewal, Markov, birth and death. Prerequisite: 116.

3 units, Win (Stein) MWF 1:15

217B. Introduction to Stochastic Processes—Continuation of 217A.

3 units, Spr (Stein) MWF 1:15


3 units, Win (Lieberman) MWF 9


3 units, Win (Woodworth) MWF 11

220. Statistical Inference—For graduate students. Lectures same as Statistics 120.

3 units, Spr (Lieberman) MWF 9

220H. Statistical Inference—Honors version of 220.

3 units, Spr (Woodworth) MWF 11

221. Analysis of Variance—Theory of general linear hypotheses; important special cases of analysis of variance; case of unequal class frequencies. Prerequisite: 120 and some knowledge of matrix algebra, or consent of the instructor.

3 units, Win (Efron) MWF 10

222. Analysis of Variance II—Special topics under Model I; consequences of relaxing assumptions; randomization basis of inference; components of variance; applications. Prerequisite: 221.

3 units, Win (Efron) MWF 10

230A,B,C. Advanced Probability—Mathematical foundations, beginning with development of Lebesgue measure and integration. Fundamental concepts of probability, limit laws, laws of large numbers, convergence theorems, infinitely divisible distributions, conditional expectations, martingales. Prerequisite: Mathematics 116 or equivalent.

230A. 3 units, Aut (Siegmund) MWF 1:15

230B. 3 units, Win (Siegmund) MWF 1:15

230C. 3 units, Spr (Siegmund) MWF 1:15

236A. Mathematical Statistics—A survey of classical and modern statistics from an advanced mathematical point of view. Probability, games and decision theory, estimation, testing hypothesis, confidence intervals, Neyman-Pearson theory, large sample theory, non-parametric inference, sequential analysis, design of experiments. Prerequisites: 220; completion of, or concurrent registration in 221 and Mathematics 205A.

3 units, Aut (Olshen) MWF 2:15

236B. Mathematical Statistics—Continuation of 236A.

3 units, Win (Olshen) MWF 2:15

236C. Mathematical Statistics—Continuation of 236B.

3 units, Spr (Olshen) MWF 2:15
242A. Introduction to Time Series Analysis—Model fitting and prediction theory, correlation analysis, spectral analysis, and regression analysis of univariate and multivariate time series. Applications to communication theory (extraction and detection of signals in noise), statistical control theory, and economic time series. Prerequisites: 217A and 219.

3 units, Aut (Anderson) MWF 3:15

242B. Introduction to Time Series Analysis—Continuation of 242A.

3 units, Win (Anderson) MWF 3:15

249. Dynamic Optimization (Stochastic)—(Enroll in Operations Research 349.) Optimal prediction and filtering theory of linear systems; realization of theory of random processes, nonlinear prediction, plus some recent research results. Prerequisites: O.R. 347A, B or equivalent or consent of instructor.

3 units, Aut (Kalman) given 1969–70


3 units, Win (——) TTh 4:15–5:30


3 units, Spr (——) MW 4:15–5:30

252. Operations Research—(Enroll in Operations Research 252.) For graduate students who have not had the equivalent of Operations Research 152 and 153. Prerequisites: Calculus and Statistics 27, or 110, or 116.

4 units, Aut, Win (——) MW 4:15–6:05

255. Linear Programming—(Enroll in Operations Research 240.) This course will survey linear programming, emphasizing standard model formulation, fundamental theorems, variations of the simplex method and parame-
ate analysis of variance, classification problems. Application of group theory to multivariate analysis.

3 units, Win (Olkin) TTh 11:00-12:15

324B. Multivariate Analysis—Continuation of 324A.

3 units, Spr (Olkin) TTh 11:00-12:15

326A. Sequential Analysis — The Wald sequential probability ratio test, operating characteristics and applications; Bayes sequential decision problems; asymptotic shapes; sequential design of experiments; special topics. Prerequisites: 217A and 220.

3 units, Aut (Chernoff) MW 11

326B. Sequential Analysis—General theory of optimal stopping with applications to sequential statistical decision problems.

3 units, Win (Siegmund) MW 11

326C. Sequential Analysis — Continuous time sequential problems; stochastic control problems; one-armed and two-armed bandit problems; special topics.

3 units, Spr (Chernoff, Siegmund) MW 11

328A. Non-Parametric Statistical Inference —Statistical inference when functional form of underlying distribution is unknown; rank order statistics; sign tests; non-parametric discriminant analysis; non-parametric tolerance limits; theory of runs.

3 units, given 1969-70

328B. Non-Parametric Statistical Inference—Continuation of 328A.

3 units, given 1969-70


3 units, Aut (Stein) MWF 3:15

332B. Large Sample Theory—Continuation of 332A.

3 units, Win (Stein) MWF 3:15

336A. Decision Theory and Statistical Inference—Minimax theorem, admissibility and complete class theorem, formulation of statistical decision problems, sufficient statistics, testing hypotheses, estimation, comparison of experiments, and sequential problems. Prerequisites: 236A, B, C.

3 units, given 1969-70

336B. Decision Theory and Statistical Inference—Continuation of 336A.

3 units, given 1969-70

336C. Decision Theory and Statistical Inference—Continuation of 336B.

3 units, given 1969-70

343A. Foundations of Time Series Analysis —Hilbert space and function space methods of studying the probabilistic structure and statistical theory of time series. Prerequisite: 230B.

3 units, Win (Parzen) MWF 1:15

343B. Foundations of Time Series Analysis—Continuation of 343A.

3 units, Spr (Parzen) MWF 1:15

345. Special Topics in Time Series Analysis—Discussion of current theoretical and empirical research on time series analysis.

3 units, Spr (Parzen) T 1:15-3:05

351A. Geometrical Probability and Applications—Distribution of points in Euclidean space, random lines in a plane and in space, coverage problems, packing problems, measure and density for sets of geometrical objects, integral geometry for functions of convex plane figures and surfaces; emphasis on breadth of the fields of application (for example, astronomy, atomic physics, biology, crystallography, physical chemistry, sampling theory); unsolved problems.

3 units, Win (Solomon) TTh 10

351B. Geometrical Probability and Applications—Continuation of 351A.

3 units, Spr (Solomon) TTh 10

361. Classification and Pattern Recognition—An examination and comparison of procedures which use random data to define classes, to discriminate between classes, to assign individuals to classes, and to estimate error rates in assignment. Source material will be drawn from the current literature in mathematical statistics, and will include parametric and non-parametric approaches. Prerequisite: 236. Recommended: 324 and 328.

3 units, given 1969-70
384. Special Topics in Multivariate Analysis: Matrix Analysis and Inequalities—Consideration will be given to those topics in matrix theory and inequalities which are generally omitted from courses in matrix theory. Applications in statistics will be stressed. Prerequisites: Mathematics 113 and 114. Recommended: Statistics 220.

3 units, given 1969–70

399. Research—Research work as distinguished from independent study of nonresearch character listed in Statistics 199 and 299.

Any quarter (Staff) by arrangement
SCHOOL of LAW

Dean: Bayless Manning
Professors: Marc A. Franklin, Carl Bernhardt Spaeth
Lecturer: George Torzsay-Biber

THE WORK OF THE LAW SCHOOL

The School of Law was established as a department of the University in 1893. Its purpose is to provide a thorough legal education for students who are fitted by their maturity and their previous academic training to pursue professional study under university methods of instruction. The curriculum leading to the first degree in law (LL.B.) constitutes an adequate preparation for the practice of law in any English-speaking jurisdiction. Graduate work leading to the degrees of Master of Laws and Doctor of the Science of Law is also offered. (For full Law School Curriculum and Faculty see the School of Law Bulletin.) The Law School is on a two-term academic calendar. Registration for the Autumn Term will be held on September 4, 1968, and classes for Spring Term will terminate on June 11, 1969.

COURSES

GRADUATE

The following courses are open to qualified graduate students of other departments of the University upon permission of the instructor:

233. Introduction to the Civil Law System—This introductory course will be conducted in English and will be based on materials in English. It is the basic comparative law offering, its function being to introduce the student to the civil law system. Among the matters discussed will be the history of Roman law in Europe following the fall of the Roman Empire; the movement for codification and reform in the Eighteenth and Nineteenth centuries and the nature and impact of the Code Napoleon; the structure of the legal process in Italy and the roles played by legislature, executive, court, public authority and the legal profession; civil procedure, evidence and the trial of civil actions in Italian courts; the Italian Civil Code, and the movement toward unification of private law in Western Europe.

3 term units, Aut term

283. Roman Law—Study of Roman law as it has developed from the time of Augustus to that of Justinian. Although the private law will be studied in its entirety, emphasis will be on those parts which are still operative in modern civil law systems and in international law. Legal institutions will be studied through actual problems drawn mainly from Justinian's Digest and their solutions will be discussed in historical context. The main purpose of the course is to identify and study the fundamental principles of Roman law and, in addition, to provide a background for further study in jurisprudence, legal history, and comparative law. Roman text will be provided in English translation. Some knowledge of Latin is desirable but not required. A paper will be required.

3 term units, Spr term

333. Selected Problems in International Law and Organizations—Case studies will be selected from among the following: problems faced by the Organization of American States and the United Nations in Guatemala, the Dominican Republic, and Cuba; the United Nations and the Congo; the cluster of related questions presented by South Africa, South West Africa, and Rhodesia; the United Nations, SEATO, and Vietnam. Attention will be focused on the international aspects of civil strife.

3 term units, Aut term

NONPROFESSIONAL

The following nonprofessional course, open to juniors and seniors, as well as to graduate students in other departments, may be counted toward the A.B. degree but not toward professional degrees in law.

104. Law in Society — This course is designed for students who do not intend to undertake the professional study of law. Its purpose is to provide insight into how the law and legal institutions function as one important means of social control. The pri-
mary focus is on courts—a philosophical and functional study of their role and their relationships with other branches of government. Though not ignoring constitutional law, our main concern is with courts in their nonconstitutional role. We will explore this in a context relevant to communication: the law of defamation, privacy, government regulation of broadcasting, and free speech. Court opinions and readings provide the basis for class discussion.

5 quarter units, MTWThF 9, Spr Qtr (Franklin)
Dean: Robert J. Glaser

The School of Medicine was established as a department of the University in 1908, when the Cooper Medical College, which had been operating in San Francisco, was transferred to Stanford. Until 1959 clinical teaching and some teaching of the basic medical sciences were carried out in San Francisco, while the remainder was conducted on the University campus near Palo Alto.

In 1953 the Trustees of the University determined that the School of Medicine should be consolidated on the University campus in new facilities. Following many months of planning and preparation, and the development of a new program of medical education, and the construction of the Stanford Medical Center buildings for teaching, research and patient care activities, the School began its operation at Stanford in September 1959.

The purposes of the School of Medicine are to provide a basic education in medicine for students working toward the Doctor of Medicine degree, to offer advanced work in the basic sciences leading to the Doctor of Philosophy degree, and to conduct teaching and research programs to advance knowledge of the medical and related sciences and application of that knowledge to problems of illness and health. The following section outlines the plan of work toward the M.D. degree which is described in more detail in the separate School of Medicine Bulletin.

The Stanford Plan of Medical Education

The Stanford Plan of Medical Education is a five-year program which emphasizes medical education as an integral part of University education. The medical sciences are presented not only as they relate to medical knowledge and the treatment of patients, but also in the context of developing human knowledge. The unity of the medical sciences is stressed, rather than their diversity. Other major concerns are the role of medicine in society and the parts played by the patient and physician as members of society. The program is based on the belief that medical education is graduate education and that firsthand experience with the scientific method is essential. Therefore the Stanford Plan encourages learning in terms of attitude toward, and approach to, problems in medicine rather than in terms of acquiring techniques or accumulating data at the expense of interpretation. Each student is given maximum opportunity to develop his own interests as they complement the basic knowledge included in the work required of all students.

A student entering this program will find a thorough grounding in the humanities valuable, in addition to a basic understanding of the natural sciences. In addition, he will benefit from knowledge of both a modern foreign language and of mathematics through the calculus because these subjects contribute to the breadth of his liberal education and to his ability to take the fullest advantage of his medical education. The Medical Faculty believes it would be unduly restrictive to require these courses as a condition for admission, but urges any student contemplating a career in medicine to consider their usefulness seriously.

The striking feature of the program is the provision of time equivalent to one academic year distributed through the first three years of the program. Students entering the program with a baccalaureate degree may elect to use this time in formal course work in any department of the University (including those of the School of Medicine), in work toward an advanced degree, in research in any University department, or in programs of independent study tailored to individual interests and abilities. Those students who enter after three college years must use whatever portion of University time as may be necessary to fulfill requirements for a Bachelor's degree, after which the options open to those with degrees become available. Student interest in research is encouraged. To this end there is ample free time within the medical course and special physical facilities have been designed for student use. Fellowship support is available for matriculated students who wish to undertake such activities either in the summer or during free time.

For further details, see the separate School of Medicine Bulletin. Certain depart-
ments of the School of Medicine list work in this bulletin because of its interest to students working for other degrees.

ALLIED MEDICAL SCIENCES

SCHOOL OF NURSING

The School of Nursing offers a five-academic-year program leading to a Bachelor of Science degree and certification as a Public Health Nurse. The nursing major commences in the junior year. See the separate School of Nursing Bulletin for details.

DIVISION OF PHYSICAL THERAPY

Director: Lucille Daniels
Associate Professors: Lucille Daniels, Sarah Semens. Clinical: Herbert T. Browne, Catharine Graham, Helen Hardenbergh
Clinical Instructor: Donna J. Jensen

OFFERINGS AND FACILITIES

A two-year Master's degree program, beginning in 1968-69, is being offered for students entering the field of physical therapy. Candidates are prepared for practice and for the examination for registration in California and other states. The program is designed for students who are interested in a future career in administration or in academic or clinical teaching in the field.

The current undergraduate curriculum will no longer be offered after the graduation of seniors in 1969. The one-year Master's degree program for candidates who have completed an undergraduate curriculum will be discontinued temporarily.

Classes are held at the Stanford Medical Center in the Edwards Building, which houses lecture, laboratory, seminar and research rooms, a library, and treatment facilities.

Following initial directed clinical experience in the University's integrated rehabilitation program, students are assigned to affiliated hospitals and treatment centers to assure a well-rounded background of clinical work.

ADMISSION

Requirements for admission are a Baccalaureate degree, completion of prerequisite courses, and filing of an application including scores from the Aptitude Test of the Graduate Record Examination.

Students are admitted autumn quarter each year. Dates for registration and general information will be found in the Information Bulletin of the University.

TRAINEESHIPS, SCHOLARSHIPS, AND LOANS

The U.S. Government offers traineeships through the Rehabilitation Services Administration; awards are made by the Scholarship Committee of the Division of Physical Therapy.

The Marian Williams Memorial Scholarship is awarded each year by the Committee.

The Elks National Foundation, certain of their local chapters, and other organizations offer special scholarships for physical therapy students.

The Stanford Information Bulletin lists the long-term loan policies of the University and the details of the National Defense Student Loan Program.

Further information about traineeships and scholarships may be obtained from the Division of Physical Therapy on request.

PREREQUISITES AND OTHER COURSES

Basic prerequisites are courses in biology, chemistry, mathematics, human anatomy, human physiology and psychology. Physics and statistics are recommended. Each student's academic background will be reviewed on an individual basis for admission.

As a part of the physical therapy program, students will be enrolled in courses in anatomy, physiology, neurological sciences and biostatistics that are offered by the respective departments in the Medical School. Electives related to the field of health may be selected.

COURSES

100. Introduction to Physical Therapy — General survey of history of field, common physical disabilities, and current therapeutic procedures; observation of treatment. For
undergraduate students interested in a future career in the field.

2 units, Win (Daniels) T 3:15-5:05

150. Clinical Medicine I — Basic medical terminology; the causes, process, and effects of disease; repair of tissues following injury.

3 units, Aut (Special Lecturers) M 1:15-3:05 and one hour by arrangement

162. Physical Agents I — Analysis of the principles underlying the use of electrotherapy, massage, and hydrotherapy; practice of essential techniques.

2 to 3 units, Aut (Staff) MW 10-12 and open labs. by arrangement

163. Physical Agents II — Continuation of 162.

4 units, Win (Staff) lec. M 11-12 and Th 1:15-2:05; lab. WF 8-10 and open labs. by arrangement

170. Clinical Medicine II — Basic lectures in orthopedics, medicine, and surgery.

3 units, Win (Browne, Special Lecturers) M 8-10, T 1:15-2:05


2 units, Spr (Special Lecturers) Th 1:15-3:05

182. Kinesiology and Therapeutic Exercise I — Regional approach to functional anatomy; biomechanics and neuroanatomy related to body motion; organization and development of movement; theory and practice of neuromuscular reeducation; tests and measurements.

5 units, Aut (Forward, Kent, Semans) M 10-12, WF 8-10 and open labs. by arrangement

183. Kinesiology and Therapeutic Exercise II — Continuation of 182.

5 units, Win (Kent, Semans) lec. M 10-12, W 1:15-3:05, F 2:05-4:05 and open labs. by arrangement


3 units, Spr (Kent, Semans) TTh 9-12


2 units, Sum (Staff) S 9-11

193. Psychology of the Handicapped — Special problems of handicapped individuals related to reactions to illness and disability, patient-therapist relationships; emphasis on total rehabilitation of the patient.

2 to 3 units, Spr (Special Lecturers) by arrangement

195. Directed Clinical Experience in Physical Therapy — Students are assigned part-time to hospitals, rehabilitation centers, and crippled children's schools in the local area.

1 to 4 units, any quarter (Blood, Kent) by arrangement

200. Directed Clinical Experience in Physical Therapy — Students are assigned to treatment facilities for full-time work with patients.

3 to 8 units, any quarter (Blood, Kent) by arrangement

220. Human Motion and Therapeutic Procedures I — Functional anatomy; biomechanics and neuroanatomy related to body motion; organization and development of movement; analysis and practice of related therapeutic exercise procedures; tests and measurements.

5 units, Aut (Staff) MWF 10-12

221. Human Motion and Therapeutic Procedures II — Continuation of 220.

5 units, Win (Staff) MWF 10-12

222. Human Motion and Therapeutic Procedures III — Continuation of 221.

5 units, Spr (Staff) MWF 10-12

224. Analysis of Neuromuscular Disorders in Cerebral Palsy.

4 units, Sum (Semans, Forward) by arrangement

230. Instrumentation and Analysis of Clinical Testing — Presentation, discussion of principles and techniques of testing procedures, including electromyography and dynamometry; newer developments in the field and in related clinical areas.

5 units, Spr (Staff) MWF 1:15-3:05

232. Curriculum Development and Instruction — Objectives, organization, content, techniques in teaching courses in physical therapy.

5 units, Spr (Daniels) given 1969-70
233. Directed Teaching in Physical Therapy
   1 to 5 units, any quarter (Staff) given 1969–70

234. Seminar in Administration—Administrative problems in hospitals, clinics, schools of physical therapy; interprofessional relationships in comprehensive patient care.
   5 units, Spr (Daniels) given 1969–70

   3 units, Spr (Blood) TTh 10–12

240. Continuing Case Conferences in Rehabilitation—Observation of the care of patients with extensive disability and the use of the case conference technique for the integration of services; case studies and reports.
   1 to 2 units, any quarter (Staff)
   T 1:15–3:05

246. Individual Work.
   1 to 8 units, any quarter (Staff) by arrangement

280. Seminar in Research and Thesis Problems—Basic principles of research with emphasis on material applied to physical therapy.
   3 units, Spr (Staff) MWF 1:15–2:05

   1 to 10 units, any quarter (Staff) by arrangement

295. Research.
   (Staff) by arrangement

ANATOMY

Emeriti: Charles H. Danforth, William W. Greulich, Hadley Kirkman (Professors)
Executive Head: Donald J. Gray (Acting)
Professors: Donald J. Gray, Robert S. Turner
Associate Professors: A. Kent Christensen (on leave autumn, winter quarters), Donald L. Stillwell, Jr.
Assistant Professors: Doris J. Burda, Henry J. Ralston III

Instructor: Ferrell R. Campbell
Lecturers: Dean T. Clark, Burt L. Davis, Jr., Mitchell S. Madison, Robert W. Meyer, Reuben Stutch, Bernerd O. A. Thomas

PROGRAMS OF STUDY

Instruction in the Department of Anatomy is planned primarily to meet the needs of students in medicine, but, insofar as facilities permit, all of the courses are open to other properly qualified third- and fourth-year undergraduate and graduate students. Those who are not registered in medicine but wish to take work in the Department should make arrangements in advance with the instructors concerned.

