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Published annually in

INFORMATION .......................... January

SCHOOL OF MEDICINE .................. January

SUMMER SESSION ........................ February

HOPKINS MARINE STATION ............... February

COURSES AND DEGREES .................. May

SCHOOL OF NURSING .................... June

GRADUATE SCHOOL OF BUSINESS ........ August

SCHOOL OF LAW ......................... August

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On May 7, 1970 the Senate of the Academic Council terminated academic credit for all ROTC courses as of August 31, 1970, allowing transitional arrangements for students enrolled in ROTC as of May 7, 1970. Subsequent to that action the Air Force ROTC announced that no new students would be admitted to that program.

When this Bulletin was printed, the Presidential Advisory Committee on ROTC affairs was framing recommendations regarding the future of ROTC programs at Stanford. These deliberations may result in the retention of ROTC in modified non-curricular form, or in complete termination of ROTC at Stanford. Consequently, students not enrolled in ROTC as of May 7, 1970 should make no plans which are dependent on the future existence of reserve officers training at Stanford. Up-to-date information is available from the Provost's Office.

Reference: Senate Second Report 18, May 8, 1970

Stanford, California
Published by the University
COURSES
AND DEGREES
70-71

[While every effort is made to ensure the accuracy of the information available at the time copy is prepared for this Bulletin, the University reserves the right to make changes at any time without prior notice.]
## UNIVERSITY CALENDAR

### AUTUMN QUARTER, 1970

<table>
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<tr>
<th>Date</th>
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<tbody>
<tr>
<td>Sept. 28–29</td>
<td>Monday–Tuesday Registration</td>
</tr>
<tr>
<td>Sept. 30</td>
<td>Wednesday Instruction begins</td>
</tr>
<tr>
<td>Oct. 1</td>
<td>Thursday Conferring of degrees</td>
</tr>
<tr>
<td>Oct. 4</td>
<td>Sunday Matriculation Sunday</td>
</tr>
<tr>
<td>Oct. 20</td>
<td>Tuesday Last day for registration</td>
</tr>
<tr>
<td>Oct. 27</td>
<td>Tuesday Last day for filing advanced degree applications: A.M., M.S., Engineer for April conferral; Ph.D. for June</td>
</tr>
<tr>
<td>Nov. 26–29</td>
<td>Thursday–Sunday Thanksgiving Recess</td>
</tr>
<tr>
<td>Nov. 30</td>
<td>Monday Last day for filing A.B. and B.S. applications</td>
</tr>
<tr>
<td>Dec. 14</td>
<td>Monday Last day for filing A.M., M.S., Engineer theses, and Ph.D. Dissertations</td>
</tr>
<tr>
<td>Dec. 14–18</td>
<td>Monday–Friday End-quarter examinations</td>
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### WINTER QUARTER, 1971

<table>
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<th>Date</th>
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<tbody>
<tr>
<td>Jan. 4</td>
<td>Monday Registration</td>
</tr>
<tr>
<td>Jan. 5</td>
<td>Tuesday Instruction begins</td>
</tr>
<tr>
<td>Jan. 7</td>
<td>Thursday Conferring of degrees</td>
</tr>
<tr>
<td>Jan. 15</td>
<td>Friday Last day for filing Fellowship and Graduate Scholarship applications</td>
</tr>
<tr>
<td>Jan. 25</td>
<td>Monday Last day for registration</td>
</tr>
<tr>
<td>Jan. 29</td>
<td>Friday Last day for filing A.B. and B.S. applications for April and June conferral</td>
</tr>
<tr>
<td>Feb. 1</td>
<td>Monday Last day for filing advanced degree applications: A.M., M.S., Engineer for June conferral; Ph.D. for September</td>
</tr>
<tr>
<td>Feb. 15</td>
<td>Monday Observance of Washington’s Birthday</td>
</tr>
<tr>
<td>March 8</td>
<td>Monday Founders’ Day</td>
</tr>
<tr>
<td>March 15</td>
<td>Monday Last day for filing A.M., M.S., Engineer theses; and Ph.D. Dissertations</td>
</tr>
<tr>
<td>March 15–19</td>
<td>Monday–Friday End-quarter examinations</td>
</tr>
</tbody>
</table>