Facilities are available for a limited number of doctors of medicine, or others with equivalent training, who may wish to do special dissections or pursue work on problems within the scope of the Department. Graduate study may be undertaken in such aspects of anatomy as are indicated by the courses listed. Programs combining work in anatomy and other fields of biology or medicine may be arranged.

ADVANCED DEGREES

Students desiring to become candidates for advanced degrees in anatomy should consult the general University regulations regarding such degrees, which are summarized in the section “Degrees” in this bulletin. Candidates for the degree of Doctor of Philosophy will be expected to have done the equivalent of at least the basic work offered in the Department. All programs leading to an advanced degree in anatomy must be worked out individually and approved by the Department faculty. It is expected that an average grade of B will be maintained. Approval must also be obtained by graduate students in other departments who wish to elect anatomy as a minor.

COURSES

#114. Practical Anatomy—Brief survey of human body by dissection, study of anatomical preparations. Lectures, demonstrations. For students of nursing, physiotherapy, hygiene, physical education or others similarly qualified. Cannot be substituted for any part of Anatomy 121.
   5 units, Aut (Campbell) TThF 1:15–4:05
121. Dissection of the Human Body—Demonstrations and lectures, including a series on human embryology. A few nonmedical students may be admitted by special arrangement.

3 units, Win (Burda, Gray, Turner)
   Th 1:15-4:05 and S 8:00-11:50
5 units, Spr (Lund, Ralston, Stilwells)
   W 2:15-5:05 and Th F 1:15-4:05

122. Histology—Structural and functional organization of cells, tissues, and organs, as seen with the light and electron microscopes. This course continued as 222.

3 units, Aut (Burda, Christensen, Kirkman) Th 1:15-4:05 and S 8:00-10:50
1 unit, Spr (Burda, Christensen, Kirkman)
   M 2:15-5:05

124. Cell Biology—Lectures on the living cell as an integrated biochemical system in which organelles serve as the basic units of organization. The main emphasis is on the structure and function of these organelles, and how their activities are integrated in the cell. Although Cell Biology is listed as a course in anatomy, faculty members from various other departments will participate, as well as some guest lecturers from outside the University.

4 units, Aut (Christensen)
   MTW 2:15-4:05 and F 1:15-2:05

145. Individual Work—When circumstances warrant, work not specifically provided for in scheduled courses may be carried on under supervision of one or more members of staff.

Any quarter (Staff) by arrangement

201. Topographical Anatomy—Laboratory study of fetal, infantile, adult cadavers; dissected and specially injected preparations, student reports relevant to this material. Prerequisite: 121 and 122.

2 to 5 units, any quarter (Gray) by arrangement

203. Research—By individual arrangement, approved by Department faculty.

Any quarter (Staff) by arrangement

204. Dissection of the Fetus—General introduction to fetal anatomy, or review and intensive study of selected regions. Enrollment limited. Ordinarily, prerequisites: 121 and a course in embryology.

Any quarter (Gray) by arrangement

212. Topics in Neuroanatomy—A seminar and laboratory course designed to introduce to advanced students selected research areas in neuroanatomy, emphasizing Golgi and Nauta methods and electron microscopy used for the study and interpretation of histological materials. Two lecture and four laboratory hours weekly. Limited to 10 students. Enrollment by permission of instructors.

4 units, Spr (Chow, Ralston, Staff) by arrangement, alternate years, given 1969-70

221. Dissection of the Human Body.

3 units, Aut (Gray, Lund)
   M 8:00-11:50 and S 9:00-11:50
3 units, Win (Campbell, Gray, Lund)
   M 8:00-11:50 and F 8:00-10:50
2 units, Spr (Campbell, Gray, Lund)
   S 9:00-11:50

222. Histology—Continuation of 122.

2 units, Aut (Burda, Christensen, Kirkman) F 9:00-11:50

323. Neuroanatomy—Structure of central nervous system of man, dissections, prepared slides, dissections of central nervous systems of other mammals. Prerequisite: 122. Enrollment of nonmedical students by previous permission of instructor.

5 units, Aut (Ralston, Stilwell, Turner)
   MWF 9:00-11:50

BIOCHEMISTRY

Executive Head: Arthur Kornberg


Associate Professors: George R. Stark, Lu bert Stryer

Programs of Study

The Department offers a first-year course in modern biochemistry which is required of medical students and open to qualified graduate students and senior undergraduates. Also a series of advanced courses is given by the Department; these are open to medical and graduate students who have completed the first-year course. (Additional qualifications are necessary for certain courses.)
ADVANCED DEGREES

The degree of Doctor of Philosophy is given by the Department, but not the Master's degree. Remission of fees and a personal stipend are available to those students accepted. For further information, applicants should write to Dr. G. R. Stark. A strong undergraduate background in chemistry (both physical and organic) is recommended. General University regulations about the Ph.D. degree are summarized in the section "Degrees" in this bulletin; the requirements of the Biochemistry Department are tailored to fit the background and interests of the student. Graduate students in other departments who wish to choose Biochemistry as a minor must obtain the approval of the Department.

Postdoctoral research training is available to graduates holding a Ph.D. or M.D. degree. Several fellowships, carrying stipends at current national levels, are awarded by the Department. Qualified graduates may apply to the departmental executive for further information. At present the chief research interests of the Department are in nucleic acids and proteins: their enzymatic synthesis, chemical structure, physical chemistry, and biochemical functions; and in the biochemistry of viral infection.

COURSES

101, 102. Biochemistry Lectures — These deal with basic biochemistry, and with special biochemical aspects of the various life processes. Required of medical students in Year 1, and open to graduate and advanced undergraduate students.

101. 4 units, Aut (Staff) MTWTh 11
102. 4 units, Win (Staff) MTWTh 11

102A. Biochemistry Laboratory—Required of medical students in Year 1, and open to graduate and advanced undergraduate students.

4 units, Win (Staff) MW 1:00–4:50
and T 1:00–3:50

103. Mechanisms of Biochemical Reactions — Detailed examination of a few selected topics; examples will be taken from processes such as enzyme-catalyzed hydrolyses and group transfer reactions, participation of coenzymes in enzymatic reactions, modification of enzyme structure and activity. Prerequisite: three quarters of organic chemistry; 101, 102 also recommended. Consent of the instructor required both for auditors and students enrolling for credit. 2 units, Spr (Stark) WTh 10

201. Research and Special Advanced Work. By arrangement

202. Seminar. By arrangement

211. Special Topics in Biochemical Genetics. 2 units (Kaiser) given 1969–70

212. Enzymology of Nucleic Acids—Recent advances in the enzymology of nucleotide and nucleic acid synthesis and degradation will be discussed. Special attention will be given to virus-induced enzymes. Prerequisites: Biochemistry 101 and 102. 2 units, Win (Lehman) given 1968–69

213. The Arrangement of Information in Chromosomes. 2 units (Hogness) given 1970–71

214. Ultracentrifugal Techniques of Studying Proteins, Nucleic Acids and Bacteriophages—A combined laboratory and lecture course designed to acquaint students with standard techniques and pitfalls of measuring molecular weights, sedimentation coefficients, and related information. Enrollment in the laboratory part of the course is limited, and consent of instructor is required. 3 units, Aut (Baldwin) given 1968–69

215. Special Topics in Biochemistry. 2 units (Berg) given 1969–70

217. Physical Chemistry of Proteins. 2 units (Stryer) given 1970–71

GENETICS

Executive Head: Joshua Lederberg*
Professors: Walter F. Bodmer, Joshua Lederberg, Eric M. Shooter
Associate Professor: Leonard A. Herzenberg
Assistant Professor: A. T. Ganesan
Senior Research Associates: Berthold Halpern, Elliott C. Levinthal

* Director, Lt. Joseph P. Kennedy, Jr. Laboratories for Molecular Medicine.
PROGRAMS OF STUDY

The Department offers courses for graduate students in Ph.D. and M.D. programs as well as for advanced undergraduates; programs of study and research training leading to a Ph.D. in Genetics; research training for medical students in the Medical Scientist Training Program; and research training to holders of the Ph.D. or M.D. The Department also participates in an interdepartmental program leading to a Ph.D. in Neurological Sciences.

The Department of Genetics is interested in applicants for the Ph.D. degree who have an interest in fundamental aspects of biology. It welcomes applicants with a background in biology, biochemistry and also chemistry, physics and mathematics or computation. The Department administers a Ph.D. program of unusual flexibility which makes special provision to support training in biology for students whose main background is in the physical sciences. Courses available in the Genetics Department and also in the Biochemistry, Biology, and other departments provide a broad basis for an overall training toward the Ph.D. program in Genetics.

The Genetics Department is also part of the Lt. Joseph P. Kennedy, Jr. Laboratories for Molecular Medicine which have been dedicated to further basic research in the etiology of mental retardation and the pathology of intellectual development. These facilities offer unusual opportunities for research and study in the fields of molecular biology, heredity, neurobiology, and developmental medicine. The program of the Laboratories together with courses in the various Neurological Science Departments of the Medical School and in the Biology Department cover the requirements of the Ph.D. degree in Neurological Sciences.

An Instrumentation Research Laboratory, founded with NASA support for basic research in exobiology, also offers special research opportunities in collaboration with other faculty involving advanced instrumentation, with special emphasis on real-time computer-linked experiments.

The principal areas for which research training is available at the present time are the function of DNA in bacteria, genetics of hemoglobin and immunoglobulins, genetics of antibody formation, immunogenetics and somatic cell genetics, the genetic control of human leukocyte antigens, biochemical neurogenesis, the investigation of extraterrestrial life, application of new physical methods to biochemical analysis, genetic demography, and population genetics.

Financial support for predoctoral and postdoctoral trainees is available including full tuition and personal stipend at current national levels. Support opportunities exist through appointments as part-time research assistants. However, applicants are also strongly encouraged to apply independently for National Institutes of Health, National Science Foundation, or other fellowships. Predoctoral applicants are encouraged to take the Graduate Record Examination in Biology, Chemistry, or Physics. Further inquiries should be directed to the Graduate Student adviser (predoctoral applicants) or the appropriate faculty member (postdoctoral applicants).

For further information on the availability of the following courses, consult the quarterly Time Schedule, or inquire at the Department Office. Additional courses in genetics are included in the listing of the Department of Biological Sciences.

COURSES

101. Man as Organism—Special undergraduate course (Undergraduates should enroll in Undergraduate Special 101). Impact of new biological knowledge on further evolution of the human species, the design of human beings. Topics discussed include eugenics, euphenics (control of development), mechanistic foundations of behavior, transplanted and artificial organs, duration of life, symbiosis of men and machines. Prerequisites: none.

1 unit, Aut (Lederberg, Staff) by arrangement

199. Supervised Study.

200. Individual Research.

201. Medical Genetics—Topics in general genetics and their application to human biology and pathology. Nonmedical students who wish to enroll in this course must obtain special permission from a faculty member.

2 units, Win (Staff) ThF 11

202. Medical Genetics — Continuation of 201.

2 units, Spr (Staff) TW 8
249. Cytogenetics — (Enroll in Biological Sciences 249.) Principles and modern methods of analysis of major cellular components. The structure and design of chromosomes from bacteriophages to higher organisms. The influence of chromosomal changes in development and evolution. Prerequisites: Biology 4 and 5 or 10, 11 and 12, knowledge of genetics, and consent of instructor.

3 units, Aut (Ganesan) MWF 10

302. Genetics Seminar.
(Staff) alternate F 4:15


2 units, Win (Herzenberg) alternate years, given 1969–70

308. Mathematical Genetics — (Enroll in Mathematics 279A.) Mathematical models in population genetics, ecology, population growth, and epidemiology. The first part of the course deals mainly with deterministic models in population genetics. Prerequisite: consent of instructors.

3 units, Aut (Bodmer, Karlin)
by arrangement, alternate years, given 1969–70

309. Selected Topics in Neurobiology—The course will emphasize those aspects of biochemistry which are of immediate relevance to the development and function of the nervous system. Prerequisite: consent of instructor.

2 units, Spr (Shooter) by arrangement, alternate years, given 1968–69

310. Human Population Genetics — Principles and methods of population genetics as applied to human populations. Topics covered will include estimation of mutation rates, loads, maintenance of balanced polymorphisms, population structure and the effects of genetic drift, genetic demography, transplantation genetics, etc. Emphasis will be on the comparison of theory with observation, rather than on the mathematical aspects of population genetics. However, a background of mathematics at least up to elementary calculus will be assumed. The course will be basically an extension of Genetics 201. Prerequisite: Genetics 201 or consent of instructor.

2 units, Aut (Bodmer) by arrangement, alternate years, given 1969–69

GYNECOLOGY and OBSTETRICS

Executive Head: Charles E. McLennan
Professor: Charles E. McLennan
Associate Professors: Robert C. Goodlin, Eugene C. Sandberg
Assistant Professors: Allen H. Gates, Ronald E. Gunther, Emmet J. Lamb

PROGRAMS OF STUDY

While the principal instruction in the Department is for students in medicine, candidates for the degree Master of Arts in Medical Sciences may major in Physiology of Reproduction. Candidates will be expected to have completed 45 quarter units, at least 15 units of which shall be from the following courses (or their equivalents): Anatomy 122, 145, 204, 222; Biochemistry 101, 102; Biology 103, 105; Physiology 251; Statistics 50; and 30 units of research in reproduction (Gynecology-Obstetrics 400). Each candidate will be expected to pass an oral examination covering the fundamentals of mammalian reproduction, and submit an acceptable thesis. In addition the University requirements regarding the Master’s degree, as given in the section “Degrees” of this bulletin, must be fulfilled.

COURSES

400. Research in Reproduction—Advanced course for graduate students registered in the School of Medicine, or for students working toward the degree of Master of Arts in Medical Sciences, or toward the Ph.D. under the Graduate Division Special Programs. Detailed study of particular topics in reproduction planned for the individual student by the appropriate staff member, supervised laboratory experiments. Prerequisites: Biology 12 and 116 or their equivalent.

(Staff) by arrangement
MEDICAL MICROBIOLOGY

Emeriti: Edwin W. Schultz (Professor); Helen S. Thayer (Instructor)

Executive Head: Sidney Raffel

Professors: Charles E. Clifton, Leonard Hayflick, Sidney Raffel, Carlton E. Schwerdt, Bruce A. D. Stocker

Associate Professors: Robert J. Roantree, Leon T. Rosenberg

Assistant Professors: Alfred A. Amkraut, Peter H. Duesberg

Instructor: Rodolfo W. Ferraresi

PROGRAMS OF STUDY

The Department of Medical Microbiology offers, in addition to the courses required of students of medicine, a group of courses for students who wish to specialize in various aspects of medical microbiology. An undergraduate program leading to the degree of Bachelor of Arts in Medical Microbiology is offered to seniors who have completed all of the essential premedical sciences (Biological Sciences, 15 quarter units; Chemistry, 24 quarter units; Physics, 12 quarter units), as well as Quantitative Analysis (Chemistry 110, 111). The following courses in the Department are normally covered during the senior year: Medical Microbiology 101, 225, 231, 238, 240, 242, 315; in addition, Biochemistry 101 and 102 are required. Students who fall below an average grade of C in Departmental subjects completed will become ineligible for more advanced courses.

ADVANCED DEGREES

MASTER OF ARTS

Preference in selection of students for available places is given to candidates for the Ph.D. degree. Candidates for the degree of Master of Arts will be expected to have completed the premedical requirements (see above) and Quantitative Analysis (Chemistry 111, 112), and to complete the following courses: Medical Microbiology 101, 225, 231, 238, 240, 242, 315, and Biochemistry 101, 102. At least 15 units of research bearing on the thesis subject must be completed. A grade average of B in Departmental courses is required for admission to thesis work. The candidate is expected to pass an oral examination of two hours' duration covering the fundamentals of medical microbiology, immunology, and virology at the end of the first year of work.

DOCTOR OF PHILOSOPHY

Candidates for the degree of Doctor of Philosophy must meet the preliminary requirements listed for the Master's degree and will follow courses approved by the major professors and the Department faculty, subject to general University regulations covering this degree. During the first year or two of graduate work, the foreign language requirement (French or German or a language approved by the Department) should be met, and courses taken in biochemistry (Biochemistry 101, 102), statistics (Psychology 60 or Statistics 50), the principles of computer science (e.g., Computer Science 136, 209), and molecular biology (e.g., Biology 113, 250). These general recommendations should be discussed with faculty advisers. Other recommendations contingent upon individual previous experiences and interests include: parasitology and mycology (Biology 124, 129); embryology and histology (Anatomy 112, 122, or Biology 103); genetics (Biology 248, 249, 252; Genetics 306); biochemistry (e.g., Biochemistry 211, 212, 213, 214, 215, 217); physical chemistry (e.g., Chemistry 171, 173); calculus (Mathematics 10, 11, 21, 22, 23); and general pathology (Pathology 201). The choice among these (or other) formal courses should be discussed with an adviser.

A grade average of B in Departmental and related subjects is required for admission to research work. The student is expected to pass an oral examination covering the general fields of the Department's offerings toward the end of his first year of graduate work. Students entering the Department with advanced standing in microbiology from other institutions are expected to take the final examination in Medical Microbiology 225, and in such other courses as may be stipulated, at the earliest time these examinations are regularly scheduled. Such students are required also to pass the oral examination during their first year of residence.
COURSES

101. General Bacteriology—Survey of fundamental aspects of bacteriology. Prerequisites: Biology 4, 5, and Chemistry 1, 2, 3.
5 units, Aut (Clifton, Staff), MWF 1:15; lab. MWF 2:15-4:05

121. Basic Medical Microbiology — An introduction to the principles of immunology, primarily for first-year medical students.
2 units, Spr (Staff) T 1:15-4:05 and W 1:15

222. Diseases and Care of Laboratory Animals — Lectures and demonstrations on the methods of restraint, anesthesia, and venipuncture used on the common species of laboratory animals. Emphasis will be placed upon the spontaneous diseases of laboratory animals and their influence upon research projects. Open to students of the School of Medicine and to graduate students in the biological sciences.
2 units, Aut, Win, Spr (Soave) by arrangement

225. Medical Microbiology — A course of lectures and laboratory exercises covering the fundamentals of pathogenic microbiology, with particular reference to bacteria and viruses. The course includes a discussion of the essential aspects of immunology and serology, of practical laboratory diagnosis, and of preventive measures. Prerequisites: required premedical sciences and 101, and 121 or 231.
5 units, Spr (Staff) M 8–12 and Th 9–12

231. Immunology and Serology—Lectures, demonstrations covering infection, immunity, antigen-antibody reactions. Prerequisites: 101 or 225, Biology 103 or Anatomy 122, and Biochemistry 101.
3 units, Win (Amkraut, Ferraresi, Raffel, Roantree, Rosenberg) MW 1:15 and F 2:15, alternate years, given 1968–69

231A. Immunology and Serology Laboratory.
3 units, Win (Amkraut, Ferraresi, Raffel, Roantree, Rosenberg) MW 2:15-5:05 and F 3:15-5:05, alternate years, given 1968–69

238. Bacterial Physiology — Lectures on physical and chemical aspects of bacterial growth, behavior. Prerequisites: 101 and Biochemistry 101.
3 units, Spr (Clifton) MWF 1:15

240. Virology — Lectures, demonstrations on general nature of plant, animal viruses, their relationships with their hosts. Prerequisites: 101 and 231, and Biochemistry 101.
3 units, Win (Duesberg, Schwerdt) TThF 1:15

240A. Virology Laboratory.
2 units, Win (Duesberg, Schwerdt) TTh 2:15-5:05

242. Topics in Bacterial Genetics—Lectures and demonstrations on inheritance in bacteria and their viruses, with emphasis on aspects relevant to infectious disease. Prerequisite: 101 (or equivalent). Consent of the instructor required for both auditors and students enrolling for credit.
3 units, Win (Stocker), MW 1:15 and F 2:15, alternate years, given 1969–70

250. Advanced and Special Work—Graduate students and selected undergraduate students who have completed necessary basic courses with satisfactory grade average may be admitted by instructor to advanced work on an informal basis in: general bacteriology, including bacterial physiology and genetics; medical microbiology; immunology and serology; or virology.
Up to 10 units, any quarter (Staff) by arrangement

300. Research — Students who have satisfactorily completed necessary foundation courses may elect research work in: general bacteriology, including bacterial physiology and genetics; pathogenic bacteriology; immunology and serology; or virology. Grade average of B in bacteriological subjects required for admission to research or thesis work.
Up to 10 units, any quarter (Staff) by arrangement

315. Seminar—Reports, discussions on selected topics by outside speakers. Required of all graduate students.
1 unit, Aut, Win (Staff) by arrangement

316. Literature Reviews—Review of litera-
tecture on special topics to be assigned by instructor.

3 to 5 units, any quarter (Staff) by arrangement

333. Current Topics in Immunology—An intensive review of the current literature in one or a few selected areas of interest chosen from among the following: specificity, immunogenicity, genetic variants of serum proteins, tissue specific antigens. Prerequisite: permission of the instructor.

2 units, Win (Amkraut, Raffel, Roantree, Rosenberg) by arrangement

PATHOLOGY

Emeritus: Bruno Gerstl (Associate Professor)
Executive Head: David Korn
Professors: Klaus G. Bensch, David Glick, David Korn, Lelland J. Rather, Lucien J. Rubinstein. Visiting: Ralph G. F. Parker
Associate Professors: Ronald F. Dorfman, Richard L. Kempson
Assistant Professors: George W. H. Bailey (on leave autumn quarter), Mary M. Herman (on leave 1968–69), Luis J. Fajardo, Jon C. Kosek, Robert C. Rosan, Alexander M. Saunders, Lloyd Silverman
Visiting Lecturer: Jean-Jacques E. R. Vanderhaegen

PROGRAM OF STUDY

The teaching of the Department is limited largely to the instruction of medical students, and is outlined in the School of Medicine Bulletin. The course listed below is open to nonmedical students.

COURSE

210. Histo- and Cytochemical Techniques — Diverse experimental techniques employed in histo- and cytochemical investigation will be considered with particular emphasis on quantitative aspects. Principles, methods, areas of application, and limitations will be included.

1 unit, Win (Glick) M 12:15

PHARMACOLOGY

Emeritus: Leon Kolb (Clinical Associate Professor)
Executive Head: Avram Goldstein (on leave 1968–69)
Acting Executive Head: Robert H. Dreisbach
Associate Professors: Lewis Aronow, Robert T. Schimke
Assistant Professors: Tatiana A. Assayken, Ernest F. Zimmerman
Instructors: Mannfred A. Hollinger, William B. Pratt
Visiting Lecturer: Richard K. Richards

PROGRAMS OF STUDY

The principal instruction offered by the Department of Pharmacology is for students in medicine. However, the required courses for medical students (Pharmacology 101, 201, 301) and elective courses are also open to qualified graduate students not registered in medicine. Programs leading to the degree of Doctor of Philosophy must be worked out by each student with the Department faculty. Candidates for the degree of Master of Arts are not accepted. Research opportunities are available for qualified students and for postdoctoral fellows. Prospective candidates for an advanced degree should consult the University's general requirements described in the section "Degrees" in this bulletin, and obtain further information from the Department. Consult Time Schedule for additional elective courses.

COURSES

REQUIRED COURSES


1 unit, Win (Staff) F 11
2 units, Spr (Staff) TTh 11

201. Pharmacology—Lectures and demonstrations. Drugs acting on renal, endocrine, reproductive, and other systems; general
pharmacology; toxicology; chemotherapy of infectious disease.

2 units, Aut, Win (Staff) TW 8
2 units, Spr (Staff) ThF 8

301. Pharmacology — Lectures and laboratory exercises. Problems of drug evaluation.
3 units, Win (Staff) M 8–12, T 11, and W 10–12

ELECTIVE COURSES

202. Hormonal Control of Cellular Metabolism and Development—A lecture, discussion, and reading course concerned with mechanisms of hormone effects on regulation of metabolism and development at the cellular and subcellular levels, dealing primarily with various vertebrate systems. Students should have knowledge of biochemistry and genetics.
1 unit, Win (Schimke) T 4:15

203. Cellular Regulatory Mechanisms in Carbohydrate Metabolism—A course of lectures and discussions on the different regulatory processes which keep the carbohydrate catabolic reactions in the cell in pace with its energy requirement; the effect of different hormones on the carbohydrate metabolism at the cellular and subcellular level. Prerequisite: Biochemistry 101 (first quarter) or equivalent.
1 unit, Win (Mansour) T 4:15, given 1970–71

205. Drug Metabolism—Lectures and discussions on the metabolic conversions of foreign compounds in the mammalian organism, including factors such as species, age, and genetic variability.
1 unit, Win (Aronow) T 4:15, given 1969–70

206. Drug Addiction, Tolerance, and Physical Dependence — Lectures and discussion with emphasis on recent research into the biochemical basis of these phenomena. Students should be conversant with modern biochemistry and genetics and should have taken (or be taking) courses in physiology and general pharmacology.
1 unit, Spr (Goldstein) T 4:15, given 1969–70

207. The Anti-Cancer Drugs—(Same as Radiology 207.) A joint course offered by the Departments of Pharmacology, Radiology, and Medicine. The biochemical basis of action of the anti-cancer drugs will be developed in detail, and current research trends (including clinical aspects) will be discussed by invited lecturers. Open to medical staff, and advanced medical and graduate students.
2 units, Spr (Staff) W 7:30–9:30 p.m.

213. The Use of Drugs in Population Control — Lectures and seminar discussion about population growth and its control through the use of pharmacological agents.
2 units, Aut (Kalman) T 4:15–6:05, given 1969–70

218. Environmental Toxicology.
1 unit, Aut (Dreisbach) T 4:15, given 1970–71

250. Tutorial Program—Guided readings in the literature of any area of pharmacology. A critical review paper may be required. Primarily for graduate students in pharmacology.
Any quarter (Staff) by arrangement

252. Research Methods in Pharmacology—Training in laboratory techniques applicable to pharmacological research. Primarily for graduate students in pharmacology.
Any quarter (Staff) by arrangement

259. Research Seminar—A weekly conference for discussion of current research in pharmacology.
1 unit, any quarter (Staff) by arrangement

300. Research — With the approval of the Department qualified students may elect research work in any area of pharmacology.
Any quarter (Staff) by arrangement

PHYSIOLOGY

Emeritus: James P. Baumberger (Professor)

Acting Executive Head: Maurice E. Krahl

Professors: Jefferson M. Crismon, Ronald Grant, F. Eugene Yates

Associate Professor: George A. Feigen

Assistant Professors: Julian M. Davidson, Geronimo Terres, Jr. Acting: Noel Thompson
PROGRAMS OF STUDY

The Department of Physiology offers required and elective courses for students in the School of Medicine, open also to other qualified graduate students. In addition, the Department offers advanced laboratory courses restricted to Ph.D. candidates in physiology.

The Department offers the Ph.D. degree, but not the Master's or Bachelor's degrees.

GRADUATE STUDY

Students with undergraduate or Master's degrees who have completed a year each of college chemistry (including lectures in organic chemistry), physics, calculus (differential and integral), and biology will be considered for admission to graduate study. An applicant must file a report of his scores (aptitude and advanced biology) on the Graduate Record Examination as part of his application. In the case of certain students, especially those with degrees in engineering or physics, the Department will consider admission even if the above requirements have not been met. In those cases the students will be expected to complete the requirements during their graduate studies.

Emphasis is placed on providing all graduate students with a strong background in the laboratory study of major physiological phenomena, from which they may undertake highly individual courses of advanced research and study. The total course of study is expected to occupy four years, including three summers. Required courses for all students are: Biochemistry 101 and 102 (without laboratory), Physical Chemistry (Chemistry 171 and 173), and Physiology courses 150, 151, 152, 250, 251, 350, 351, 310, and 311. In addition, students will take any three of these Physiology courses: 301, 302, 303, 304, 306, 307, 308, and 309. Other courses in computer science, mathematics, statistics, chemistry, physics, biology, or engineering may be arranged by agreement between the student and his faculty supervisor, but they are not required.

Qualifying examination — At the end of the second year in residence as a graduate student, each Ph.D. candidate will be given a written examination covering the material of the first two years of courses. This examination may be taken only after the respective course examinations have been successfully passed, and will be more comprehensive than the course examinations. Students may undertake individual programs of study after passing this examination, and the language examination.

Language examination — A reading knowledge of any one of the following languages is required: French, Russian, or German.

Dissertation and University Oral Examination — The results of independent, original work by the students are to be presented in a dissertation. The oral examination will be largely a defense of the dissertation.

FINANCIAL AID

Research assistantships or teaching assistantships are occasionally available to graduate students who have completed substantial work toward the Ph.D. degree in physiology. Tuition aid may be awarded to students holding research assistantships, and to a few first-year students.

Support for qualified students in years two through four may be applied for from the National Science Foundation and the U.S. Public Health Service.

In addition to graduate studies, this Department operates a postdoctoral program in Immunophysiology under a training grant from the U.S. Public Health Service. Two traineeships are available annually. The candidates must be U.S. citizens and holders of doctoral degrees in the Medical, Veterinary, Biological, or Physical Sciences. The stipendiary levels are set by the USPHS according to the level of experience and the number of dependents, but in any case they do not exceed $7,500 per annum. Applications should be made by letter directly to Dr. George A. Feigen before May 1.

COURSES


2 unit, Aut (Grant) FS 11

151. Circulation I—Lectures on mammalian circulation.

1 unit, Win (Crismon, Grant) F 1
152. Circulation II—Lectures on mammalian circulation; continuation of Circulation I.
3 units, Spr (―) T 1 and W 11

207. Research — Original laboratory research planned for individual students by the appropriate staff member and carried out under his guidance. Maximum 14 units in any one quarter. Open to graduate students only.

Any quarter (Staff) by arrangement

250. Physiology and Medicine — This interdepartmental course examines normal and disordered function in the respiratory, renal, fluid and electrolyte, and acid base systems. Lectures, demonstrations, clinical presentations, and laboratory projects are used.
7 units, Aut (Interdepartmental Staff) T 9–12, W 8–12, Th 8–12, and S 8

251. Endocrinology and Gastrointestinal Function — Lectures on the physiology of the endocrine, reproductive, and gastrointestinal systems.
3 units, Win (Davidson, Staff) Th 9–11 and S 8

301. Peripheral Circulation—Lectures and demonstrations on regulation of the peripheral circulation with emphasis on special features of the circulation in man. Prerequisites: Physiology 150, 151 and 152, or equivalent.
3 units, Aut (Crismon) W 4–6 and F 4, triennially, given 1969–70

3 units, Aut (Thompson) W 4–6 and F 4, biennially, given 1968–69

303. Physiological Control Systems—A lecture course for biologists on the systems analysis approach to selected physiological systems under negative feedback control. Examples for detailed analysis include regulation of arterial pressure, alveolar ventilation, adrenocortical function and pupillary area. The course includes a discussion of time bases (“biological clocks”). Prerequisites: Physiology 150, 151, 152, 250, 302, and one year of calculus.
3 units, Win (Yates) W 4–6 and F 4, biennially, given 1968–69

304. Immunophysiology Laboratory — A laboratory course in quantitative immunophysiology emphasizing basic immunological phenomena such as isolation and preparation of purified antigens and antibodies, quantitative analysis of specific precipitates, immuno-electrophoresis, immune hemolysis, isotopic labeling, identification of reactants by gel diffusion; quantitative tissue anaphylaxis. Limited to 15 students. Prerequisite: Biology 105 or consent of instructor.
4 units, Aut (Feigen, Terres) T 7:30–9:00 p.m.; lab. Th 9:00–4:05

2 units, Spr (Feigen) T 7:30–9:30 p.m., triennially, given 1970–71

307. Neurophysiology — Consideration in depth of selected aspects of central nervous system physiology. New concepts as well as new research data will be examined. Minimum 10 students. Prerequisites: Anatomy 323 and completion of Physiology 350.
2 units, Win (Grant) T 7:30–9:30 p.m.

308. Neuroendocrinology — A lecture and discussion course on selected topics of current interest in the general area of nervous and endocrine system interrelationships. Special emphasis will be placed on mechanisms for control of adenohypophyseal function; behavioral aspects of neuroendocrinology will also be treated. Prerequisites: Physiology 251 and 350, or permission of instructor.
2 units, Spr (Davidson) T 7:30–9:30 p.m., biennially, given 1968–69

309. Respiration — A lecture course designed to cover recent advances in mammalian respiration. Emphasis will be placed on the structure and function of hemoglobin, control of respiration, and environmental adaptation. Prerequisite: Physiology 250.
2 units, Spr (Terres) Th 7:30–9:30 p.m., triennially, given 1968–69
310. Physical Chemical Principles in Physiology — A quantitative, experimental approach to problems in thermodynamics, kinetics, transport, and bioelectric phenomena. Restricted to Ph.D. candidates in physiology.

2 units, Win (Feigen) TTh 2–5

311. Mammalian Physiology Laboratory — The course will introduce students to modern techniques of experimental surgery, instrumentation and data reduction in various areas of mammalian physiology, including human physiology but not including neurophysiology, which is taught in course 351. Prerequisites: Physiology 150, 151, 250, and 251. Open to Ph.D. and M.D. candidates only. Limited to 16 students.

2 to 4 units, Spr (Grant, Staff) by arrangement

350. Neurophysiology — Lectures on the basic physiology of the mammalian central nervous system. Anatomy 323 must be taken previously or concurrently, and Medicine 300 (Neurology) should be taken concurrently.

3 units, Aut (Grant) MWF 8

351. Neurophysiology Laboratory — Basic mammalian neurophysiological techniques. Open to Ph.D. candidates and qualified medical students only. Prerequisites: Physiology 350 and Anatomy 323.

2 units, Win (Grant and Neurology Staff) by arrangement

PROGRAM IN SPEECH AND HEARING SCIENCES

Emeritus: Virgil A. Anderson (Professor)
Director: Earl D. Schubert
Professors: Jon Eisenson, Earl D. Schubert
Associate Professors: Dorothy A. Huntington. Acting: Joel Stark. Clinical: Richard F. Dixon
Assistant Professors: James H. Dewson III (on leave 1968–69). Clinical: Lyman S. Barrett, Donald R. Calvert
Instructor: Robert H. Gottsleben

OFFERINGS AND FACILITIES

Activities in the Program are designed to prepare students for research, teaching at the university level, and for professional careers in the fields of language disorders, audiology, and the speech and hearing sciences. The programs are so organized as to make ample provision for electives outside the major, thus encouraging the student to gain a broad education along with his specialty.

The Program is fortunate in having its own library which contains a highly-selected core of books and journals, not only in the fields of speech and hearing but in related areas as well. Speech and hearing clinics provide opportunities for the student to supplement his experience and to conduct research with a wide range of speech and hearing disorders. The Scottish Rite Institute for Childhood Aphasia, a unit of the Division, provides additional facilities for training and research with a selected group of children with language disabilities. The speech and hearing laboratories are well instrumented for a wide variety of research projects, as well as for training in techniques of instrumental research.

SCHOLARSHIPS AND ASSISTANTSHIPS

The Phi Chapter of Kappa Alpha Theta Fund and the J. D. Zellerbach Fund provide scholarships specifically for students in the Program. Applications for these special scholarships should be made directly to the Director of the Program.

Assistantships are available to students who have sufficient background of training and experience. In addition, traineeships from the Vocational Rehabilitation Administration and from the Children’s Bureau are available for graduate students with the proper qualifications. A limited number of postdoctoral traineeships in audiology are available from the National Institute of Neurological Diseases and Blindness. Applications for assistantships or traineeships should be made directly to the Director of the Program.

PROGRAMS OF STUDY

DOCTOR OF PHILOSOPHY

The University’s basic requirements for the doctorate (residence, dissertation, examination, etc.) are discussed in the section “Degrees” in this bulletin. The student may specialize in any one of the three fields—
language disorders, audiology, or speech and hearing sciences.

Each student's doctoral program is planned individually with the needs and interests of the candidate in mind. The general University requirements for the doctorate are followed as they apply to residence, application for candidacy, etc. A reading knowledge of one foreign language is required.

Ordinarily doctoral candidates will complete a minimum of fifteen units of 400 (Doctoral Research) which is the formal course registration for the dissertation. The candidate is expected to attend a special doctoral dissertation seminar during each quarter of his residence or until his dissertation has been completed. (See course 400 for days and hours.)

Candidates for the doctorate may include a formal minor as a part of their total program. The minor is chosen in consultation with the candidate's major adviser, but the content and details of the minor program are specified and administered by the department in which the minor is taken.

The student will take a qualifying examination prior to admission to the University oral examination. The University oral examination will be focused on the dissertation.

**Postdoctoral**

A limited number of postdoctoral trainees and fellows will be accepted each year. For information, write to the Director of the Program.

**Non-Majors**

It is hoped that a number of the courses will prove useful as electives to graduate students from other departments.

**COURSES**

200. Individual Study—Study under direction in fields or subjects of special interest. Prerequisite: permission of instructor.

1 to 3 units, any quarter (Staff)

by arrangement

212. Phonetic Theory—Study of the basic types of sound elements characteristic of spoken language. Special emphasis will be placed on phonetic and phonemic sound change, with applications to English. Prerequisite: knowledge of phonetic or phonemic transcription.

3 units, Aut (Bush) MWF 2:15

220. Psychology of Speech—Origin, development of speech, semantics; relation of speech to thought, emotion, personality.

3 units, Aut (Eisenson) MWF 9

223. Speech and Language Development—Psycho-social, intellectual, and linguistic correlates.

3 units, Spr (Stark) MWF 8

230. Speech Science I—Study of the structure of the speech mechanism and its function. Special attention will be given to recent research in respiratory control, the nature of phonation, and the articulatory adjustments characteristic of spoken language.

4 units, Win (Bush) MTWF 2:15

231. Speech Science II—Study of the acoustic characteristics of speech with reference to their physiological and perceptual correlates.

3 units, Spr (Huntington) MWF 2:15

250. Stuttering—Theories of etiology and therapeutic approaches to stuttering.

3 units, Win (Eisenson) MWF 9

Sum (——) MTWF 1:15

252. Aphasia—Historical survey, pathology; methods of testing, diagnosis, therapy.

3 units, Spr (Eisenson) MWF 9

253. Aphasia in Children—Language disorders and related problems in children with perceptual dysfunctions. Prerequisite: permission of instructor.

3 units, Win (Stark) TWF 1:15

Sum (Eisenson) MTWF 9

270. Clinical Practice in Speech and Hearing—Prerequisite: permission of instructor.

1 to 4 units, any quarter (Staff)

by arrangement

271. Clinical Practice in Audiology—Prerequisite: permission of instructor.

1 to 4 units, any quarter (Dixon, Staff)

by arrangement

281. Hearing Measurements and Interpretation—Theory, practice in measurement of audition. Interpretation of hearing tests.

4 units, Win (Dixon) MWF 8 and one hour by arrangement
284. Advanced Clinical Audiology — Differential diagnostic procedures. Prerequisite: 281 or equivalent.
4 units, Spr (Dixon) MTWF 8

286. Industrial Audiology — Determining industrial hazards to hearing; medico-legal problems of noise-induced hearing loss; control measures. Prerequisite: permission of instructor.
2 units, Spr (Dixon) TTh 9

289. Aural Rehabilitation—Speech reading, auditory training, and speech training for the acoustically handicapped.
4 units, Win (---) MTWF 10

290. Language Training for the Deaf Child —Unless otherwise arranged, the student is expected to register for 1 unit of 270 concurrently. Prerequisite: permission of instructor.
4 units, Spr (---) MTWF 10

291. Hearing Aids and Residual Hearing—Description and acoustic measurement of wearable amplification systems. Hearing aids as rehabilitative devices. Prerequisite: permission of instructor.
3 units, Aut (Dixon) MTWF 8

292. The Auditory Process — A systematic survey of our current knowledge of the operation of the auditory system. Emphasis is placed on acquiring a knowledge of the acoustic signal, and on an understanding of the methods of measuring a sensory process.
4 units, Win (Schubert) MTWF 10

300. Independent Study — Advanced individual study under direction in fields or subjects of special interest. Maximum 12 units in any one quarter.
Any quarter (Staff) by arrangement

301. Research — Individual research projects under direction. Maximum 12 units in any one quarter.
Any quarter (Staff) by arrangement

308. Research Methods — Prerequisite: some training in statistics.
3 units, Aut (Huntington) MWF 1:15

310. Experimental Phonetics I — Study of experimental work in physiological characteristics of speech. Lectures, demonstrations, laboratory.
4 units, Aut (Huntington) Th 9–11 and two hours by arrangement

311. Experimental Phonetics II — Study of experimental work in acoustic characteristics of speech. Lectures, demonstrations, laboratory.
4 units, Win (Huntington) Th 9–11 and two hours by arrangement

4 units, Spr (Huntington) Th 9–11 and two hours by arrangement

330. Seminar in Phonetics and Speech Science—Material will vary from year to year; hence, may be repeated for credit.
4 units, Spr (Bush) MW 3:15–5:05

340. Seminar in Speech Pathology—Material will vary from year to year; hence, may be repeated for credit.
4 units, Aut (Stark) MW 3:15–5:05
3 units, Sum (Stark) MW 3:15–5:05

366. Acoustic Instrumentation I — Basic principles of electronic circuits. Description and application of instrumentation commonly used in speech and hearing sciences. Prerequisite: permission of instructor.
3 units, Aut (---) M 7–10 p.m.