### SPRING QUARTER, 1971

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<thead>
<tr>
<th>Date</th>
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<tbody>
<tr>
<td>March 29</td>
<td>Monday Registration</td>
</tr>
<tr>
<td>March 30</td>
<td>Tuesday Instruction begins</td>
</tr>
<tr>
<td>April 1</td>
<td>Thursday Conferring of degrees</td>
</tr>
<tr>
<td>April 19</td>
<td>Monday Last day for registration</td>
</tr>
<tr>
<td>April 26</td>
<td>Monday Last day for filing advanced degree applications: A.M., M.S., Engineer for September conferral; Ph.D. for January</td>
</tr>
<tr>
<td>May 1</td>
<td>Saturday Last day for filing Undergraduate Scholarship applications, matriculated undergraduates</td>
</tr>
<tr>
<td>May 17</td>
<td>Monday Last day for filing Ph.D. Dissertations</td>
</tr>
<tr>
<td>May 31</td>
<td>Monday Observance of Memorial Day</td>
</tr>
<tr>
<td>June 3</td>
<td>Thursday Last day for filing A.M., M.S., Engineer theses</td>
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<tr>
<td>June 4–9</td>
<td>Friday–Wednesday End-quarter examinations</td>
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<tr>
<td>June 12</td>
<td>Saturday Senior Class Day</td>
</tr>
<tr>
<td>June 13</td>
<td>Sunday Commencement</td>
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### SUMMER QUARTER, 1971

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<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>June 21</td>
<td>Monday Registration</td>
</tr>
<tr>
<td>June 22</td>
<td>Tuesday Instruction begins</td>
</tr>
<tr>
<td>July 5</td>
<td>Monday Observance of Independence Day</td>
</tr>
<tr>
<td>Aug. 13–14</td>
<td>Friday–Saturday Eight-week term examinations</td>
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<tr>
<td>Aug. 14</td>
<td>Saturday Eight-week term closes</td>
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<tr>
<td>Aug. 31</td>
<td>Tuesday Quarter closes</td>
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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

The aims of undergraduate education at Stanford are twofold—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 undergraduate curriculum at Stanford allows considerable flexibility in planning individual programs of study. A student may spend much of the first two years in fulfilling general requirements, or he may begin specialization early and carry both his major and general courses over four years.

There is much 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 awarded 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, or a number of departments in the case of interdisciplinary majors, is also an essential part of the student's undergraduate experience. And in addition, good English is expected in all University course work and is a consideration in grading. It is not an exercise limited to English classes alone.

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.

GENERAL REQUIREMENTS

Writing Requirement — Each candidate for the Bachelor's degree must complete two quarters of instruction in written composition, or an equivalent. The requirement may be fulfilled by (a) courses in written composition offered by the English Department, (b) other appropriate courses designated by the Subcommittee on Writing of the Committee on Undergraduate Studies, or (c) examination. Students scoring "4" or "5" on the CEEB advanced placement test in English
literature may choose to be exempted from the writing requirement if they wish. In addition, a small percentage of students who score high in the CEEB achievement test in English composition will be allowed the option of being exempted from the requirement if they wish. Writing courses taken to satisfy the requirement ordinarily will be taken in the first year. Students demonstrating sufficient skill in writing in the first quarter may be exempted from the second quarter on certification by the instructor.

Distribution Requirements—Each candidate for the Bachelor's degree must complete at least three quarter courses of at least three units in each of the following broad areas: (a) humanities and fine arts; (b) social sciences; and (c) mathematics, natural sciences, and technology. With careful planning, all students attending a Stanford overseas campus can work toward the satisfaction of the distribution requirements in humanities and fine arts, and social sciences. Courses taken on a Pass/Fail basis may not be counted toward the satisfaction of general requirements.

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: (see deadlines in Time Schedule calendar.)

1. Completion of 180 (quarter) units of University work, including Writing/Distribution requirements.
2. Attainment of at least a 2.0 grade point average on a 4.0 scale for all registered units at Stanford.
3. Completion of curriculum requirements of the major department and the recommendation of that department. (Curriculum and other special requirements are listed under each department in Courses and Degrees.)
4. Completion of at least 45 units (including the last 15) at Stanford. (In special cases, students who have obtained at least 135 units in resident work and have completed major and Writing/Distribution requirements may petition for a waiver of the last work-in-residence requirement.)
5. Three quarters in resident study.

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.

If a student fails to meet requirements, he must reapply.

The degree is conferred at the end of the quarter in which the requirements are met, but diplomas are issued and Commencement exercises are held only in June.

Second Bachelor 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 for candidacy 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.

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 Writing/Distribution requirements. (See School of Engineering for Co-Terminal A.B. and B.S. Program.)