370. Clinical Internship—In-service clinical practice and observation in selected speech and hearing centers. Prerequisite: permission of instructor.
1 to 12 units, any quarter (Staff) by arrangement

380. Seminar in Audiology—Material will vary from year to year; hence, may be repeated for credit.
4 units, Win (Dixon) MW 3:15–5:05
3 units, Sum (Dixon) MW 3:15–5:05

381. Seminar in Experimental Audiology—Material will vary from year to year; hence, may be repeated for credit.
1 to 4 units, Win (Dewson) by arrangement

4 units, Aut (Schubert) MTWF 11
393. Experimental Audiology II: The Peripheral Mechanism—Study of the mechanics and electrophysiology of the middle and inner ear. Analysis of the ear as a transducer, and of the neural encoding process. Prerequisite: permission of instructor.

3 to 4 units, Win (Schubert) MWF 10

394. Experimental Audiology III: Central Auditory Mechanisms—Anatomy and physiology of the central auditory system. Demonstration of electrophysiological research procedures. Prerequisite: permission of instructor.

4 units, Spr (Dewson) MTWF 11

400. Doctoral Research.

1 to 15 units, any quarter, (Staff) T 4:15

AFRICAN STUDIES
NDEA LANGUAGE
AND AREA CENTER

Director: Joseph Greenberg

The African Studies Language and Area Center offers courses in beginning and advanced Hausa, beginning and advanced Swahili and Yoruba through the Department of Linguistics. In other departments in the University, courses are offered which cover the political development of Africa, European expansion in the African area, expansion and contraction of Islamic domains, foreign trade problems of developing countries; comparative sociology, peoples of Africa, education in a developing country, and other courses dealing in whole or in part with the study of Africa. No degree is offered in African Studies as such. The degrees are offered from the various individual departments. For a complete list of courses available in African Studies, please see the sections for the Departments of Anthropology, School of Education (Stanford International Development Education Center), Food Research Institute, History, School of Law, Linguistics, Sociology, and Political Science.

For further information please write to Joseph H. Greenberg, Chairman, Committee on African Studies, Stanford University, Stanford, California 94305.
BIOPHYSICS PROGRAM

Committee on Biophysics
Chairman: Mitchel Weissbluth
Professors: William A. Little (Physics), Harden M. McConnell (Chemistry)
Associate Professors: Philip C. Hanawalt (Biological Sciences), Eric M. Shooter (Genetics), Mitchel Weissbluth (Applied Physics), Dow O. Woodward (Biological Sciences)
Lecturers and Research Biophysicists: Earl E. Jacobs, Howard H. Pattee
Research Associate: John E. Maling

Offerings and Facilities
The Biophysics Program offers instruction and research opportunities leading to the degree of Doctor of Philosophy in Biophysics. Students admitted to the Program may perform their graduate research in the Biophysics Laboratory or, through special arrangements, in other University departments.

The Laboratory has its own library and research facilities for staff and students. Opportunities for research are currently available in the fields of electron paramagnetic resonance spectroscopy, cellular control mechanisms, physical chemistry of bacterial DNA during the growth cycle, molecular photobiology, abiogenic molecular evolution and the origin of life, thermoluminescence, Mossbauer resonance, mitochondrial electron transport and oxidative phosphorylations, magnetic and optical properties of metallo-proteins, theoretical biophysics.

Program of Study
The program is designed for graduate students only, and leads to the degree of Doctor of Philosophy in Biophysics. Each student's program will be worked out with his adviser. Typical requirements for the degree are as follows:
1. Training in physics equivalent to that of an undergraduate physics major at Stanford. Students with a comparable background will automatically satisfy this requirement; others will need to take only those courses in which deficiencies exist.
2. A graduate minor in one field selected from biology, chemistry, or physics. The requirements for the minor, as specified by the respective departments, are as follows:
   a) Minors in physics must take either Physics 210, 211, and 212 or Physics 130, 131, and 132 or Physics 170, 171, and 172 with the appropriate prerequisites. All physics minors must pass the comprehensive examination given to physics majors, but need take this examination only when they feel prepared for it.
   b) Minors in chemistry must complete, with a grade point average of 3.00 or better, at least 12 units of chemistry courses more advanced than those that meet the minimum requirements for the Bachelor's degree in chemistry. At least 3 units must be from Chemistry 221, 223, 225, 251, 253, 271 or 273.
   c) The minor requirement in Biology is fulfilled by the successful passing of the Departmental qualifying examination.

Students may petition for permission to substitute other fields of specialization (e.g., mathematics, electrical engineering) to satisfy the requirements of the minor.

3. Completion of the following courses with a grade point average of 3.00 or better:
   a) Chemistry 271, 273, 275.
   b) Biochemistry 101, 102, 102A.
   c) Biology 113A, 114.
   e) Four units of any other life science courses which include laboratory work.

4. Reading ability in one language selected from French, German, or Russian.

5. After fulfilling the above requirement, each student must pass a comprehensive examination based primarily on course material. He may then apply for Ph.D. candidacy.

6. Each student is required to pass the University oral examination which is to be taken only after the student has substantially completed his research.
7. The satisfactory completion of research and acceptance of the resulting dissertation conclude the requirements.

**Courses**

200. Molecular Biophysics—(Enroll in Biological Sciences 250.) A survey of physical approaches to biological problems at the molecular level. Lectures include discussion of intra- and intermolecular forces and their relation to biological structure, physical methods for characterizing macromolecules, the interaction of electromagnetic radiation with biological molecules, isotopic tracer techniques, and classical physics of cellular processes. Assigned readings and problems. Prerequisites: Biology 10, Chemistry 121, and Physics 57, or permission of instructor.

3 units, Aut (Hanawalt) TTh 10, T 7:15 p.m.

220, 221. Energy, Entropy, and Information—A rigorous analysis of the energy, entropy, and information transformations accomplished by living organisms. The lectures will include a generalized theoretical development of the fundamental principles of energy, entropy, and information transformations in open systems and their application to the detailed reactions of cell metabolism and to the origin and evolution of complex chemical systems, life and the phenomenon of consciousness. Prerequisite: permission of instructor.

220. 3 units, Win (Jacobs) by arrangement
221. 3 units, Spr (Jacobs) by arrangement

230, 231, 232. Advanced Molecular Biophysics—Properties of biological molecules from the standpoint of quantum mechanics. Molecular orbitals, ligand fields, group theory, interpretation of spectra, magnetic properties, electron spin resonance, interaction with radiation, mechanisms of energy and charge transfer. Prerequisite: Physics 132 and Chemistry 275 (may be taken concurrently).

230. 2 units, Aut (Weissbluth) MW 1:15
231. 2 units, Win (Weissbluth) MW 1:15
232. 2 units, Spr (Weissbluth) MW 1:15
Alternate years, given 1968–69


3 units, Spr (Pattee) by arrangement

250. Molecular Photobiology—Lecture topics include photochemistry of molecules of biological interest, effects of ultraviolet light on simple biological systems, photoreactivation, photodynamic action, etc.

2 units, Spr (Hanawalt, Smith) W II–I

252. Radiation Biology—(Enroll in Radiology 14.) Radiological physics, target theory and other mechanisms of biologic action, radiochemistry and radiation biochemistry, cellular radiobiology, general and special radiation pathology, acute lethal and immunological effects of whole-body exposure, genetic effects of radiation, relative biological effectiveness (RBE) as a function of linear energy transfer (LET), recovery kinetics, radiation carcinogenesis and other late effects, and applications of radiobiology to clinical radiotherapy. See Medical School Bulletin.

2 units, Spr (Kaplan)

253. Radioactivation Analysis—(Enroll in Civil Engineering 278.) The use of radioactivation as a research tool: radioactivation, properties of radioisotopes, sources of irradiations, activation analysis, practices and uses in biology, chemistry, physics, and engineering.

2 units, Spr (Staff) TTh 11

255. Biophysical Measurements—A course covering the underlying theory, experimental procedures, and methods of interpretation of modern biophysical instruments and techniques. The staff will arrange instruction on two or three of the following topics each year: electron paramagnetic resonance, infrared spectroscopy, electrochemical measurements, chromatography, optical microscopy, microdensitometry, spectrofluorimetry, radioactive tracer methods, ultracentrifugation, ultraviolet spectroscopy, and computer techniques.

Any quarter (Pattee, Staff) by arrangement
   2 units, Win (Pattee) by arrangement

300. Research.
   Any quarter (Staff) by arrangement

310. Literature of Biophysics — Intensive study of literature of any special topic in biophysics. Preparation of a report.
   Any quarter (Staff) by arrangement

COMPUTATION CENTER

Director: Edward A. Feigenbaum
Deputy Director: Norman R. Nielsen
Associate Director for the Campus Facility: Roderic M. Fredrickson
Associate Director for the SLAC Facility: Charles R. Dickens
Associate Director for the Real Time Facility: Giovanni Wiederhold
Interfacility Associate Director: Ronald D. Jamtggaard
Affiliated Faculty:
   Professors: George E. Forsythe, John G. Herriot, William F. Miller
   Associate Professors: Edward A. Feigenbaum, Gene H. Golub
   Assistant Professors: William M. McKee-man, Niklaus E. Wirth

The Stanford Computation Center was established in 1953 to provide high-speed digital electronic computing facilities for research work at the University. Its present mission is to provide University-wide computation service for both education and research through the Campus Facility. In addition, it is responsible for systems and operations management at the ACME Medical Research Facility and the Hybrid Computer Laboratory for on-line data acquisition and experiment control, and at the SLAC Linear Accelerator Facility for high energy physics calculations. The services of the Campus Facility are available to University staff members in connection with research work and to students in connection with Stanford courses.

The Campus Facility of the Computation Center is housed in Pine and Polya Halls on the Jordan Quadrangle. The equipment currently operated by the Facility includes a drum based IBM 360/67 computing system with high speed disks for on-line storage of users’ programs and data. There is also a variety of peripheral gear such as tape units, graphical plotters, and typewriter terminals. Many of these terminals are located remotely throughout the campus, permitting users to interact directly and immediately with the computer without the necessity of frequent trips to Pine Hall.

In addition to the above equipment, the Facility maintains a comprehensive library of analysis programs and statistical routines to assist users in solving their data processing problems. Programming languages available on the Stanford 360 include ALGOL, COBOL, FORTRAN, GPSS, LISP, PL/1, and 360 ASSEMBLER. Many other software packages that run under the IBM operating system OS/360 are available to users.

It is the desire of the Campus Facility to assist actual and potential users of its services as much as possible. The staff in Polya Hall stands ready to provide advice and counsel in program development and problem solving. Nevertheless, it is expected that all users will do their own programming and will make any necessary adaptations of available programs for their particular application.

INSTRUCTION

At various times throughout the year the Campus Facility offers short courses in the use of the data processing and time-sharing equipment at the Facility as well as in the use of the major programming languages
available at Stanford. In addition, when special requirements exist for computer education in particular areas, the Campus Facility is prepared to offer courses to meet those needs.

1. Introduction to a Programming Language—FORTRAN, Job Control Language, PL/1, etc. Courses are offered continuously for those persons desirous of developing solutions to their problems through the use of the facilities available at the Campus Facility.

No credit; any quarter (Staff) by arrangement; usually meets 2 hours per day for six days over a period of two weeks as announced. The classes include an informal supervised programming laboratory. Contact the User Services Group at the Campus Facility for registration or information about these courses. Do not register officially with the registrar.

Other introductory courses:
Introduction to Programming — See Computer Science 5, 50A,B, 126, 136, 238.

**FOOD RESEARCH INSTITUTE**

*Emeriti:* Merrill K. Bennett, Karl Brandt, Joseph S. Davis, Helen C. Farnsworth, S. Daniel Neumark, E. Louise Peffer, Vernon D. Wickizer, Holbrook Working (Professors)

*Director:* William O. Jones

*Professors:* Roger W. Gray, Bruce F. Johnston, William O. Jones, Dudley Kirk

*Associate Professors:* John A. Jamison, Benton F. Massell, Clark W. Reynolds, Pan A. Yotopoulos

*Assistant Professors:* Paul I. Mandell (Geography), Scott R. Pearson, C. Peter Timmer, Victor C. Uchendu

*Associate Agronomist:* Kenneth R. M. Anthony

*Associate Statistician:* Rosamond H. Peirce

*Librarian:* Charles C. Milford

**OFFERINGS AND FACILITIES**

The Food Research Institute endeavors to familiarize graduate students with both the methods and results of its long research into problems of food supply, distribution, and consumption and into the economic development of agriculture. A number of specialized courses of instruction, some of them unique in character, are offered. In addition to the courses given in the Food Research Institute, students enrolled there are required to enroll in approved courses in other departments, and Ph.D. candidates are required to complete an approved program in the Department of Economics.

The Institute does not undertake supervision of studies leading to a Bachelor’s degree, though certain of its courses may be counted toward a major in economics and in some special programs in other social sciences.

The graduate program is designed especially for students who plan careers in research into the economics of food and agriculture, whether in universities, governments, or private business. Students presenting evidence of high ability together with appropriate training, such as a Bachelor’s degree or better, in economics or agricultural economics, may be accepted for graduate study in the Institute, leading to the degrees of Master of Arts and Doctor of Philosophy.

The Institute’s specialized library contains some 50,000 items, including up-to-date series of rare periodicals from over fifty countries, and is open for reference to students and others.

The Institute publishes a journal, *Food Research Institute Studies*, three times a year, which serves primarily as an outlet for staff research in progress.

**MASTER OF ARTS**

The requirement for the Master’s degree is the satisfactory completion of an approved program of study amounting to not less than 45 units of credit, at least half of which must be Food Research Institute courses.

**DOCTOR OF PHILOSOPHY**

To qualify for admission to candidacy for the degree of Doctor of Philosophy in the graduate study program of the Food Re-
search Institute, a student must have satisfied the faculty of the Institute that he is qualified to complete with success the program outlined below. Students are usually recommended for admission to candidacy only after they have completed with distinction the Master’s program of the Institute.

To be recommended to the University Committee on the Graduate Division for the degree of Doctor of Philosophy, the following requirements must be fulfilled:

1. Completion of at least two years in the program of the Institute.
2. Completion of a dissertation acceptable to the faculty of the Institute and to the University Committee on the Graduate Division. The subject should be approved prior to application for admission to candidacy, and the dissertation must be substantially completed before taking the examinations described in the following paragraph.
3. Demonstration of scholarly proficiency in Institute comprehensive written examinations and in an oral examination administered by the University Committee on the Graduate Division. Such examinations will cover the dissertation subject and three fields of study, ordinarily from the following list: General Commodity Analysis; Economics of Agriculture; Commodity Prices and Markets; Agricultural Marketing; Economics of Food Consumption; Agriculture in Tropical Economies; International Trade in Primary Commodities; and Agriculture and Economic Growth. Other fields may be offered by arrangement with the Instruction Committee.
4. Completion of a minor in statistics, or in economics, or of an alternate program, approved by the Institute, which conforms to one of the following guidelines:
   a. The candidate will be required to take the core course on the theory of income and economic fluctuations offered by the Economics Department (Econ. 210, 211, 212). In addition, he must complete two of the following regular “sequence” courses offered by that department:
      Economics 202, 203, 204. (Price and Allocation Theory)
      Economics 215, 216. (Economic Development)
   b. Candidates who do not have a strong background in economic theory will be required to take additional work in price and allocation theory. This work may be taken in the Economics Department, Engineering-Economics Systems, or the Graduate School of Business, with the approval of the Instruction Committee.
   c. All candidates must complete the following:
      1) The income and economic fluctuation sequence (Econ. 210, 211, 212).
      2) At least two courses of statistics beyond the elementary course.
      3) Either Mathematics 43 or Statistics 63 (Mathematics for Social Scientists). Completion of Statistics and Mathematics courses shall require grades of C or better.
5. To meet the foreign language requirement, a candidate must demonstrate a reading knowledge of two languages other than English. Upon written petition to the Instruction Committee, a candidate may secure permission to offer an approved program in mathematics, statistics, or other area in lieu of a second foreign language. The approved program in mathematics or statistics must entail course work beyond the requirements stated above.

If a candidate desires to offer languages other than French or German, he should obtain permission of the Instruction Committee. In general, a candidate will be allowed to substitute another Romance language for French or another Germanic language for German if such other language will facilitate the candidate’s program of research. In the case of foreign students, whose original language is not English, the candidate’s native language may be accepted as one of the two languages.

**FELLOWSHIPS AND SCHOLARSHIPS**

The Food Research Institute has available a limited number of fellowships and scholarships for qualified students. University fellowships, in addition, are open to all stu-
students. Applications for all fellowships and scholarships should be made to the Admissions Office, Stanford University.

COURSES

#1. Human Geography—This course seeks to acquaint the student with the geographic point of view and some of the materials of geography fundamental to an understanding of man-environment relations and patterns of resource use. Major themes are the relation between changing earth environments and human evolution, changing man-land relations in culture history, natural environments and contemporary livelihood systems, the determinants of the spatial structure of economic and social institutions, and the determinants of patterns of resource evaluation and utilization. Instruction is given in those branches of physical geography most relevant to the concerns of social sciences.

5 units, Win (Mandell) MTWThF 10

103. Economics of Food Consumption — (May be taken as 203 by graduate students.) Food supplies and requirements in a developing economy; the major food groups, international contrasts and trends in food-consumption patterns; interrelations of food, population, and economic progress.

5 units, Aut (Johnston) MTWThF 11

105. Commodity Futures Markets and Prices—(May be taken as 205 by graduate students.) Description of the uses and functioning of commodity futures markets, with emphasis upon business uses of the markets. The meaning of hedging and the evolution of hedging practice. Determinants of the level of market use, and the relationship between level of use and market usefulness. Consideration from the evidence of price behavior, trading composition, and external influences, of the performance of futures markets in price determination and other functions. The extent, influence, and importance of speculation in commodity futures.

5 units, Aut (Gray) MW 4:15–6:05

118. The Geography of Latin America — Examines the important features of the physical environment of Latin America and their influence upon patterns of economic growth and national development. The major sectors of the economy are viewed with regard to historical and contemporary patterns of location, and resource utilization.

5 units, Spr (Mandell) MTWThF

134. Economics of American Agriculture — (May be taken as 234 by graduate students.) The structure and organization of American Agriculture. Economic analysis and policy problems.

5 units (Staff) by arrangement

135. Population Problems—(May be taken as 235 by graduate students.) Analysis of U.S. and world population growth. Economic and social causes and consequences of trends in births, deaths, and migration. Population in relation to food and development; population theories and policies; national family planning programs.

5 units, Win (Kirk) by arrangement

140. Physical Resources and Problems of Their Efficient Use in Agriculture—(May be taken as 240 by graduate students.) The physical, technical, economic, and social determinants of patterns of resource use are examined. Principles of soil science, hydrology, climatology, and crop ecology are discussed in terms relevant to the students of the economic and social problems of agriculture and agrarian societies. Tropical resource problems are considered.

5 units, Spr (Mandell) MTWThF 3:15

160. Economic Development of Tropical Africa—Traditional organization of production and distribution, economic achievements under European rule, economic problems of political independence. Food and agricultural economies, internal and external trade, levels and standards of living, national accounts, development plans, and capital formation.

5 units (Staff) by arrangement

170. International Aspects of Economic Development—(May be taken as 270 by graduate students.) Topics will include export instability, the terms of trade, exports vs. import-substitution, the prospects for commodity trade, trade in manufactures, capital inflows, commercial policy, foreign aid, and customs unions. Emphasis will be on theory and related empirical evidence. Prerequisite: previous work in international trade theory or economic development.