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 Graduate Studies. Candidacy is valid for five years from date of such approval and may be renewed by the submission and approval of a new application, or extended upon the recommendation of the major department. All applications or petitions to the University Committee on Graduate Studies 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, Room 117, Old Union, Stanford University, Stanford, California 94305.

MASTER OF ARTS OR MASTER OF SCIENCE

Upon recommendation to the Senate of the Academic Council by the faculty of the major department and the University Committee on Graduate Studies, 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 at least 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 Graduate Studies 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, or extended upon the recommendation of the major department.

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 Graduate Studies. 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, Room 117, Old Union.

**MASTER OF ARCHITECTURE**

Upon recommendation to the Senate of the Academic Council by the faculty of the Department of Art and Architecture and the University Committee on Graduate Studies, 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 Senate of the Academic Council by the faculty of the Graduate School of Business and the University Committee on Graduate Studies, 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.)

**MASTER OF EDUCATIONAL ADMINISTRATION**

A program jointly sponsored by the Stanford Graduate School of Business and the Stanford School of Education leads to the degree of Master of Educational Administration (M.Ed.Adm.). Upon recommendation to the Senate of the Academic Council by the Joint Program Degree Committee and the University Committee on Graduate Studies, the degree is conferred on candidates who have satisfied the requirements laid down by the sponsoring Schools and the University.

A description of the program and admission qualifications can be obtained by writing the Office of Admissions, School of Education, Stanford University.

**ENGINEER**

**General Regulations**—Upon recommendation to the Senate of the Academic Council by the faculty of the major department and the University Committee on Graduate Studies, 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 Graduate Studies 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
DEGREES

renewed by the approval of a new application by the major department and the University Committee, or extended upon the recommendation of the major department.

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 Graduate Studies, 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, Room 117, Old Union.

MASTER OF FINE ARTS

General Regulations—Upon recommendation to the Senate of the Academic Council by the faculty of the major department and the University Committee on Graduate Studies, the degree of Master of Fine Arts (M.F.A.) is conferred on candidates who have satisfactorily completed at least 48 quarter units 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.

MASTER OF JURISPRUDENCE

The Master of Jurisprudence (J.M.) is a nonprofessional degree. Its requirements include successful completion of the first year of law school plus an additional academic year of full-time law study. The J.M. degree terminates a course of study at the Law School. Candidates may elect to take the degree in the early spring of their second year. Holders of the J.M. degree who at a later date wish to apply for admission to complete the J.D. program may do so, but re-admission is not automatic.

DOCTOR OF MUSICAL ARTS

Upon recommendation to the Senate of the Academic Council by the faculty of the Department of Music and the University Committee on Graduate Studies, 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 musicological 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 appropriate to the area of concentration is also required. Further information concerning the requirements will be found in this bulletin and may be obtained from the office of the Chairman of the Department of Music.

DOCTOR OF JURISPRUDENCE

Upon recommendation to the Senate of the Academic Council by the faculty of the School of Law and the University Committee on Graduate Studies, the degree of Doctor of Jurisprudence (J.D.) 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 THE SCIENCE OF LAW

Admission to candidacy for the degree of Master of the Science of Law (J.S.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 Senate of the Academic Council by the faculty of the School of Medicine and the University Committee on Graduate Studies, 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 Senate of the Academic Council by the faculty of the major department and the University Committee on Graduate Studies, 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 requirements which must be completed as a graduate at Stanford are a minimum of 36 quarter units and a minimum of three full quarters (or the equivalent in part-time registrations as calculated on tuition payments). 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 procedures, the major department may certify him to the University Committee on Graduate Studies 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 C34, which must be
DEGREES

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, or extended upon the recommendation of the major department.

Foreign Language Requirement

The requirement of the reading knowledge of one or more foreign languages is left to the option of individual departments or schools. A candidate who has a foreign language requirement must meet his department's deadlines in submitting language report(s) (Form G28) to the Graduate Study Office.

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 chairman, appointed by the Dean of the Graduate Division, presiding, (2) four or more faculty members appointed by the Dean of the Graduate Division to represent the major and minor departments (upon the departments' recommendation), (3) 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 chairman 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. At least one other member in addition to the principal adviser must belong to Academic Council. 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, Room 117, Old Union. 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
1970–71

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.

SUMMER SESSION

The Summer Session of 1971 will be eight weeks in length, except in certain schools which will offer ten-week courses.