3 units, Win (Massell) M 2:15
COURSES PRIMARILY FOR GRADUATE STUDENTS

203. Economics of Food Consumption — See 103.
5 units, Aut (Johnston) MTWThF 11

205. Commodity Futures Markets and Prices — See 105.
5 units, Aut (Gray) MW 4:15–6:05

215. Marketing Problems in Agriculture —
Analysis of institutional arrangements in food marketing. Evaluation of control schemes, cooperatives, and of the performance of the private marketing mechanism. Consideration of current trends in market organization, procurement practices, vertical integration, and marketing policies.
3 units, Spr (Jamison) T 4:15–6:05

5 units, Win (Reynolds) MW 4:15–6:05

234. Economics of American Agriculture —
See 134.


240. Resources and Problems of Resource Utilization — See 140.

260. Seminar: Contemporary African Problems — Reports and discussion of current research into economic problems of tropical Africa in the 1960’s. Seniors admitted with permission of instructor.
3 units (Staff) by arrangement

265. Seminar: Economics of Tropical Agriculture — Selected topics in organization of production and marketing of agricultural products for home consumption and for export. Students will be required to initiate work on research papers to be presented and defended in the second quarter. Open to advanced undergraduate students with permission of instructor.
3 to 5 units, Win (Jones) MTW 11

266. Seminar: Economics of Tropical Agriculture — Continuation of 265.
3 to 5 units, Spr (Jones) T 4:15–6:05

270. International Aspects of Economic Development — See 170.

285. Demography of the Developing Countries — The demographic position of the major regions in relation to their problems of economic and social development. Problems of population policy.
3 units, Spr (Kirk) by arrangement

303. Seminar: Food Supply and Agriculture in Relation to Economic Growth — Primarily for second-year graduate students in the Food Research Institute. Prerequisite: Food Research 203 or permission of instructor.
3 units, Win (Johnston) by arrangement

304. Seminar: Foreign Trade Problems of Developing Countries — Reports and discussion of current research on specific aspects of the international aspects of economic development. Prerequisite: permission of instructor.
3 units, Spr (Massett) by arrangement

305. Seminar: The Economic Theory of Futures Trading — Consideration of conflicting theories of futures trading, the functions and performance of futures markets, and the evidence to support the theories.
3 units, Win (Gray) by arrangement

3 units, Spr (Reynolds) by arrangement

371, 372, 373, 374. Directed Reading and Research.

371. 3 units, Aut (Staff) by arrangement
372. 3 units, Win (Staff) by arrangement
373. 3 units, Spr (Staff) by arrangement
374. 3 units, Sum (Staff) by arrangement

401, 402, 403, 404. Advanced Directed Reading and Research.

401. 3 units, Aut (Staff) by arrangement
402. 3 units, Win (Staff) by arrangement
403. 3 units, Spr (Staff) by arrangement
404. 3 units, Sum (Staff) by arrangement
GRADUATE DIVISION SPECIAL PROGRAMS

Dean of the Graduate Division: Virgil K. Whitaker
Associate Dean: Robert M. Rosenzweig

SPECIAL PH.D. PROGRAM

The Graduate Division Special Programs make provision for students whose plans for study toward the Ph.D. degree do not fall within the province of any one department. Such a program may be individually planned for an unusually well-qualified graduate student who has already been admitted to a department or school of the University and enrolled therein.

A student with a well-considered program not now provided for in the existing departments or special programs of the University may then approach a professor qualified to give him guidance. The professor, if he believes the program desirable, will gather a special committee consisting of at least three other members of the Academic Council who represent the student's various fields of interest. Included in the advisory committee must be professors from at least two departments of the University. Before the student embarks on the program, this committee will address a Declaration of Intention (Form G54) to the University Committee on the Graduate Division:

1. Defining the area of the special program, showing that the University is qualified to offer it, and proposing a title for the degree.
2. Outlining the program of study and research contemplated.
3. Indicating, if possible, the nature of the dissertation contemplated.

If this Declaration is approved by the University Committee on the Graduate Division, the special committee will supervise the candidate's work and sign the forms ordinarily transmitted by major departments. The chairman of the special committee will normally direct the dissertation. Students registering for special research under the guidance of their committee or for the Ph.D. dissertation should use the following course numbers:

400. Research.
   By arrangement
   By arrangement

COURSES FOR GRADUATE STUDENTS

337A, 337B, 337C. Seminar in Public Affairs — The core seminar in the University's Public Affairs Fellowship Program, focusing on the contemporary role of democratic government and the responsibilities of its leaders: the nature of democratic government and politics; the dynamics of social, economic, and political change; and critical emerging issues of public policy. Enrollment required of and limited to Public Affairs Fellows. Credit will be given only for completion of the entire sequence.

337A. 5 units, Aut (Hutchinson) by arrangement
337B. 5 units, Win (Hutchinson) by arrangement
337C. 5 units, Spr (Hutchinson) by arrangement

338A, 338B, 338C. Seminar in Planning, Programming, Budgeting Systems — The core seminar in the University's Educational Program in Systematic Analysis. Enrollment is normally limited to appointed Fellows, but in certain circumstances may be extended to other students where mutual benefit will prevail. The seminar will concentrate on formulation of program structures, analysis of alternatives, organizational and managerial principles, budget formulations and uses, and systems analysis. Special presentations in engineering economy, probability and statistics, and operations research will be included. Group discussion will be encouraged in order to keep the seminar topics within the Federal context, and to pace the seminar with current progress in Federal Program Budgeting. Credit will be given only for completion of the entire sequence.

338A. 5 units, Aut (Hemmes) by arrangement
338B. 5 units, Win (Hemmes) by arrangement
OTHER DEPARTMENTS, INSTITUTES, AND PROGRAMS

338C. 5 units, Spr (Hemmes) by arrangement

340. The Human Potentiality — An inquiry directed to the question what is the nature of man's highest potentiality and how does he move in the direction of its realization. Points of view taken from the fields of the behavioral sciences, humanistic psychology, parapsychology, literature and philosophy, and various religious teachings will be compared and evaluated in group discussion. Enrollment limited to 15.

2 units, Aut, Win, Spr (Harman) MW 4:15-6:05

The following courses, though given within the departments listed, may be taken by any interested graduate students:

ANTHROPOLOGY

256. Cultural Transmission.

COMPUTER SCIENCE

126. Computing in the Social Sciences and Humanities.

136. Introduction to Algorithmic Processes.

EDUCATION

200. History of Education.

206A. Comparative Education.

220. Introduction to Public School Administration.

299. Children's Literature.

308. Introduction to American Higher Education.

315. Cultural Transmission.

325A,B,C. School Facility Planning.

ENGLISH

204. Advanced Exposition.

208. Introduction to Modern Linguistics.


270. Contemporary American Fiction.

FOOD RESEARCH INSTITUTE


GEOLOGY

287. Minerals, Politics, and Economics.

GRADUATE SCHOOL OF BUSINESS

For course offerings in the Graduate School of Business, please refer to their current Degree Programs Bulletin.

HOOVER INSTITUTION

Note — The following courses taught by staff members of the Hoover Institution are offered for academic credit as indicated.

211. Seminar: An Interdisciplinary Approach to the History of Africa from 1800—The partition of Africa. Contrasting theories of imperialism. European penetration and administration. Development of exploitation. Decolonization in Africa. The imperial impact appraised. Experts from other disciplines will be brought in to show how their field sheds light on African history and how use of methods of linguistics, for example, can be of help to African historians.

5 units, Spr (Duignan, Gann)

221. Seminar: An Interdisciplinary Approach to the History of Africa up to 1800—Survey of location and nature of sources available; special problems of methodology. A brief survey of the early history of man in Africa. The peopling of Africa. The emergence of early African states. The special features of the African civilizations. Role of the slave trade. European colonization up to 1800. The abolitionist movement and its impact on Africa. Experts from other disciplines will be brought in to show how their field sheds light on African history and how use of methods of linguistics, for example, can be of help to African historians.

5 units, Win (Duignan, Gann)


5 units, any quarter (Gann or Duignan)

261. Historical Background to Modern Africa—After a brief survey of the period of precontact and early European contact, emphasis is given to the European penetration, conquest, and administration of Africa.

4 units, Win (Gann)

299. Directed Reading and/or Special Research in Hoover Institution Fields — Advanced individual work by arrangement.

Any quarter (Staff or authorized faculty member)

INDUSTRIAL ENGINEERING

229. Engineering Economy.
INTERNATIONAL STUDIES

The Committee on International Studies coordinates resources for regional and comparative studies at Stanford, and inquiries about opportunities in the international field may be addressed to the CIS, Room 2R, Building I, Stanford University, Stanford, California 94305. Virtually all area-related courses are offered by individual schools and departments and are listed thereunder in this bulletin. Special programs leading to the A.M. in Latin American Studies and the A.M. in East Asian Studies are described under those headings.

Interdisciplinary faculty committees on African Studies, East Asian Studies, Latin American Studies, Russian, East European and Communist Studies, and Western European Studies coordinate and enrich University resources for the study of their respective regions. Members of these committees stand ready to counsel students who wish to emphasize one of these regions in their graduate or undergraduate programs to complement a departmental specialization. In some instances, special fellowship support is available. Inquiries about area-related opportunities may be addressed to the relevant committee c/o CIS.

No Ph.D. is offered in area studies, but a qualified doctoral candidate will be assisted in designing a cross-disciplinary program focused on the region of his interest. The Graduate Division Special Ph.D. Program outlined at the beginning of this section enables a student to pursue a doctoral program in the area of his special interest, if that interest cannot be accommodated within a regular departmental Ph.D. program.

HOOVER INSTITUTION
on WAR, REVOLUTION and PEACE

Emeriti: Harold H. Fisher, Ralph H. Lutz (Chairmen); Joseph S. Davis, Edgar E. Robinson, Graham H. Stuart (Councilors)

Director: W. Glenn Campbell

Associate Director and Professor: Witold S. Sworakowski

Executive Assistant to the Director: Alan H. Belmont

Information Officer: James R. Hobson

International Political Studies Program Director: Stefan T. Possony

African Studies Program Director: Peter Duignan

Senior Staff Members: Richard V. Allen, Milorad M. Drachkovitch, Roger A. Freeman, Lewis H. Gann

Senior Research Fellow: Karl Brandt

Research Fellows: Kia-ngau Chang, Theodore Draper, Paul J. Friedrich, Dimitri von Mohrenschildt, Bertram D. Wolfe, Yuan-li Wu


Head, Publications Department: Karol Maichel

Editor: Carole Norton

Curators: Joseph W. Bingaman (Latin America Collection), Anna M. Bourguina (Nicolaeovsky Collection), Peter Duignan (Africa Collection), R. W. Lyman (Honorary Curator, British Labor Collection), John T. Ma (East Asia Collection), Karl Maichel (East European Collection), Philip T. McLean (Special Collections), Agnes F. Peterson (Western European Collection), George S. Rentz (Middle East Collection). Deputy Curators: Tamotsu Takase (East Asia Collection), David H. L. Tseng (East Asia Collection)

Archivist, Herbert Hoover Archives: Rita R. Campbell

Librarian, Western Languages Collection: Kenneth M. Glazier

Librarian, East Asia Collection: John T. Ma
Since its founding by Herbert Hoover in 1919 as a special collection dealing with the causes and consequences of World War I, the Hoover Institution on War, Revolution and Peace has become a national and international center of documentation and research on problems of political, economic, and social change in the twentieth century.

The world-wide coverage of the Institution's collections gives them special value in this period when so many problems are international in scope. While each of the major area collections (Western Europe, Eastern Europe, East Asia, Africa, and the Middle East) is in itself outstanding, the distinguishing feature of this Institution lies in the fact that it houses under one roof for convenient study the records of the major upheavals of the contemporary world.

The Institution's holdings include government documents, files of newspapers and serials, manuscript memoirs, diaries and personal papers of men and women important in world affairs, publications of ephemeral societies and of resistance and underground movements, and the publications and records of national and international bodies, both official and unofficial, as well as books and pamphlets, many of them rare and irreplaceable.

The Institution has its own resident research staff of historians, economists, and political scientists as well as persons broadly trained and experienced in international law and the social sciences generally. The research program is concerned primarily with promoting basic research and documentary studies, which provide the foundation upon which new knowledge is built. The Institution is, however, concerned with dynamic rather than static research, that is, with studying problems where the findings can make important contributions to national policy. Since 1919 almost 200 volumes have been published by the Institution and several major new projects are under way; for example, a history of the Communist International, a Yearbook on International Communist Affairs, several volumes on colonialism in Africa, a comprehensive study of the growth of American government, and monographs on Communist China as an economic power.

In addition to its own research staff, the Institution has been used continually by American and foreign scholars. Considering the value of the collections, every effort will be made to increase the use of Institution resources by providing more funds for predoctoral and postdoctoral fellowships.

In these ways, by acquisitions, by research, by publications, and by fellowships, the Institution carries out its functions of collecting the living documents of international affairs, organizing and making them available for use, fostering their utilization, and encouraging and aiding the spread of knowledge.

Several of the Senior Scholars on the Institution's staff teach courses at Stanford University. See listings under Undergraduate Special Programs and Graduate Division Special Programs; also see History, Political Science, and Senior Colloquia for other courses offered by staff members.

**COMMITTEE on HYDROLOGY**

**Committee in Charge:** Ray K. Linsley (Chairman), Norman H. Crawford (on leave winter, spring quarters), Joseph B. Franzini, John W. Harbaugh, Paul Kruger (on leave 1968-69), Perry McCarty (on leave 1968-69), Byrne Perry

**Programs of Study**

The Committee on Hydrology, which includes faculty from the Departments of Civil Engineering and Geology, administers a program of graduate studies leading to degrees of M.S. in Hydrology and Ph.D. in Hydrology.

The program is interdisciplinary and covers a wide range of the Hydrologic Sciences, emphasizing surface hydrology and groundwater hydrology together with those parts of meteorology and oceanography that are related to the hydrologic cycle. Studies involving the impact of the Nuclear Age on hydrology are also available.
MASTER OF SCIENCE

This program is available to students having the Bachelor's degree in Civil Engineering, Chemical Engineering, Chemistry, Geology, Geophysics, Agronomy, Forestry, Meteorology, Nuclear Science or Engineering, and related fields. In order to earn the M.S. degree in one year, the student should have completed basic courses in physics, chemistry, mathematics through an introduction to differential equations, geology, and elementary fluid mechanics.

The M.S. program will include 45 or more units of which at least 35 must come from the following list of courses:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.E. 165</td>
<td>Hydrometeorology</td>
<td>2</td>
</tr>
<tr>
<td>C.E. 171</td>
<td>Environmental Radioactivity</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 207</td>
<td>Advanced Hydraulics</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 209</td>
<td>Hydraulics of Open Channels</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 280A</td>
<td>Advanced Hydrology</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 280B</td>
<td>Advanced Hydrology</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 261A</td>
<td>Nuclear Hydrology</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 261B</td>
<td>Nuclear Hydrology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>C.E. 262</td>
<td>Advanced Hydraulic Engineering</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 263</td>
<td>Sedimentation Problems</td>
<td>2</td>
</tr>
<tr>
<td>C.E. 264</td>
<td>Ocean and Coastline Engineering</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 265A</td>
<td>Flow in Permeable Media</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 265B</td>
<td>Applied Hydrodynamics</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 267</td>
<td>Hydrologic Simulation</td>
<td>2</td>
</tr>
<tr>
<td>C.E. 268</td>
<td>Mechanics of Flow through Soils</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 269</td>
<td>Water-Resources Engineering Seminar</td>
<td>1</td>
</tr>
<tr>
<td>C.E. 273</td>
<td>Water Resources Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 276</td>
<td>Water Quality in Water Resources</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 277</td>
<td>Nuclear Civil Engineering</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 278</td>
<td>Radioactivation Analysis</td>
<td>2</td>
</tr>
<tr>
<td>Geol. 106</td>
<td>Physical Oceanography</td>
<td>4</td>
</tr>
<tr>
<td>Geol. 115</td>
<td>Introduction to Biological Oceanography</td>
<td></td>
</tr>
<tr>
<td>Geol. 171</td>
<td>Introduction to Geochemistry</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 204</td>
<td>Computer Applications in the Earth Sciences</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 209</td>
<td>Physics of Underground Fluids</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 233</td>
<td>Principles of Geomorphology</td>
<td>4</td>
</tr>
<tr>
<td>Geol. 285</td>
<td>Hydrogeology</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 284</td>
<td>Engineering Geology</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 286</td>
<td>Development of Ground-water Resources</td>
<td>3</td>
</tr>
<tr>
<td>Engr. 171</td>
<td>Nuclear Energy</td>
<td>3</td>
</tr>
<tr>
<td>Engr. 172</td>
<td>Nuclear Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>Engr. 175</td>
<td>Nuclear Measurements Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>Engr. 178</td>
<td>Radiochemistry Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>C.S. 136</td>
<td>Introduction to Algorithmic Processes</td>
<td>3</td>
</tr>
<tr>
<td>I.E. 141A</td>
<td>Utilization of Computers</td>
<td>4</td>
</tr>
<tr>
<td>Stat. 110</td>
<td>Statistical Methods in Engineering</td>
<td>4</td>
</tr>
<tr>
<td>Stat. 116</td>
<td>Theory of Probability</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 233</td>
<td>Statistical Models in Civil Engineering</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 234</td>
<td>Decision Making in Civil Engineering</td>
<td>2</td>
</tr>
<tr>
<td>C.E. 235</td>
<td>Stochastic Process Models in Civil Engineering</td>
<td>2</td>
</tr>
</tbody>
</table>

The program is subject to approval by the Committee and must represent a strong, coherent course of study in the student's area of professional interest. Sample curricula may be obtained on request from the Committee.

DOCTOR OF PHILOSOPHY

Ph.D. programs will be determined by discussion with the Committee on Hydrology but will normally include the substantial equivalent of the M.S. program plus an additional minimum of 45 units of course work, totaling at least 90 units. To become a Ph.D. candidate the student must demonstrate proficiency in one foreign language, pass a qualifying examination specified by the Committee and have a grade point average in graduate work of at least 3.00. Minimum residence requirements for the Ph.D. are nine quarters (six semesters) of graduate study; at least six quarters must be at Stanford. Completion of all requirements including the dissertation is rarely accomplished within the minimum time requirement, and students should expect to spend as much as one year beyond the minimum. A minor in Hydrology is not offered for Ph.D. programs in other departments of the University.

FINANCIAL ASSISTANCE

In addition to the usual University aid, a limited number of research assistantships are available. Assistants customarily work under supervision of a faculty member on one of the current research projects with which Committee members are involved. At the present time there are, among others, projects in such areas as computer simulation of watershed behavior; hydrologic effects of weather modification; laboratory studies of wind-wave generation; fluid mechanics of groundwater flow and unsaturated flow in soils; measurements of environmental radioactivity; hydromechanics of water waves; transport processes at the air-sea interface; simulation of shallow-water marine processes on the digital computer; effect of geology, hydrology, and pollution on ground and surface water quality; water quality control in water resource development. Where possible, students are assigned to projects that are in line with their professional interests. Research results are often used by doctoral candidates as a basis for a dissertation.
INTER-UNIVERSITY CENTER for JAPANESE STUDIES in TOKYO

ADMINISTERED BY
STANFORD UNIVERSITY

The Inter-University Center for Japanese Studies in Tokyo, Japan, is a cooperative enterprise of twelve major academic institutions in the United States and Canada with Stanford University as the administrative agency. The purpose of the Center is to provide qualified graduate and undergraduate students with intensive audio-lingual Japanese language instruction, as well as to further the students' familiarity with Japanese texts and materials preparatory or leading to research in given disciplinary or professional fields. The location of the Center in Tokyo provides maximum opportunities for students to gain fluency in both the written and spoken language in a Japanese-speaking and Japanese cultural environment. Language study is carried on in small classes or in individual tutorial sessions by Japanese instructors. Advanced students are given opportunities for specialized work in the language, as well as other individual study, dependent upon their linguistic qualifications and their degree programs as established by their home institutions.

The academic year at the Center is equivalent to four full quarters, beginning in early September. Any student may apply for admission provided that (a) he is a student in good standing, and is a degree candidate at an accredited university or college; (b) he will have successfully completed prior to attendance a minimum of two years of Japanese or its equivalent at the college level; and (c) he takes a written and oral screening examination in the Japanese language.

For further information please write to:

Graduate Overseas and Special Programs
Room 113, Building 10A
Stanford University
Stanford, California 94305

INTER-UNIVERSITY PROGRAM for CHINESE LANGUAGE STUDIES in TAIPEI

ADMINISTERED BY
STANFORD UNIVERSITY

The Inter-University Program for Chinese Language Studies in Taipei, Taiwan, was established in September 1963, under the sponsorship of nine American universities, with Stanford University as the administrative agency. The Program is a cooperative effort drawing upon the accumulated experience of the profession in providing advanced language training in a Chinese cultural area and is not intended to be a substitute for strong language offerings at American institutions.

The purpose of the Program is to provide graduate and undergraduate students with intensive audio-lingual language instruction, as well as to further the students' familiarity with Chinese texts and materials preparatory or leading to research in given disciplinary or professional fields.