This announcement includes, for the Summer Session of 1971, 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 1971.
GRADUATE SCHOOL of BUSINESS


Dean: Arjay Miller


Assistant Deans: Donald A. Phillips, Gary G. Williams


Acting Assistant Professor: Laurence T. Pinfield

Lecturers: C. Sidney Cottle, Gerald J. Eskin, Mark D. Larkin, Lamar Lee, Samuel A. Pond, Karl M. Buppenthal, Sterling D. Sessions, Dan Throop Smith

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, Stanford University, Stanford, California 94305, 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 chairman 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 scho-
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.

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 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. Physical Processes of Geology
Geol. 204. Computer Applications in Earth Sciences
Geol. 320. Advanced Structural Geology
Opportunities exist to develop laboratories to meet the requirements of new research projects. For example, a high-pressure tri-axial 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 SCIENCES**

Environmental Earth Sciences are concerned with the effects of man’s activities on earth processes and, conversely, with the influence of earth processes on the works of man. The flexible interdisciplinary programs described below are intended (a) to involve natural scientists and engineers in the planning and management of the environment, (b) to provide socio-humanistic environmental planners and managers with a natural-science and engineering background, and (c) to combine a knowledge of environmental characteristics and functioning with capabilities for modeling and predicting management effects.

The San Francisco Bay region, an area of rapid population growth, is a challenging field laboratory. Here, human activity has spread into areas that are replete with geologic hazards such as active faults, subsiding ground, and unstable slopes. With increasing population, problems of water distribution, waste disposal, marine pollution, and water and air pollution have been intensified.

**BACHELOR OF SCIENCE (an option in the Department of Geology)**

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

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biol. Sci. 1, 21</td>
<td>General Biology</td>
<td>9</td>
</tr>
<tr>
<td>Chem. 1, 2</td>
<td>General Chemistry</td>
<td>8</td>
</tr>
<tr>
<td>Civ. Engr. 170</td>
<td>Man &amp; His Environment</td>
<td>3</td>
</tr>
<tr>
<td>Comp. Sci. 5</td>
<td>Introduction to Programming</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 1, 2</td>
<td>Geoscience I, II</td>
<td>10</td>
</tr>
<tr>
<td>Geol. 18</td>
<td>Framework of Geology</td>
<td>5</td>
</tr>
</tbody>
</table>

The following courses will be of interest to students having suitable prerequisites:

- Biol. Sci. 22, 23. General Biology
- Biol. Sci. 115A, B. Population Biology
- Chem. 3. General Chemistry
- Engr. 161. Engineering Economy
- Food Res. Inst. 100. Human Geography
- Food Res. Inst. 135. Population Problems
- Geol. 5. Introduction to Environmental Earth Sciences
- Geol. 103. Structural Geology
- Geol. 107. Introduction to Probability and Statistics in Geology
- Geol. 115. Introduction to Biological Oceanography
- Indus. Eng. 50. Human Values in a Technological Society
- Law 252. Conservation Issues
- Law 373. Water Law
- Math. 113. Linear Algebra and Matrix Theory
- Mech. Eng. 137. Air Pollution
- Physics 29 (or 57, 58). Atomic Physics
- Pol. Sci. 100. Introduction to Public Administration

**MASTER OF SCIENCE AND DOCTOR OF PHILOSOPHY**

Students must meet the requirements of specific departments. Meaningful interdisciplinary programs are prepared to meet career objectives. A large number of courses from many departments contribute to this curriculum. In addition to the courses listed above, the following offerings in the School of Earth Sciences may be of interest:

- Geol. 200. Mechanics of Earth Materials
- Geol. 210. Introduction to Marine Geology
- Geol. 233. Principles of Geomorphology
- Geol. 235. Photogrammetry and Photogeology
- Geol. 284. Engineering Geology
- Geol. 285. Hydrogeology
- Geol. 286. Development of Ground-Water Resources
- Geol. 487. Seminar in Hydrogeology

**Emeriti:** Siemon W. Muller, Charles F. Park, Jr., A. Myra Keen (Professors)

**Chairman:** John W. Harbaugh

**Vice Chairman:** Robert R. Compton (on leave Aut, Spr, 1970–71)

**GEOLOGY**

*Emeriti:* Siemon W. Muller, Charles F. Park, Jr., A. Myra Keen (Professors)

*Chairman:* John W. Harbaugh

*Vice Chairman:* Robert R. Compton (on leave Aut, Spr, 1970–71)


Assistant Professors: James C. Ingle, Jr., Arvid M. Johnson (Mineral Engineering), Paul Switzer (Statistics)


Programs of Study

Bachelor of Science

The program leading to the degree of Bachelor of Science in Geology provides a high degree of flexibility for each individual student. Of the total of 180 units required for the bachelor's degree, not more than 135 are in the form of formal requirements, permitting the student to take elective courses totaling at least 45 units, or one-fourth of his undergraduate program. The required courses for a student majoring in geology can be grouped into three categories: (1) required courses offered within the Department of Geology, (2) courses in chemistry, physics, and mathematics that are essential to the geology curriculum but are taught in departments other than the Department of Geology, and (3) the University's requirements which mostly pertain to courses in subjects other than science.

Core Course Sequence in Geology

The geology courses that are required form an integrated core course sequence totaling 50 units. All undergraduate geology majors are expected to complete the core course sequence, regardless of their intended subsequent specialization in geology. The core course sequence is as follows:

<table>
<thead>
<tr>
<th>Courses</th>
<th>Quarter</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Geoscience I</td>
<td>Aut, Win, Spr</td>
<td>5</td>
</tr>
<tr>
<td>2. Geoscience II</td>
<td>Win, Spr</td>
<td>4</td>
</tr>
<tr>
<td>18. Framework of Geology</td>
<td>Spr</td>
<td>5</td>
</tr>
<tr>
<td>105. Structural Geology</td>
<td>Spr</td>
<td>5</td>
</tr>
<tr>
<td>120. Field Geology</td>
<td>Sum</td>
<td>12</td>
</tr>
<tr>
<td>121A. Mineralogy and Crystal Chemistry</td>
<td>Aut</td>
<td>4</td>
</tr>
<tr>
<td>121B. Petrology</td>
<td>Win</td>
<td>4</td>
</tr>
<tr>
<td>122A. Sedimentary Geology</td>
<td>Win</td>
<td>4</td>
</tr>
<tr>
<td>122B. Stratigraphic Geology and Paleocology</td>
<td>Win</td>
<td>4</td>
</tr>
<tr>
<td>130. Advanced Field Geology and Research</td>
<td>Aut, Win, Spr</td>
<td>3</td>
</tr>
</tbody>
</table>

Total core course units in geology 50

The core course sequence places emphasis on problem solving and provides an early introduction to field geology. A student can enter the core course sequence as early as his freshman year, but entry in the sophomore or junior year is also feasible. If the student enters as late as the beginning of his junior year, however, it is essential that he have completed most of the requirements in mathematics, chemistry, and physics, as well as having taken courses equivalent to Geology 1 and 2, if he is not to be delayed in obtaining the bachelor's degree.

The minimum number of required courses in mathematics, physics, and chemistry for the Bachelor of Science in Geology varies with a student's high school preparation in these subjects, his general quantitative ability, and the speed at which he wishes to gain proficiency. Students with interests in analytical aspects of geology should plan on completing mathematics courses through differential equations as well as taking courses in statistics (such as Geology 107). The following course sequences describe the minimum requirements:

Mathematics

1. For students entering Stanford with only high school algebra and trigonometry: Mathematics 10, 11, 21, and 23 (Analytical Geometry and Calculus) 15
2. For students entering Stanford with only high school algebra and trigonometry but desiring to take courses at a more rapid pace: Mathematics 41, 42, and 43 (Analytical Geometry and Calculus) 15
3. For students entering Stanford with credit in analytical geometry: Mathematics 41A, 42A, and 43A (Calculus) 12

Physic
1. For students with average interest and ability in physics and with mathematical preparation through Mathematics 11 or 41 and concurrent registration in Mathematics 21 or 41: Physics 51 (Mechanics), 53 (Electricity), and 55 (Heat and Light) 12
2. For students with exceptional ability and interest in physics, advanced placement in mathematics, and concurrent registration in Mathematics 43: Physics 59 and 60 (Advanced Freshman Physics) 8

Chemistry
1. For the majority of students majoring in geology and with mathematical preparation (or concurrent registration in) Mathematics 10 or 41: Chemistry 4 and 5 (General Chemistry for students in engineering and science) 8
2. In some instances the following sequence may be substituted for Chemistry 4 and 5 with consent of the advisor: Chemistry 1, 2, and 3 (General Chemistry for students in chemistry, biology, and medicine). 13

Maximum possible required units in mathematics, physics, and chemistry 40
Minimum possible required units in mathematics, physics, and chemistry 28

Electives
A student entering Stanford with credit in high school algebra, trigonometry, and natural science normally will have a minimum of 45 units of free electives in addition to the core curriculum in geology and requirements of the University. These elective units afford an opportunity to acquire substantial strength in one or more of the many subdisciplines in geology and allied earth sciences at the undergraduate level. Alternately, elective units can be utilized to complete requirements for a Standard Teaching Credential or to acquire depth in a discipline outside the earth sciences such as civil engineering or marine biology. Appropriate electives that are in accord with the interests of a student can be selected in conference with his advisor. There are no constraints on elective courses to be taken, and the courses may be taken in the Department of Geology or any other department of the University.