Undergraduate, graduate, or postdoctoral candidates are eligible to apply to the Program if they have successfully completed a minimum of two academic years, or its equivalent, of Chinese language study at the college level. Applicants must also pass a short written and oral screening examination in the Chinese language.

For further information please address your inquiries to:

Graduate Overseas and Special Programs
Room 113, Building 10A
Stanford University
Stanford, California 94305
LIBRARIES

Emeriti: Elizabeth Hadden, Minna Stillman (Associate Librarians); Alice Charlton (Chief Catalog Librarian); Jeannette M. Hitchcock (Chief of Division of Special Collections); Margaret Wells (Education Librarian); Grace E. Stillson (Assistant Chief Catalog Librarian); Ruth Scibird (Curator of the Stanford Collection)

University Libraries

Director: Rutherford D. Rogers
 Associate Directors: Elmer M. Grieder, David C. Weber
 Assistant Director and Librarian, J. Henry Meyer Memorial Library: Assistant Director for Automation: Allen B. Veaner
 Administrative Services: Lawrence C. Pearson
 Division Chiefs: Julius P. Barclay (Special Collections); Joseph A. Belloli (Humanities and Social Sciences); Jennette E. Hitchcock (Catalog); Judy H. Fair (Government Documents); Jack Plotkin (Circulation); B. Jack Pooler (Science); Ralph W. Hansen (Acquisition)
 University Archivist: Ralph W. Hansen
 Curators — Resources Development Program: James Breedlove (Latin America); Peter Frank (Germanic Languages); Paul J. Kann (Romance Languages); Peter Kudrik (Slavic Languages)
 Curators — Honorary: George T. Keating (Music Bibliography); Irving Whittemore Robbins, Jr., (Rare Books and Manuscripts); Elmer E. Robinson (Americana); Albert Sperisen (Typography)

Food Research Library
 Librarian: Charles Milford

Hoover Institution — See listing elsewhere in this catalog.

J. Hugh Jackson Library of Business
 Director: Marion M. Smith
 Reference Librarians: Charles T. Pfingsten, David Zachringer; Catalog Librarian: Lilian Stauffer; Librarian, International Center for the Advancement of Management Education: David Allen

Lane Medical Library
 Chief Librarian: Clara S. Manson
 Reference Librarian: A. V. Hoen; Catalog Librarian: Elena Wang

Law Library
 Chief Librarian: J. Myron Jacobstein
 Acquisition Librarian: Howard W. Sugarman; Head Catalog Librarian: Rosalee Long; Reference Librarian: George Torzsay-Biber

Linear Accelerator Center Library
 Chief Librarian: George Owens
 Acquisitions: Louise Addis; Cataloging and Reference: Robert C. Gex

Facilities

All faculty, staff, and registered students of the University are entitled to use the University Libraries. Information is available in the booklet Your Libraries at Stanford University or in special leaflets about general borrowing regulations, book stack access, interlibrary loans, photocopies, microtext reading machines, etc. Persons wishing an introduction to the library are urged to see the Chief, Humanities and Social Sciences Division.

Information regarding special borrowing privileges for individuals not connected with the University may be obtained at the Service Desk in the Circulation Division of the Main Library. With some exceptions, individual cards may be obtained upon payment of an annual fee of $12.50 for Stanford alumni and $25.00 for others. Special permission must be secured to use the collections of the following libraries which have their own regulations and in some cases require payment of fees: Hoover Institution on War, Revolution and Peace; Law Library; Lane Medical Library; J. Hugh Jackson Library of Business; Food Research Institute; and Linear Accelerator Center. Special regulations are in force for high school, college, or university students from other institutions, who may consult the Circulation Service Desk attendant or their own school librarians for information. Industrial firms wishing to use the Libraries should consult the Director of
the Technical Information Service for information regarding subscriptions.

The Libraries of the University altogether contain about 3,000,000 volumes, 900,000 manuscripts, 120,000 sheet maps, 300,000 microtext sheets, and considerable other material. A principal part of the Libraries' collections is concentrated in the stack of the Main Library, which houses about 750,000 volumes on its seven levels. The various library units are described in the following paragraphs; the Library of the Hoover Institution on War, Revolution and Peace is described elsewhere in this catalog.

J. HENRY MEYER MEMORIAL LIBRARY

The Meyer Memorial Library, with a collection of about 75,000 volumes and housing language laboratories, an Audio Library, a Forum Room and seminar rooms, was opened in November 1966.

The library is open from 8 a.m. to midnight Monday through Saturday, and from 1 p.m. to midnight on Sunday during school sessions; extended study will be possible from 10 p.m. until 2:30 a.m. each evening, Monday through Saturday, and from 8 a.m. on Sunday until 2:30 a.m. Monday in one or two seminar rooms. A more detailed listing of hours and other services can be found in the Guide to the J. Henry Meyer Memorial Library.

Gathered primarily for undergraduate needs, the collection contains books on "reserve" for courses and available for short circulation periods, some on "closed reserve" at the second floor Loan Desk, but most shelved with the open collection and marked as being on reserve. The library also provides a wide range of major works supplementing course assignments in most academic disciplines, basic reference works, a wide selection of current periodicals, and a broad collection of books in all fields of general undergraduate interest.

Audio Library facilities on the first floor are available for classroom or individual use and include a general listening room as well as three rooms for listening by groups of up to nine persons. A selected collection on disc and tape comprises music, literature, drama and other significant and historical recordings. Audio programs may also be produced in the seven seminar rooms and the larger Forum Room on the first floor. Also on that floor are four language laboratories which provide instructional facilities for students enrolled in undergraduate language courses.

MAIN LIBRARY

When school is in session, the Main Library is open Monday through Friday from 8:00 a.m. to 11:00 p.m. On Saturday the hours are 8:00 a.m. to 5:00 p.m., and on Sunday from 1:00 p.m. to 11:00 p.m. Hours of opening for other rooms and other libraries on the campus are listed in Your Libraries at Stanford University. The Main Library provides 906 seats and quarters for the following:

The Humanities and Social Sciences rooms, the center for reference service in the Main Library, contain reference and subject collections totaling about 34,000 volumes and current issues of more than 1,400 periodicals. The Library's Central Map Collection is located in the Shainwald Room for the social sciences. The Microtext and Newspaper Reading Room is in the basement.

The Government Documents Library brings together most of the Library's collection of municipal, state, federal, foreign, and international documents. It is especially strong in the publications of the United States, Great Britain, Canada, Australia, and the United Nations.

The Division of Special Collections, the main reading room of which is the Albert M. Bender Room, services the Library's rare and valuable books and manuscripts, and administers a number of specialized research collections. Among the most important of these are: the Antoine Borel Collection, manuscript material on California political history; the Frederick E. Brasch Collection on Sir Isaac Newton and the History of Scientific Thought covering a full history of several branches of the physical sciences centering around the life and thought of Newton; the Bernard DeVoto Papers covering his career in literature, history, and politics; the Charlotte Ashley Felton Memorial Library, devoted to British and American literature of the nineteenth and twentieth centuries (published works, first editions, variant editions, bibliographies, criticisms, and biographical material of selected au-
OTHER DEPARTMENTS, INSTITUTES, AND PROGRAMS

SPECIAL LIBRARIES IN THE HUMANITIES AND SOCIAL SCIENCES

The Cubberley Library of Education, with three reading rooms on the second floor of the School of Education building, houses about 75,000 books, periodicals, text books, curriculum guides, and pamphlets in the field of education. Other special collections include college catalogs and state and city school reports.

The Music Library, located on the second floor of The Knoll, comprises the general collection of musical scores, books, and recordings for the use of music students, faculty, and the University at large. Adjoining the Music Library are the Archive of Recorded Sound and the Harry R. Lange Historical Collection of Musical Instruments and Books.

Other special libraries in the humanities and social sciences are: Asian Languages, Briggs Memorial (English), Classics, Communication, Graduate Program in Humanities, Jones Collection (in creative writing), modern European languages, Physical Education for Women, Tanner Memorial Library of Philosophy, and Victor J. West Memorial (political science).

SPECIAL LIBRARIES IN THE SCIENCES

The Library's collections in science and engineering are assembled in eight major groups of departmental libraries—Biology, Chemistry, Computer Science, Engineering, Geology, Marine Biology, Mathematics-Statistics, and Physics.

The Frederic M. Falconer Biology Library, located on the second floor of Herrin Hall, houses general publications in botany and zoology as well as specialized materials in the experimental fields of biology. Branches are the Systematic Biology Library which includes systematics, natural history and entomology, and the Dudley Herbarium Library which specializes in distributional studies of the flora of western North America.

The Hopkins Marine Station Library at Pacific Grove provides a working collection in marine biology and oceanography.

The Swain Chemistry Library, located in Room One in the Chemistry Building, contains the major works in the field of Chemistry. Its branch, the Chemical Engineering Library, contains materials related to the chemical and petroleum industries.

The Engineering Library, located on the first floor of the Main Library, contains most of the library materials in the field of engineering. Its specialized branches include the Guggenheim Aeronautics Library, the Radioscience Laboratory Library, the Ryan Nuclear Technology Library, the Solid State Library, the Engineering-Economic Planning Library, and the Electrical Engineering Library.

The Branner Geological Library, located in Room 333 of the Outer Quadrangle, houses collections on geology, mineralogy, paleontology, geophysics, geophysics, mining and metallurgy, as well as geological maps and the U.S. Geological Survey topographical sheets. Specialized branch libraries include the Conchology Library, the Geophysics Library, the Micropaleontology Library, the Mineralogy Library, and the Permafrost Library.

The Mathematics-Statistics Library is located in Room 414 of the Sloan Mathematics Center.

The Computer Science Library, Room 170, Polya Hall, houses a specialized collection covering the full range of computer theory and application.

The Physics Library is located in Room 301 of the Varian Building. Its branches are the Hansen Microwave Laboratory Library, specializing in microwave physics and engineering, and the Plasma Physics Library, serving the Plasma Physics Institute.

BUSINESS

The J. Hugh Jackson Library, located in the Graduate School of Business Building, is primarily a working laboratory available to students in the Graduate School of Business in the daily preparation of their work.
Members of the Stanford Community may use the library upon identification. The library contains over 115,000 cataloged items and additional miscellaneous pamphlets and reports. It maintains extensive holdings of corporate annual reports from the leading stock exchanges. It receives in excess of 2,000 trade, financial, labor, and general business periodicals. In addition, it subscribes to many of the leading labor, financial, marketing, and business research services. Branch libraries serve the International Center for Advanced Management Education and the Stanford-Sloan Program.

**FOOD RESEARCH INSTITUTE**

The Food Research Institute Library, located in Room 32, Inner Quadrangle, is intended primarily for staff research and instruction in international food economics. Its collection of over 50,000 items is especially strong in federal, foreign, and international documents containing commodity and trade statistics. The Library is open to other faculty, staff, and students.

**LAW**

The Law School Library contains about 170,000 volumes. In addition to extensive holdings in Anglo-American law, there are important special collections of French, German, Italian, Indian, British Commonwealth, and early State laws. The International Legal Studies Collection of international law and organization and of foreign and comparative law is of increasing importance.

The Law Library is primarily intended for use by students, faculty, and research staff of the Law School. Other faculty, staff, and students are welcome to use the Law Library when in need of legal materials.

**MEDICINE**

The Lane Medical Library, located at Room 100 in the Lane Building of the Medical Center, contains about 200,000 volumes and currently receives about 2,200 journals. The Barkan Library of Ophthalmology and Otalaryngology and the Medical History Collection are notable special collections. Specialized branches include the Anatomy Library and the Medical Microbiology Library.

**COURSE**

1. Use of the Library—Introduction to the Library; emphasis on major types of material and use of catalogs, bibliographies, indexes, abstracts, other aids to study. Primarily for freshmen and sophomores.

1 unit, Aut, Win, Spr (Staff) T11

See also Senior Colloquia.

**STANFORD LINEAR ACCELERATOR CENTER**

The Stanford Linear Accelerator Center Library (SLAC) is located in Room 308, Central Laboratory Building on Sand Hill Road. The collection is primarily for use by the staff of the Center.

**PHYSICAL EDUCATION for MEN**

*Emeriti*: Allen Elward, Edward M. Twiggs, Harry M. Wolter (*Directors*); C. Myron Sprague (*Associate Director*); Elwyn Bugg, Ernest P. Hunt (*Associate Professors*)

*Executive Head and Director of Physical Education and Athletics*: Charles A. Taylor

*Assistant Director of Athletics*: Robert G. Young

*Directors*: Howard Dallmar (Basketball), William P. Fehring (Intramurals and Club Sports), Charles E. Finger (Golf), James Gaughran (Aquatics), John Gilmore (Gymnastics), Richard Gould (Tennis), Payton Jordan (Track), Peter Kmetovic (Rugby), Raymond E. Lunny, Jr. (Boxing), Fred J. Priddle (Soccer), John Ralston (Football), David M. Reed (Wrestling), J. Ray Young (Baseball)

*Assistant Directors*: Jerome Barland (Track), Terry DeSylvia (Football), Clyde F. Devine (Diving), Robert Gambold (Football), James Mora (Football), Paul Neumann (Basketball), Edward Peasley (Football), James Smith (Aquatics), Richard A. Ver-
meil (Football), Michael White (Football).
Professor: John E. Nixon (Director of Professional Education)
Associate Professor: Wesley K. Ruff (Director of Physical Education)

OFFERINGS AND FACILITIES

ATHLETICS
In keeping with our cultural heritage and American university tradition, Stanford offers its students a wide variety of competitive opportunities in intercollegiate sports. Stanford has always managed to be vigorously competitive in all sports, both within the Conference and on the national level. Our sports effort has, through the years, continually improved both in quantity and quality and we look ahead in anticipation of continued achievement. Through its membership in the National Collegiate Athletic Association, the Athletic Association of Western Universities, and other such organizations, Stanford meets teams of outstanding universities throughout America in a number of sports every year. The Indians usually schedule such teams on a home-and-home basis which means that Stanford athletes travel extensively to major cities throughout the United States. Sports for which the University grants the Stanford Sport Award are football, basketball, track and field, baseball, swimming, golf, tennis, boxing, wrestling, gymnastics, rugby, soccer, water polo, and cross country. Other sports which have regular schedules include, among others, crew and rifleshooting.

PHYSICAL EDUCATION AND INTRAMURALS
The Physical Education Program is designed to accommodate the interests and needs expressed by our students. Students may elect the activity of their choice and quality instruction with appropriate facilities can be expected. The Intramural Sports Program is designed to provide competitive sports opportunities for those men who desire competition but do not care to participate in the intercollegiate sports program. All students are encouraged to participate in their favorite sports activities. Proceeding on the premise that man is an integrated, indivisible organism in need of both physical and intellectual stimulation, Stanford provides a vigorous and well-rounded program of physical education and intramural athletics. Our students have traditionally enjoyed participation in recreational sports. Our sports instruction program is designed to nurture the participation habit and hopefully thus enhance the fulfillment life brings to Stanford graduates. All sports included in the competitive program, listed above, and others are included in the instructional program. The intramural program varies, to accommodate student interest but basically includes seven-man touch football, two- and six-man volleyball, bowling, table tennis, horseshoes, handball, wrestling, basketball, softball, tennis, swimming, golf, gymnastics, and track and field. Those who are not interested in or do not have the physical qualifications for intercollegiate competition find our intramural program an avenue for expanding social contacts, an opportunity for exercise and a source of sheer enjoyment.

Student organized club teams are encouraged by the department. The club teams represent Stanford and the club organization. The Department assists in matters of administration, facilities, organization, scheduling, some financial assistance, and provides awards for outstanding achievement.

Women’s activities are conducted by the Department of Physical Education for Women. Activity courses, such as equitation, folk and square dancing, rifflery, bowling, and archery are offered coeducationally.

ACADEMIC DEGREES AND TEACHING CREDENTIALS IN PHYSICAL EDUCATION FOR MEN
The Department of Physical Education and Athletics for Men cooperates with the School of Education by providing faculty, facilities, and equipment necessary to the conduct of the Professional Education Program for Men which leads to academic degrees and valid teaching credentials in the State of California. See the “School of Education” section of this Bulletin for details of requirements leading to:

Degrees—Men majoring in physical education may become candidates for the A.M., Ed.D., and the Ph.D. degrees in Education, with concentration in physical education. At the present time there is no A.B. degree with concentration in physical education.
**Teaching Credentials** — Men desiring to teach physical education classes and coach athletic teams at the secondary and junior college levels should enter the physical education credential program in the sophomore or junior year. The candidate takes a sequence of courses in his junior and senior years. He then enters the Stanford Secondary Intern Program in the School of Education. Normally, he completes this program at the end of the first graduate year.

See Dr. John Nixon or Dr. Wesley Ruff for further information.

**Facilities**

Abundant space has been a factor in the development of an extensive athletic plant. Included in the facilities for men are:

The Stadium, seating 90,000 and encircling a standard American football field encircled by a quarter-mile track with a 220-yard straightaway.

Angell Field, named for Dr. Frank Angell, pioneer member of the University faculty who devoted much time and interest to the development of athletics. It is a specialized facility for track and field, and its quarter-mile track also has a 220-yard straightaway. The runways have recently been covered with a new all-weather surface.

Sunken Diamond, a turfed baseball field used exclusively for varsity baseball. Provides seating for 3,000 spectators.

Harry Maloney Field, a turfed field for soccer, rugby, football practice, and other field sports. It is named for the former director of minor sports at Stanford, an active member of the faculty for 36 years.

Three other turfed fields for football and rugby, intramural sports fields, and a freshman baseball diamond.

Three varsity tennis courts, hard-surfac ed, with stands for spectators, and fourteen practice tennis courts.

Roscoe Maples Pavilion, the new basketball pavilion seating 8,200 spectators. It is scheduled for completion in 1968.

When completed, the present Pavilion will be converted for use by boxing, wrestling, gymnastics, club sports, etc.

Encina Gymnasium, including a basketball floor, three bleacher-flanked swimming pools, offices, rooms for gymnastics, combatives, and other indoor sports.

The Pavilion, 2700-seat structure housing the facilities used for varsity and freshman intercollegiate competition in several sports.

Facilities used jointly by men and women include the riding stables and an 18-hole championship golf course on the campus.

The Department of Athletics is near the Gymnasium and the Pavilion and contains offices of the director, his staff, and all coaches. This building is also headquarters for the Military, Air, and Naval Science programs.

**Fees**

Fees are charged for enrollment in bowling, equitation, golf, rifle marksmanship, and scuba diving.

**Courses**

Note—All courses are normally taken for one unit of credit.

02. Modified Programs — Individually prescribed exercise programs adapted to fit special needs of students for whom usual class activities are not suitable. Admission on recommendation of Coordinator of Physical Education.

Auto, Win, Spr (Ruff) three periods a week

03. Freshman Seminars.

Auto, Win, Spr (Gilmore) by arrangement

05. Physical Education Leadership.

Auto, Win, Spr (Ruff, Gilmore) by arrangement

07. Experimental Physical Conditioning.

Auto, Win, Spr (Ruff) by arrangement

08. Club Sports.

Auto, Win, Spr (Staff) by arrangement


Auto, Win, Spr (Staff) TTh 11

11A. Basketball, Freshman.

Auto, Win (Neumann) MTWThF 2:15


Auto, Win, Spr (Lunny) MWF 2:15 or 3:15

14A. Football, Freshman.