All courses numbered in the 100's and 200's are open to qualified undergraduate students and the number of courses offered within a given subdiscipline commonly exceed the number of elective units available to a student. Thus the following lists of recommended electives should simply be viewed as guidelines in constructing an individual curriculum. Interdisciplinary programs of study are encouraged.

Recommended Electives (Courses considered of special importance are marked with an asterisk.)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Qtr.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>*Geol. 107. Introduction to Probability and Statistics in Geology</td>
<td>Win</td>
<td>3</td>
</tr>
<tr>
<td>*Geol. 171. Introduction to Geochemistry</td>
<td>Aut</td>
<td>3</td>
</tr>
<tr>
<td>*Geol. 172. Geological Thermodynamics</td>
<td>Win</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 200. Physical Processes of Geology</td>
<td>Aut</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 203. Instrumental Methods and Analytical Techniques in Earth Sciences</td>
<td>Aut</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 210. Introduction to Marine Geology</td>
<td>Spr</td>
<td>5</td>
</tr>
<tr>
<td>*Geol. 220. Optical Mineralogy</td>
<td>Aut</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 222. Igneous and Metamorphic Petrology</td>
<td>Win</td>
<td>6</td>
</tr>
<tr>
<td>Geol. 223. Sedimentary Petrology</td>
<td>Spr</td>
<td>6</td>
</tr>
<tr>
<td>*Geol. 233. Principles of Geomorphology</td>
<td>Aut</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 234. Map Interpretation and the Scientific Method</td>
<td>Aut</td>
<td>5</td>
</tr>
<tr>
<td>*Geophys. 190. General Geophysics</td>
<td>Aut</td>
<td>3</td>
</tr>
<tr>
<td>Geophys. 191. Geophysical Field Techniques</td>
<td>Spr</td>
<td>4</td>
</tr>
<tr>
<td>Chem. 171. Physical Chemistry</td>
<td>Aut</td>
<td>3</td>
</tr>
<tr>
<td>Math. 130. Ordinary Differential Equations</td>
<td>Aut,</td>
<td>5</td>
</tr>
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Maximum possible required units in geology and allied earth sciences 40
Minimum possible required units in geology and allied earth sciences 28

2. For students planning emphasis in sedimentary geology:

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<th>Courses</th>
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<tr>
<td>Geol. 204A. Computer Applications in Earth Sciences</td>
<td>Aut</td>
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Maximum possible required units in geology and allied earth sciences 40
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3. For students planning emphasis in theoretical geology:

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<tr>
<td>*Geol. 223. Sedimentary Petrology</td>
<td>Spr</td>
<td>6</td>
</tr>
<tr>
<td>Geol. 233. Principles of Geomorphology</td>
<td>Aut</td>
<td>5</td>
</tr>
<tr>
<td>*Geol. 260. Geochronology</td>
<td>Spr</td>
<td>4</td>
</tr>
<tr>
<td>Geophys. 190. General Geophysics</td>
<td>Aut</td>
<td>3</td>
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Minimum possible required units in theoretical geology 28

Electives
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Maximum possible required units in geology and allied earth sciences 40
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</tr>
<tr>
<td>Geol. 171. Introduction to Geochemistry</td>
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<tr>
<td>Geol. 204A. Computer Applications in Earth Sciences</td>
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<tr>
<td>Geol. 204B. Computer Applications in Earth Sciences</td>
<td>Win</td>
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<tr>
<td>Geol. 210. Introduction to Marine Geology</td>
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</table>

Maximum possible required units in geology and allied earth sciences 40
Minimum possible required units in geology and allied earth sciences 28

3. For students planning emphasis in theoretical geology:
<table>
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<tr>
<th>Courses</th>
<th>Qtr. Unit</th>
<th>Courses</th>
<th>Qtr. Unit</th>
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<tr>
<td>*Geol. 171. Introduction to Geochemistry</td>
<td>Aut 3</td>
<td>Civil Engr. 114. Mechanics of Materials</td>
<td>Aut 4</td>
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<tr>
<td>*Geol. 172. Geological Thermodynamics</td>
<td>Win 3</td>
<td>Civil Engr. 190. Soil Mechanics and Foundations</td>
<td>Aut 4</td>
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<td>*Geol. 200. Physical Processes of Geology</td>
<td>Aut 5</td>
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<td>*Geol. 203. Instrumental and Analytical Techniques in Earth Sciences</td>
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<td>Geol. 204A. Computer Applications in Earth Sciences</td>
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<td>Geol. 204B. Computer Applications in Earth Sciences</td>
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<tr>
<td>Geol. 205. Applications of Probability and Statistics in Geology</td>
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<tr>
<td>Geol. 271. Geochemistry</td>
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<td>*Geophys. 190. General Geophysics</td>
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<tr>
<td>Geophys. 250. Geomagnetism and Paleomagnetism</td>
<td>Win 3</td>
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<tr>
<td>Geophys. 295. Advanced General Geophysics</td>
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<tr>
<td>*Chem. 171. Physical Chemistry</td>
<td>Aut 3</td>
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<tr>
<td>*Math. 130. Ordinary Differential Equations</td>
<td>Win 3</td>
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<td>4. For students planning emphasis in paleontology:</td>
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<tr>
<td>*Geol. 107. Introduction to Probability and Statistics in Geology</td>
<td>Win 3</td>
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<tr>
<td>*Geol. 112. Elementary Paleontology</td>
<td>Spr 5</td>
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<tr>
<td>Geol. 119. Vertebrates of the Past</td>
<td>Aut 3</td>
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<tr>
<td>Geol. 171. Introduction to Geochemistry</td>
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<tr>
<td>Geol. 210. Introduction to Marine Geology</td>
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<tr>
<td>*Geol. 214. Advanced Invertebrate Paleontology II</td>
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<tr>
<td>Geol. 218. Introduction to Micropaleontology</td>
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<tr>
<td>*Geol. 260. Geochronology</td>
<td>Spr 4</td>
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<tr>
<td>*Biol. Sci. L. Introductory Biology</td>
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<td>*Biol. Sci. 102. Invertebrate Biology</td>
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<td>Biol. Sci. 111H. Marine Invertebrates</td>
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<td>Biol. Sci. 112H. Marine Invertebrates</td>
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<td>Biol. Sci. 175H. Problems in Marine Biology</td>
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<td>Biol. Sci. 222H. Biological Oceanography</td>
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<td>5. For students planning emphasis in engineering geology:</td>
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<td>*Geol. 100. Introduction to Environmental Earth Sciences I</td>
<td>Win 5</td>
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<td>Geol. 171. Introduction to Geochemistry</td>
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<td>*Geol. 200. Physical Processes of Geology</td>
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<td>*Geol. 220. Optical Mineralogy</td>
<td>Aut 5</td>
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<tr>
<td>Geol. 222. Igneous &amp; Metamorphic Petrology</td>
<td>Win 6</td>
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<td>Geol. 223. Sedimentary Petrology</td>
<td>Spr 6</td>
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<tr>
<td>Geol. 233. Principles of Geomorphology</td>
<td>Aut 5</td>
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<td>Geol. 235. Photogametry &amp; Photography</td>
<td>Spr 5</td>
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<tr>
<td>*Geol. 284. Engineering Geology</td>
<td>Aut 4</td>
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<td>*Geol. 285. Hydrogeology</td>
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<tr>
<td>Geol. 286. Development of Groundwater Resources</td>
<td>Spr 3</td>
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<td>*Geophys. 190. General Geophysics</td>
<td>Aut 3</td>
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<tr>
<td>Geophys. 191. Geophysical Field Techniques</td>
<td>Spr 4</td>
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<tr>
<td>Min. Engr. 200. Introduction to Rock Mechanics</td>
<td>Win 3</td>
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<tr>
<td>Engr. 11. Applied Mechanics: Statics and Stress Analysis</td>
<td>Aut,Win,Spr 4</td>
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<td>6. For students planning emphasis in economic geology:</td>
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<tr>
<td>*Geol. 107. Introduction to Probability and Statistics in Geology</td>
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<tr>
<td>*Geol. 171. Introduction to Geochemistry</td>
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<td>*Geol. 172. Geological Thermodynamics</td>
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<td>Geol. 204A. Computer Applications in Earth Sciences</td>
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<td>Geol. 204B. Computer Applications in Earth Sciences</td>
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<td>*Geol. 220. Optical Mineralogy</td>
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<tr>
<td>Geol. 222. Igneous and Metamorphic Petrology</td>
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<td>Geol. 271. Geochemistry</td>
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<td>*Geol. 281A. Introduction to Ore Deposits</td>
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<tr>
<td>*Geol. 281B. Ore Deposits</td>
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<tr>
<td>*Geol. 281C. Ore Genesis</td>
<td>Spr 3</td>
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<tr>
<td>*Geol. 283. Laboratory Study of Opaque Minerals</td>
<td>Win 4</td>
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<td>Geol. 287. Minerals, Politics and Economics</td>
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<td>Geol. 288. Genesis of the Metallic Ores</td>
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<td>Min. Engr. 101. Elements of Mining</td>
<td>Aut 3</td>
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<td>Min. Engr. 200. Introduction to Rock Mechanics</td>
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<tr>
<td>Min. Engr. 296A. Airborne Exploration</td>
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<tr>
<td>Min. Engr. 296C. Airborne Exploration</td>
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<td>7. For students planning emphasis in geochemistry:</td>
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<td>*Geol. 172. Geological Thermodynamics</td>
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<td>*Geol. 271. Geochemistry</td>
<td>Win 3</td>
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<td>*Geol. 203. Instrumental and Analytical Techniques in Earth Sciences</td>
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<td>Geol. 222. Igneous and Metamorphic Petrology</td>
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<td>Geol. 223. Sedimentary Petrology</td>
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<td>*Chem. 111. Quantitative Analysis</td>
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<td>Chem. 121. Organic Chemistry</td>
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<tr>
<td>*Chem. 171. Physical Chemistry</td>
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</table>