Auto (DeSylvia) MTWThF 4:15


Auto, Win, Spr (Finger) MW or TTh 11 or 1:15, and nine holes additional
15A. Golf, Freshman.
   Aut, Win, Spr (Finger) MTWThF 3:15–5:30

   Aut, Win, Spr (Gilmore) MWF 2:15

17. Volleyball.
   Aut, Win, Spr (Staff) MW 2:15

17B. Volleyball and Team Games.
   Aut, Win, Spr (Staff) TTh 2:15

   Aut, Win, Spr (Staff) MW or TTh 10, 11, 1:15 and 2:15

19B. Bowling, Tournament.
   Aut, Win, Spr (Staff) MW and by arrangement

   Aut, Win, Spr (Smith) MWF 11

20A. Swimming, Freshman.
   Aut, Win (Gaughran) MTWThF 4:15

21. Tennis, Elementary.
   Aut, Win, Spr (Staff) MWF 11, 1:15, 2:15, 3:15, or 4:15

21A. Tennis, Freshman.
   Aut, Win, Spr (Gould) MTWThF 3:15–5:05

22. Track, Elementary.
   Aut, Win, Spr (Barland) TTh 10

22A. Track, Freshman.
   Aut, Win, Spr (Jordan, Barland) MTWThF 3:15

23. Wrestling, Elementary.
   Aut, Win (Reed) MWF 2:15

23A. Wrestling, Freshman.
   Aut, Win (Reed) MTWThF 4:15

24. Diving, Elementary.
   Aut, Spr (Staff) TTh 11

27. Crew, Elementary.
   Aut, Win, Spr (Staff) MTWThF 4:15 and 8 9

29. Water Polo.
   Aut, Spr (Smith) TTh 2:15

29A. Water Polo, Freshman.
   Aut, Spr (Smith) MTWThF 3:15

30A. Baseball, Freshman.
   Aut, Win, Spr (Boles) MTWThF 3:15–5:30

39A. Soccer, Freshman.
   Aut (Priddle) MTWThF 4:15

41. Physical Conditioning.
   Aut, Win, Spr (Staff) MWF 4:15

111A. Basketball, Varsity.
   Aut, Win (Dallmar) MTWThF 4:15–6:05

112. Boxing, Advanced.
   Aut, Win, Spr (Lunny) MTTh 4:15

113. Judo, Beginning.
   Aut, Win, Spr (Kitaura) TTh 11

113B. Judo, Advanced.
   Aut, Win, Spr (Kitaura) TTh 12

114A. Football, Varsity.
   Aut, Spr (Ralston) MTWThF 3:15–5:30

115. Golf, Advanced.
   Aut, Win, Spr (Finger) MTWThF and by arrangement

115A. Golf, Varsity.
   Aut, Win, Spr (Finger) MTWThF 3:15–5:30

116A. Gymnastics, Varsity.
   Aut, Win, Spr (Gilmore) MWF 3:15

118. Life Saving.
   Aut (Gaughran) TTh 2:15

   Aut, Win, Spr (Smith) MWF 2:15

120. Swimming, Advanced.
   Aut, Win, Spr (Smith) MWF 10

120A. Swimming, Varsity.
   Aut, Win, Spr (Gaughran) MTWThF 4:15

121. Tennis, Advanced.
   Aut, Win, Spr (Staff) TTh 11, 2:15, 3:15, or 4:15

121A. Tennis, Varsity.
   Aut, Win, Spr (Gould) MTWThF 3:15

122A. Track, Varsity.
   Aut, Win, Spr (Jordan) MTWThF 3:15

123. Wrestling, Advanced.
   Aut, Win (Reed) MTTh 4:15

123A. Wrestling, Varsity.
   Aut, Win (Reed) MTWThF 4:15–6:05

124. Diving, Advanced.
   Aut, Spr (Staff) TTh 11

124A. Diving, Varsity.
   Aut, Win (Devine) MTWThF 4:15
127A. Crew, Varsity.
  Aut, Win, Spr (Staff) MTWThF 4:15 and S 10
128. Water Safety Instruction, Part I.
  Spr (Gaughran) MTWThF 3:15
128B. Water Safety Instruction, Part II.
  Spr (Gaughran, Staff) MTWThF 3:15
129A. Water Polo.
  Aut, Spr (Gaughran) MTWThF 4:15
130. Baseball, Junior Varsity.
  Spr (Young) MTWThF 3:15–5:05
130A. Baseball, Varsity.
  Aut, Win, Spr (Young) MTWThF 3:15–5:05
139. Soccer, Beginning.
  Aut, Win, Spr (Priddle) MWF 4:15
139A. Soccer, Varsity.
  Aut, Win, Spr (Priddle) MTWThF 4:15
140. Rugby, Beginning.
  Win (Kmetovic) MWThS 4:15
140A. Rugby, Varsity.
  Win (Kmetovic) MWThS 4:15
142. Skin Diving.
  Aut, Win, Spr (Gaughran, Smith) TTh 2:15
142B. Scuba Diving.
  Aut, Win, Spr (Gaughran, Smith) TTh 2:15
151. Rifle and Pistol Marksmanship—Open to all undergraduate students.
  Aut, Win, Spr (Staff) MTWThF by arrangement
151B. Pistol Marksmanship — Open to all undergraduate students.
  Aut, Win, Spr (Staff) MTWThF by arrangement
153. Weight Training.
  Aut, Win, Spr (Staff) MWF 11, 1:15, 2:15, 3:15 or 4:15
192, 193, 194. Techniques of Athletic Management.
  Aut, Win, Spr (Taylor, Staff) by arrangement
  Aut, Win, Spr (Fehring) by arrangement
Coeducational classes are offered as listed under Physical Education for Women.
PHYSICAL EDUCATION for WOMEN

Emeriti: Maud L. Knapp (Professor), Margaret C. Barr (Associate Professor), Sylvia P. Cain (Instructor)
Executive Head: Luell W. Guthrie
Associate Professors: Luell W. Guthrie, Marian S. Ruch
Assistant Professors: Carroll S. Gordon, Miriam B. Lidster, Pamela L. Strathairn
Instructors: Judith R. Book, Mary Margaret Neal, Inga Weiss-Lepnis
Teaching Specialists: Jean P. Helliwell (Fencing), Heidi Klaus (Gymnastics, Track and Field), Margaret F. Newport (Badminton, Tennis), Shirley H. Schoof (Bowling)

Offerings and Facilities

The aims of the physical education program for women are threefold: to provide an opportunity for participation in a variety of physical activities, to afford specialization in one or more areas of activity, and to provide instruction for all levels of competency.

The program is designed: (1) to increase understanding of the value and role of physical education activities in developing and maintaining total fitness throughout life, (2) to encourage continued participation, both during and after college, in physical activity appropriate to health status as well as interest, and (3) to develop leadership skills which have particular application to community service, volunteer agencies, recreation groups, and domestic and foreign Peace Corps.

Each student is afforded the opportunity for developing interest in many kinds of physical activity and for developing competency in selected activities in order that future participation is more readily selected for recreational purposes. Instructional, recreational, creative, and several forms of competitive experiences are provided in the variety of aquatic, dance, sports, and other physical education activities. Homogeneous skill groupings for instruction in most activities enable the student, beginner through advanced performer, to achieve success within the limits of her capabilities. The program also includes instruction and recreation for coeducational groups.

Competitive and Recreational Opportunities

Recreational and competitive events in the intramural and intercollegiate programs are offered in cooperation with the Women's Recreation Association.

The intramural and intercollegiate programs include: archery, badminton, basketball, bowling, fencing, field hockey, golf, gymnastics, swimming, tennis, track and field, and volleyball. A planned co-recreational program includes badminton, bowling, golf, swimming, tennis, and volleyball. Special events offered include ballet, folk and square dancing, modern dance, synchronized swimming, and other activities of current interest.

The Department is affiliated with the Girls and Women's Sports Division of the American and California Associations for Health, Physical Education and Recreation, the Women's National Officials Rating Committee, the National Association for Physical Education of College Women, the Western Society for Physical Education of College Women, and the Athletic Association of Western Universities. The Women's Recreation Association is a member of the National and Pacific Southwest Regional Athletic and Recreation Federation for College Women.

Policy governing women's participation in intercollegiate competition is formed by the Department and the Women's Recreation Association in keeping with policies of affiliated organizations.

Facilities, Equipment, Costumes, and Fees

The Women's Gymnasium houses a basketball floor and area for other indoor activities, dance studio, posture studio, small activities room, dance as well as physical education library, study rooms, offices, and shower and locker room.

The outdoor facilities include a heated 75-foot pool with one-meter springboard; two WRA tennis courts for recreation; six tennis courts used primarily for instruction; short fairway and green for golf practice; turfed field for archery, field hockey, golf, and softball.
In addition the Riding Stable and 18-hole championship Stanford Golf Course are used jointly by men and women.

All equipment, except badminton and tennis rackets, bowling balls and shoes and golf clubs, is provided by the Department. Golf clubs may be rented and bowling balls and shoes are included in the bowling fees.

Gym suits, leotards, swim suits, and towels are furnished and laundered. The student must provide her own white socks and tennis shoes, swimming cap, and appropriate riding clothes.

Fees are charged for enrollment in bowling and equitation classes. The bowling fee includes use of ball and shoes.

**Physical Education Courses**

All courses have a 1-unit value although students may elect to enroll for 0-units in any course. Limits in class size necessitate enrollment through the Women's Physical Education Department during preregistration or registration days.

**Courses for Physical Activity:**

These courses are offered for women students only or as coeducational classes as listed. A maximum of 12 units of credit will be accepted toward graduation.

**Courses Related to Community Leadership:**

These courses are designed for developing competency in skills which have particular application to service in the community. Each course is open to men and women students unless otherwise noted.

**Courses for Physical Activity Coeducational Classes**

**19. Bowling.**

Aut, Win, Spr (Staff) TTh 9, MW or TTh 10, 11, 1:15 or 2:15

**40. Archery, Elementary.**

Aut, Spr (Book) TTh 12:50–2:05

**41. Archery, Intermediate — Prerequisite: promoted from 40 or equivalent.**

Aut, Spr (Book)

**61. Modern Dance, Elementary.**

Aut (Weiss-Lepnis) MWF 10

**62. Modern Dance, Intermediate.**

Aut, Win, Spr (Weiss-Lepnis) WF 11:00–12:15

**63. Ballet, Elementary.**

Win (Weiss-Lepnis) MWF 10

**64. Ballet, Intermediate.**

Spr (Weiss-Lepnis) MWF 10

**68. Social Dance, Elementary.**

Given 1969–70

**69. Social Dance, Intermediate.**

Given 1969–70

**70. Ethnic Dance, Elementary.**

Aut, Win, Spr (——)

**71. Ethnic Dance, Intermediate.**

Given 1969–70

**72. Folk Dance, Elementary.**

Aut, Win, Spr (——)

**73. Folk Dance, Intermediate.**

Given 1969–70

**140. Archery, Advanced — Prerequisite: one year's shooting experience.**

Aut, Spr (Book)

**142. Skin and Scuba Diving — Prerequisite: one-quarter mile timed swimming test. (See Physical Education for Men.)**

**148. Equitation.**

Elementary—English and Western seat.

Aut, Win, Spr (Melville) MTTh 1:15

Intermediate—English and Western seat. Prerequisite: ability to canter securely.

Aut, Win, Spr (Melville) MTTh 10 or 4:15

Advanced — English seat. Prerequisite: secure in all three gaits, knowledge of leads and diagonals, and previous instruction.

Aut, Win, Spr (Melville) MTTh 11

Jumping — Prerequisite: same as for Advanced.

Aut, Win, Spr (Melville) MTTh 3:15

**151. Rifle and Pistol Marksmanship — (See Physical Education for Men.)**

**161. Modern Dance, Advanced.**

Aut, Win, Spr (Weiss-Lepnis) MW 4:15–5:30

**166. Dance Workshop — Prerequisite: intermediate or advanced ability in modern dance.**

Aut (Weiss-Lepnis) T 7:00–9:30 p.m.
167. Choreography and Production — Prerequisite: 166 or equivalent.
Win, Spr (Weiss-Lepnis) T 7:00–9:30 p.m.

172. Folk Dance, Advanced.
Given 1969–70

173. Folk Dance, Exhibition.
Given 1969–70

177. Historic Dance: Primitive and Ancient.
Given 1969–70

COURSES FOR WOMEN STUDENTS

1. Posture—Figure control and posture improvement with individual conditioning.
   Aut (Ruch) MWF 10 or 1:15
   Win (Ruch) MWF 9, 10, or 1:15
   Spr (Ruch) MWF 10

2. Conditioning — Group exercises to improve agility, strength, balance, coordination and endurance, in sports and swimming.
   Aut (Klaus) MWF 3:15
   Win (Klaus, Ruch) MWF 10, 2:15 or 3:15
   Spr (Klaus) TTh 2:15–3:30

3. Rhythmic Gymnastics—Exercises to music using small hand equipment.
   Aut, Win, Spr (Book) TTh 11:00–12:15

   Aut, Win (Klaus) TTh 2:15–3:30
   Spr (Klaus) MWF 3:15

5. Apparatus Gymnastics, Intermediate — Prerequisite: promoted from 4 or equivalent.
   Aut, Win, Spr (Klaus) MWF 2:15

8. Track and Field, Elementary.
   Aut, Spr (Klaus) MW 4:15–5:30

   Aut (Newport) MWF 1:15
   Win (Gordon) MW 12:50–2:05
   Spr (Newport) MWF 1:15

12. Fencing, Elementary.
   Aut (Hellwell) MWF 9 or 10
   Win, Spr (Hellwell) MWF 9

   Aut, Spr (Hellwell) TTh 10 and one hour by arrangement
   Win (Hellwell) MWF 10; TTh 10 and one hour by arrangement

15. Tennis, Elementary—For students with no previous experience or limited knowledge of and ability in fundamental strokes.
   Aut (Neal) MWF 10 or 1:15 or TTh 3:15–4:30
   Win, Spr (Neal) MWF 10 or 1:15

16. Tennis, Intermediate — Prerequisite: knowledge of rules and scoring, average ability in fundamental strokes.
   Aut (Neal) MWF 9; (Newport) TTh 10 and one hour by arrangement;
   (Neal) WF 11:00–12:15;
   (Newport) MWF 2:15
   Win (Neal) WF 11:00–12:15 or MWF 2:15
   Spr (Neal) MWF 9; (Guthrie) TTh 10 and one hour by arrangement;
   (Neal) WF 11:00–12:15;
   (Newport) MWF 2:15
   Sum (——)

20. Basketball — Prerequisite: limited experience or average ability.
   Win (Strathairn) TTh 3:15–4:30

23. Field Hockey, Elementary.
   Aut (Book) TTh 4:15

24. Field Hockey, Intermediate — Prerequisite: one season playing experience.
   Aut (Book) TTh 4:15

27. Volleyball.
   Aut (Book) MW 3:15–4:30
   Win, Spr (Book)

31. Swimming, Elementary — For students unable to swim safely in deep water.
   Aut (Strathairn) MWF 1:15
   Spr (Strathairn) MWF 2:15

32. Swimming, Intermediate — Ability to float, tread water, and swim safely in deep water.
   Aut (Ruch) MWF 2:15
   Spr (Ruch) MWF 3:15

35. Lifesaving — This is the American Red Cross Senior Lifesaving Course. Prerequi-
sites: strong swimmer; ability to swim a quarter mile without rest, to swim underwater, and to surface dive.

**Win (Strathairn)** MW or TTh 12:50–2:05
**Spr (Strathairn)** TTh 11:00–12:15

36. Aquatic Art—Synchronized swimming, water ballet, stunts, and figures. Prerequisite: above average ability in performing the crawlstroke, backstroke, breaststroke and sidestroke.

**Aut (Ruch)** MW 3:15 and one practice hour

44. **Golf, Elementary** — For students who have never had golf instruction.

**Aut, Spr (Gordon)** MW 10 or 2:15; TTh 11 or 2:15; each with one practice hour

**Win (Gordon)** MW 10, TTh 11 or 2:15; each with one practice hour

**Sum (——)**

45. **Golf, Intermediate** — Prerequisite: instruction or ability to play nine holes with a score under 60.

**Aut, Spr (Gordon)** TTh 10, MW 1:15 or 3:15; each with one practice hour

**Win (Gordon)** TTh 10 or MW 2:15; each with one practice hour

56. **Jazz Dance, Elementary** — Techniques of dance as seen in musicals.

**Aut (Book)**

**Win (Book)** MW 12:50–2:05 or TTh 2:15–3:30

57. **Jazz Dance, Intermediate** — Prerequisite: promoted from 56 or equivalent.

**Win (Book)** TTh 12:50–2:05

**Spr (Book)** MW 12:50–2:05

110. **Badminton, Advanced** — Prerequisite: promotion from 10 or previous experience which has provided above average ability in clears, smashes, net shots, serves, and knowledge of rules and strategy.

**Aut (Newport)** TTh 12:50–2:05

**Win (Neal)** TTh 12:50–2:05

112. **Fencing, Advanced.**

**Aut, Win (Hellwell)** MWF 2:15

**Spr (Hellwell)** MWF 10 or 2:15

113. **Fencing, Tournament.**

**Aut, Win, Spr (Hellwell)** TTh 11 and M 7:45 p.m.

114. **Tennis, Advanced**—Prerequisite: promoted from 16 or extensive experience which has provided above average ability in forehand, backhand, volley, and serve in addition to knowledge of lob, smash, and chop.

**Aut (Newport)** TTh 11:00–12:15;

**(Guthrie) TTh 2:15–3:30;**

**(Neal) MW 3:15–4:30**

**Win (Guthrie)** TTh 11:00–12:15; (Neal) TTh 2:15–3:30

**Spr (Neal) TTh 11:00–12:15; (Newport) TTh 2:15–3:30 or MW 3:15–4:30**

115. **Tennis, Tournament** — Prerequisite: promoted from 114 or equivalent experience including USLTA tournaments or school team participation.

**Aut (Guthrie) TTh 12:50–2:05**

**Win (Guthrie) TTh 12:50–2:05 or W 5 and two practice hours; by permission of instructor**

**Spr (Neal) TTh 12:50–2:05; (Newport) TTh 3:15–4:30**

119. **Bowling, Tournament** — Members of this class will participate in intercollegiate competitions.

**Aut, Win, Spr (Schoof) M 8:30–10:00 p.m.**

120. **Basketball, Advanced** — Prerequisite: above average ability or two seasons of playing experience.

**Win (Strathairn) MW 3:15–4:30**

121. **Basketball, Tournament** — Selected members of this class will play intercollegiate games. Prerequisite: eligible for 120.

**Win (Strathairn) MTTh 4:15**

130. **Swimming, Advanced** — Prerequisite: promoted from 32, or above average ability in performing the crawlstroke, backstroke, breaststroke, and sidestroke.

**Aut, Spr (Strathairn)** TTh 3:15 and one practice hour

131. **Swimming, Competitive** — All members of this class will participate in swimming meets. No prior experience necessary. Prerequisite: good form in at least one of the racing strokes.

**Aut, Spr (Strathairn) MW or TTh 4:15 and one practice hour**

135A. **Water Safety Instructor’s Course** — This is the 15-hour Part I of the American Red Cross W.S.I. course which focuses upon
swimming and lifesaving skills of the enrollees. Prerequisite: current American Red Cross Senior Lifesaving certificate and concurrent enrollment in 135B.

135B. Water Safety Instructor’s Course — This is the 15-hour Part II of the American Red Cross W.S.I. course which focuses upon the teaching of swimming and lifesaving by the enrollees. Prerequisites: concurrent enrollment in 135A or current W.S.I. course completion card.

Spr (Strathairn) MWF 12:50-2:05

144. Golf, Advanced — Prerequisite: promoted from 45, or ability to play 18 holes with a score under 110.

Aut, Win, Spr (Gordon) T1:15 and two practice hours

145. Golf, Tournament — All members of this class will play a limited number of matches (intramural and intercollegiate) during the quarter. Prerequisite: playing experience with average score below 100 for 18 holes.

Aut, Win, Spr (Gordon) T1:15 and two practice hours

SENIOR COLLOQUIA

Committee on General Studies: Robert A. Walker (Chairman), Richard H. Eastman, Lorenz Eitner, H. Bruce Franklin, Edwin M. Good, Richard W. Lyman, Herbert L. Packer, Joseph M. Pettit, David C. Regnery, Robert R. Sears, Lorie Tarshis

Under the General Studies Program, one Senior Colloquium is required of all seniors who are candidates for the A.B. degree, with a few exceptions. The exceptions are those students entering the Schools of Law or Medicine at the end of their third year, and those enrolled in Honors programs in Humanities or Social Thought and Institutions. The Colloquia listed below will be offered during the current year unless otherwise indicated in the Time Schedule.

The Senior Colloquia are limited to 15 students each and are structured around subjects or issues of continuing importance, or a basic document of enduring significance. They are designed to stimulate serious thought rather than to impart information for its own sake. Thus the emphasis is on discussion and analysis, not lectures.

Students are not admitted to a Colloquium being taught by a faculty member of their major department. The required Colloquium must be taken for a letter grade; additional Colloquia may be taken for either a letter grade or “Pass-Fail.” All Colloquia
are open to interested B.S. candidates.
Descriptions and reading lists can be found in the current General Studies Program Bulletin.

#4. Identity and the College Student.
2 units, Aut, Spr (Maurer, Health Service)
Th 8–10 p.m.

#5. The Meaning of Death in Western Culture.
2 units, Aut (Black, Counseling and Testing) W 7:30–9:30 p.m.

2 units, Spr (Dahl, General Studies) M 2:15–4:05

#7. The Doctor’s Dilemma.
2 units, Aut (Creger, Medical School) Th 7:30–9:30 p.m.

#8. Economic and Political Aspects of Petroleum Development.
2 units, Win (Marsden, Petroleum Engineering) W 4:15–6:05

2 units, Aut (Peck, Communication) W 7:30–9:30 p.m.

#10. Modern Short Fiction.
2 units, Aut (Dahl, General Studies) M 2:15–4:05

#11. An Introduction to Poetry.
2 units, Win (Dahl, General Studies) M 2:15–4:05

#12. Explorations in Science Fiction.
2 units, Win (Driessel, Speech and Drama) T 2:15–4:05

#14. The Modern German Drama.
2 units, Spr (Meads, German) M 4:15–6:05

#16. Right of Privacy: Legal and Theoretical Bases.
2 Units, Win (Gregory, General Secretary’s Office) F 2:15–4:05

#17. Patterns of Lay Religious Participation: A Comparative Sociological Exploration.
2 units, Spr (Hotchkiss, Anthropology) W 4:15–6:05

#18. The World of Aldous Huxley.
2 units, Spr (Gregory, General Secretary’s Office) F 2:15–4:05

#19. Nationalism and Revolution in the Arab World.
2 units, Spr (Nabti, Hoover Institution) Th 2:15–4:05

#20. Greek Literary Criticism.
2 units, Spr (Mellor, Classics) T 2:15–4:05

#21. U.S. Foreign Policy Toward the Middle East.
2 units, Win (Nabti, Hoover Institution) Th 2:15–4:05

#22. Islam and Modernization in the Middle East.
2 units, Aut (Ownby, General Studies) T 2:15–4:05

#23. Islam and Modernization in Egypt.
2 units, Spr (Ownby, General Studies) T 2:15–4:05

2 units, Win (R. Campbell, Hoover Institution) Th 2:15–4:05

#28. The Destiny of Europe.
2 units, Aut, Win, Spr (Hilton, Spanish and Portuguese) W 4:15–6:05

#29. The Influence of Western Ideas on the Middle East.
2 units, Aut (Nabti, Hoover Institution) Th 2:15–4:05

#30. World Political Significance of the Middle East.
2 units, Win (Keller, Placement Service) T 4:15–6:05

#31. Christianity, Marxism, and Existentialism.
2 units, Aut, Spr (McCoy, General Studies) T 8–10 p.m.

#36. Crisis and Change in Latin America.
2 units, Aut (Hanley, Overseas Campuses) M 2:15–4:05

#39. The Influence of Geographic Factors Upon the Development of Nations.
2 units, Aut, Win, Spr (Terry, General Studies) W 7:30–9:30 p.m.
#42. Dilemmas of the Graduating Senior.
2 units, Aut (Crockett, Health Service)
W 7:30–9:30 p.m.

#45. Photography: Composition, Content, and Expression. (Requirement: 35mm, single lens reflex camera.)
2 units, Spr (Kahn, Art and Architecture)
T 1:15–3:05

#47. The Place of Aircraft, Missiles, and Spacecraft in Twentieth Century Civilization.
2 units, Win (Hoff, Aeronautics and Astronautics) Th 2:15–4:05

#49. The Russian Revolution.
2 units, Aut (Mazour, History) W 2:15–4:05

#50. Human Values in a Technological Society.
2 units, Aut, Win (Thompson, Industrial Engineering) T 2:15–4:05
Spr (Thompson, Industrial Engineering) M 2:15–4:05

#60. The Literature and History of the Organ.
2 units, Aut (Nanney, Music) W 2:15–4:05

#65. Parapsychology.
2 units, Aut (Smith, Humanities)
M 7:30–9:30 p.m.

#71. Masters of Modern Architecture.
2 units, Win (Cole, Speech and Drama) T 2:15–4:05

#75. Masterpieces of Choral Music.
2 units, Win (Schmidt, Music) Th 2:15–4:05

#78. Man-Machine Decision Responsibility.
2 units, Spr (Bennigson, Industrial Engineering) T 7:30–9:30 p.m.

#79. Leisure in Modern Life.
2 units, Win (Cuthrie, Women’s Physical Education) Th 4:15–6:05

#85. The History of the Book.
2 units, Aut, Win, Spr (Lenkey, Library)
T 2:15–4:05

#90. Current Controversies over American Education.
2 units, Win (Thomas, Education)
T 4:15–6:05

2 units, Aut (Higgins, Education)
Th 2:15–4:05

#93. The Tragic Sense of Life in Unamuno.
2 units, Spr (Schevill, Spanish and Portuguese) W 4:15–6:05

#94. Civil Disobedience.
2 units, Aut (Schrader, Speech and Drama) Th 2:15–4:05

#96. The Underdeveloped Countries: Population, Food Supply, Industrialization.
2 units, Win (White, General Studies) Th 3:15–5:05

#98. Issues in Science and Religion.
2 units, Aut, Spr (Bube, Materials Science Engineering) T 4:15–6:05

#99. Ceremony and Symbol in Religion and Society.
2 units, Spr (Minto, University Chaplain)
Th 2:15–4:05

#100. Man’s Quest for Meaning.
2 units, Aut, Win, Spr (Rathbun, Law and Business Schools) W 4:15–6:05

#101. Problems and Politics of Southeast Asia.
2 units, Aut (Sokol, Political Science) T 4:15–6:05

#103. Lenin-Stalin-Khrushchev.
2 units, Spr (Drachkovitch, Political Science) Th 4:15–6:05

#104. Symbols and Meaning in Science and Culture.
2 units, Aut (Ripley, Physical Sciences)
W 2:15–4:05

#108. The Structure of American Education.
2 units, Aut (Mayer, Sociology) M 4:15–6:05

#109. Professionals and Organizations.
2 units, Aut (Zelditch, Sociology) M 4:15–6:05

#110. Man as a Factor in Evolution.
2 units, Win (Holm, Biological Sciences) Th 2:15–4:05

#111. The Human Maturation Process.
2 units, Aut (Fitton, General Studies) W 8–10 p.m.
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<th>Course Title</th>
<th>Units</th>
<th>Instructor(s)</th>
<th>Time</th>
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<td>#112</td>
<td>Behavioral Research and Phenomenology.</td>
<td>2</td>
<td>Alexander, Sociology</td>
<td>W 2:15-4:05</td>
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<td>#114</td>
<td>The Greek Historian Herodotus.</td>
<td>2</td>
<td>Raubitschek, Classics</td>
<td>Th 2:15-4:05</td>
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<tr>
<td>#116</td>
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<td>2</td>
<td>Kulsar, Speech and Drama</td>
<td>M 1:15-3:05</td>
</tr>
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<td>2</td>
<td>Thalmann, Geology</td>
<td>T 4:15-6:05</td>
</tr>
<tr>
<td>#122</td>
<td>Fossil Man and the Ice Age.</td>
<td>2</td>
<td>Cohn, French and Italian</td>
<td>T 2:15-4:05</td>
</tr>
<tr>
<td>#123</td>
<td>Voltaire and Johnson.</td>
<td>2</td>
<td>Loftis, English</td>
<td>W 4:15-6:05</td>
</tr>
<tr>
<td>#127</td>
<td>Herman Melville's Moby Dick.</td>
<td>2</td>
<td>H. Trimpi, English</td>
<td>Th 2:15-4:05</td>
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<tr>
<td>#142</td>
<td>Communism and the American Response.</td>
<td>2</td>
<td>Fisher, Hoover Institution</td>
<td>W 4:15-6:05</td>
</tr>
<tr>
<td>#143</td>
<td>American and Russian Foreign Relations: Contrasts and Similarities in Foreign Policy Styles.</td>
<td>2</td>
<td>Fisher, Hoover Institution</td>
<td>W 4:15-6:05</td>
</tr>
<tr>
<td>#146</td>
<td>Mystics and Mysticism.</td>
<td>2</td>
<td>Watkins, Political Science</td>
<td>T 2:15-4:05</td>
</tr>
<tr>
<td>#149</td>
<td>The Age of Jefferson.</td>
<td>2</td>
<td>Miller, History</td>
<td>T 2:15-4:05</td>
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<tr>
<td>#151</td>
<td>Psychology and International Behavior.</td>
<td>2</td>
<td>Geiwitz, Psychology</td>
<td>M 2:15-4:05</td>
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<tr>
<td>#157</td>
<td>Law and the Social Structure.</td>
<td>2</td>
<td>Davis, Dean of Students' Office</td>
<td>T 7:30-9:30 p.m.</td>
</tr>
<tr>
<td>#159</td>
<td>The Pattern of Cities.</td>
<td>2</td>
<td>Sanders, Planning and Architecture</td>
<td>W 7:30-9:30 p.m.</td>
</tr>
<tr>
<td>#170</td>
<td>Jean-Paul Sartre: Selected Fiction and Critical Writings.</td>
<td>2</td>
<td>Cohn, French and Italian</td>
<td>T 2:15-4:05</td>
</tr>
<tr>
<td>#179</td>
<td>Century 21: Technological Change and Human Values</td>
<td>2</td>
<td>Wallia, General Studies</td>
<td>Th 7:30-9:30 p.m.</td>
</tr>
<tr>
<td>#183</td>
<td>Christian Impact on Africa.</td>
<td>2</td>
<td>Minto, University Chaplain</td>
<td>T 2:15-4:05</td>
</tr>
<tr>
<td>#195</td>
<td>Social Science Approaches to Music.</td>
<td>2</td>
<td>Farnsworth, Psychology</td>
<td>T 2:15-4:05</td>
</tr>
<tr>
<td>#196</td>
<td>Mozart and His Music.</td>
<td>2</td>
<td>Kuhn, Music</td>
<td>M 2:15-4:05</td>
</tr>
<tr>
<td>#200</td>
<td>Psychiatry for Amateur Psychiatrists.</td>
<td>2</td>
<td>Paulsen, Health Service and Medical School</td>
<td>T 8-10 p.m.</td>
</tr>
</tbody>
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**SPECIAL OPPORTUNITIES IN GRADUATE STUDY**

**INSTITUTE FOR PLASMA RESEARCH**

Executive Committee: Peter A. Sturrock (Chairman), Daniel Bershadter, Oscar Buneeman, I-Dee Chang, Marvin Chodorow, Frederick W. Crawford, Donald A. Dunn, Von R. Eshleman, Robert H. Eustis, Gordon S. Kino, Charles H. Kruger, Morton Mitchner

The Institute is an interdepartmental organization coordinating teaching and research in plasma physics at Stanford and incorporating three laboratories.

The Plasma Physics Laboratory (Director, Donald A. Dunn) emphasizes experimental work on waves and instabilities, containment systems and plasma propulsion, and theoretical work on instabilities, nonlinear effects, plasma turbulence, computer simulation, and plasma astrophysics.
The Aerophysics Laboratory (Director, Daniel Bershader) conducts experimental and theoretical research on plasma and plasma flow at high density and moderate temperature, using shock tubes and advanced interferometric and spectroscopic equipment.

The Plasma Gasdynamics Laboratory (Director, Robert H. Eustis) concentrates on experimental and theoretical research related to magnetohydrodynamic energy conversion, such as nonequilibrium thermodynamics, transport processes, spectroscopy and plasma diagnostics.

The facilities of the Institute are available to any interested and qualified student, who must be admitted by and registered in a department or division. The Aeronautics and Astronautics Department, Electrical Engineering Department, Mechanical Engineering Department, and Applied Physics Division provide opportunities leading to an M.S. or Ph.D. degree for work in plasma physics. A number of plasma courses are listed by these departments and by the School of Engineering.

Further information is available from the laboratory directors and from the Chairman of the Executive Committee.

SPACE SCIENCE AND RELATED PROGRAMS

Committee in Charge: Peter A. Sturrock (Chairman), Daniel Bershader, Ronald N. Bracewell, Frederick W. Crawford, Von R. Eshleman, Robert A. Helliwell, Robert L. Kovach

Space science, which is the study of natural phenomena by observations from space vehicles, is actively pursued by many groups at Stanford. Experimental research in progress includes development of experimental packages to be carried by rockets, satellites, and space probes for studies including: radio emission in the magnetosphere; radio measurements of the interplanetary media and of planetary atmospheres; plasma waves in space; infrared and radar sensing of planetary surfaces; x-ray astronomy; and gravitation.

Related observations by means of ground-based equipment are made at the Radioscience Laboratory (ionospheric and magnetospheric structure and radio properties); the Radio Astronomy Institute (the sun and other radio sources); and the Center for Radar Astronomy (magnetospheric and cislunar media, sun and moon), operated jointly with Stanford Research Institute.

This experimental work is supported by theoretical studies, including a program in astrophysics emphasizing solar-terrestrial relations, solar physics, and nonthermal phenomena in quasars and radio galaxies. There is also a strong laboratory program in the simulation of space plasma phenomena.

Courses related to many of the above topics will be found listed under Engineering, Aeronautics and Astronautics, Electrical Engineering, Geophysics, and Applied Physics.

The Space Science and Related Programs are available to any interested and qualified graduate student, who must be admitted by and registered in a department or division. The Aeronautics and Astronautics Department, Electrical Engineering Department, and Applied Physics Division provide opportunities leading to a Ph.D. degree for work in space science, astronomy, or astrophysics.

In case a study program is not appropriate to any one department, a student has the privilege, under the general provisions of the Graduate Division Special Programs, of proposing a special program leading to a Ph.D. degree on a topic such as space science, astronomy, or astrophysics.

Further information is available from the Chairman of the Committee in Charge.

STANFORD LINEAR ACCELERATOR CENTER

Director: Wolfgang K. H. Panofsky
Deputy Director: Matthew Sands
Associate Directors: Joseph Ballam (Research Division); Robert H. Moulton, Jr. (Administrative Services Division); Richard B. Neal (Technical Division); Frederick V. L. Findar (Business Services Division)

Professors: Joseph Ballam, Sam M. Berman, James D. Bjorken, Sidney D. Drell, Wil-
UNDERGRADUATE SPECIAL PROGRAMS

Associate Dean: Robert R. Hind

UNDERGRADUATE SPECIAL COURSES

In 1964 the Committee on Undergraduate Education established a new category of courses for undergraduates to be called "Undergraduate Special Courses." One category of these courses is special offerings for undergraduates by members of the graduate professional schools. These are not intended to introduce the technical content of the professional schools into the undergraduate curriculum, but are to be general in character. Their principal purpose is to enrich the curriculum for undergraduates by drawing upon the resources of the professional schools as well as other parts of the University which customarily have not participated in undergraduate work. A second purpose is to offer an opportunity to introduce experimental courses, interdisciplinary courses, and other types which for various reasons might be listed as "Undergraduate Special" rather than under the aus-
OTHER DEPARTMENTS, INSTITUTES, AND PROGRAMS

pieces of a particular department.

A third category is student-initiated courses which may be initiated under the following policy:

1. Students may arrange with any member of the University faculty to conduct a seminar course on a topic of their mutual choosing which is consistent with the academic standards of the University, subject to the conditions and approvals below. Such courses may also be arranged by faculty residents or other staff members.

2. Academic credit of up to three units may be given for participation in such seminars. Grades shall be given in the normal manner, with the pass-fail option available upon the instructor's approval.

3. All proposed seminars must be approved by the Committee on Undergraduate Education. Organizers are to file with the Committee the following information:
   a. Course title and description, number of units
   b. A description of the manner in which the course will be conducted, and a meeting schedule
   c. A reading list
   d. The name of the instructor and any others who will assist in teaching the course

4. Organizers must also furnish to the Committee a statement from the instructor that he approves the course description as submitted, and that he agrees to assume full academic responsibility for its conduct.

5. If approved, seminars shall be listed as Undergraduate Special courses with the regular course offerings for the quarter. The maximum number of students to be enrolled shall be determined by the instructor in advance.

6. Proposal must be filed on or before the following dates, for the respective quarters:

<table>
<thead>
<tr>
<th>Quarter in which the course will be offered</th>
<th>Filing Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer or Autumn</td>
<td>May 15</td>
</tr>
<tr>
<td>Winter</td>
<td>Nov. 15</td>
</tr>
<tr>
<td>Spring</td>
<td>Feb. 15</td>
</tr>
</tbody>
</table>

7. No more than one Undergraduate Special seminar may be taken for academic credit in any one quarter.

101. Man as Organism — This course will deal with man's future, emphasizing the kinds of difficult decisions that must be made in the next few decades on many essentially biological problems: population, racial discrimination, abortion and euthanasia, organ transplantation and the provision of artificial organs, eugenics and the consequences of medical care, the calculated control of prenatal development, of sex and genetic constitution, and the projection of human behavior and its objectives on computing machinery. In alternate years the course will be addressed to students who have had advanced biology and those who have not. The course in autumn, 1967 will be directed to the more advanced students.

   1 unit, Aut (Lederberg, Staff) TTh 11

102. Risk and Insurance — The course will cover the general or "classical" theory of risk, an introduction to the theory of games, and analytical case study. It will give the student the kind of knowledge needed to analyze and solve problems involving personal and business decisions in the field of risk and insurance management.

   2 units, Aut, Spr (Serbein) MW 4:15

103. Progress in Medicine — This will be a series of lectures by members of the Medical School faculty. It will be open to undergraduates, graduates, staff, and the public; only matriculated Stanford undergraduates may enroll for credit.

   1 unit, Aut, Win, Spr (Pesch, Staff) W 8:00 p.m.

110. Stanford-in-Washington Seminar — Open to returning participants in the Stanford-in-Washington intern program. The primary purpose of the seminar is to expand knowledge of the function of the legislative and executive branches of the Federal government in the legislative process. Consent of instructor required.

   2 units, Aut (Horn) M 4:15–6:05

FRESHMAN SEMINARS

(Program for Undergraduate Creative Development)

The Freshman Seminar program, inaugurated in 1965-66, allows first-year students to explore in depth a subject that holds special personal interest for them and introduces them to other members of the university community who share this interest. Led by a faculty member or advanced gradu-
ate student, each seminar group of six to eight students meets for two quarters one afternoon or evening each week in the instructor's home or laboratory. The seminar offers an opportunity for the kind of extended study which can lead to the development of a genuine sense of intellectual and social community between student and instructor.

The Freshman Seminar program is neither an honors program nor an advanced placement program. Although a few seminars do have prerequisites, most are open to any student in the freshman class who is interested in the subject of the seminar and in the challenges of study in a seminar group. Each seminar carries a total of six units of academic credit (three units for each quarter), but fulfills neither the University's General Studies nor major subject requirements. Although students do receive a grade for their seminar work, in most cases this grade is not given until the end of the second quarter of the seminar.

In 1967–68 thirty-one departments or schools in the University participated in the seminar program, offering a total of sixty-two seminars to 499 members of the freshman class. Departments participating in the program were Art and Architecture, Anthropology, Biology, Civil Engineering, Classics, Communication, Computer Science, English, French and Italian, Geology, Geophysics, History, Linguistics, Material Sciences, Music, Philosophy, Physics, Political Science, Psychology, Sociology, Statistics, as well as the Graduate School of Business, the Schools of Earth Sciences, Law, and Medicine, the Hoover Institution, the Institute for the Study of Human Problems, and the Office of Undergraduate Education. There will be similar offerings in 1968–69.

APPLICATIONS AND ADMISSION PROCEDURES

All students who accept admission to Stanford University receive in June a copy of the Freshman Seminar booklet describing seminar offerings for the coming academic year. Approximately two-thirds of these seminars are scheduled for autumn-winter, with the remaining seminars meeting in winter-spring. Applications for the autumn-winter seminars are received and processed late in the summer; students are notified of their seminar status before they arrive at Stanford for preregistration. Except for seminars with prerequisites, seminar participants are chosen at random from among those who apply. Applications for the winter-spring seminars are processed in a similar manner late in the Autumn Quarter.

Correspondence regarding the program should be addressed to the Freshman Seminar Office, Stanford University, Stanford, California 94305.

HOOVER INSTITUTION

Note—The following courses taught by staff members of the Hoover Institution are offered for academic credit as indicated.


4 units, any quarter (Gann or Duignan)

131. The History of Southern Africa from the Dutch Occupation to the Present—Political, economic, and social factors; includes South Africa, Rhodesia, Zambia, Malawi, and Mozambique.

4 units, any quarter (Gann or Duignan)

141. Eastern Europe Since 1945—Analysis of events in the “Soviet sphere” since the collapse of Nazi domination; patterns of Communist conquest, domination of the area; comparative study of most important political, social, and economic problems of the area. Prerequisites: two background courses in modern European history or international relations. Seniors and graduate students by permission.

5 units, Aut (Sworakowski)


5 units, Win (Possony)
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