**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.

**Teaching Credential for Secondary Schools**—In cooperation with the School of
Education, the Department offers a program leading to a Standard Teaching Credential in Geology for secondary-school earth-science teachers. For details about the program, inquiries should be addressed to the School of Education.

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, 18, 121A, 121B, and 105. Entry is possible at any time after the end of the sophomore year. The Honors Program consists of the following:

1. The core courses in geology, mathematics, physics, and chemistry required of all geology majors.
2. Geology 150A, B, C and 6 units of Geology 155.

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.

COTERMINAL B.S. AND M.S. PROGRAM

A Stanford undergraduate majoring in Geology may be admitted to the University Division for the purpose of working simultaneously toward bachelor's and master's degrees, provided:

1. He applies after the beginning of his eighth quarter of undergraduate work and before the end of his eleventh quarter; and
2. His admission is recommended by the school or department in which he seeks a master's degree, that department applying the same standards for admission that it would to an applicant for the Graduate Division.

Both degrees may be granted simultaneously or at the conclusion of different quarters, provided:

1. The student completes 15 full-time quarters or the equivalent (or 3 full quarters after completing 180 units). (Partial tuition registration is possible after the completion of 12 quarters),
2. The student applies for each degree at the appropriate time and to the appropriate agency,
3. The student completes all the requirements for the baccalaureate degree and is recommended for the degree by the Subcommittee on Graduation; and
4. The student completes all the requirements for the master's degree and is recommended for that degree by the University Committee on Graduate Studies.

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—For admission to the Graduate Division of the University, the candidate must have taken the Aptitude Test (Verbal and Quantitative) of the Graduate Record Examination. 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 include courses that are approximately equivalent to those of the core curriculum leading to the B.S. degree in Geology at Stanford, plus at least one course in economic geology.
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:

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

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**—For admission to the Graduate Division of the University, the candidate must have taken the Aptitude Test (Verbal and Quantitative) of the Graduate Record Examination. 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. No foreign language is required on a department-wide basis. An individual Ph.D. candidate, however, may be required to demonstrate foreign language proficiency as part of his overall program, as established by his adviser and thesis committee. 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 Graduate Studies. A candidate for the degree who fails to meet this deadline may receive an extension of one year provided that he confers with his dissertation committee and can offer a suitable plan for completion of the dissertation.

**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 trips 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 (Page) MWF 8; lab, field trips by arrangement
Win (Howard) MWF 9; lab, field trips by arrangement
Spr (Krauskopf) MWF 8; lab, field trips by arrangement
Sum (8 weeks), (——) MTWThF 9; lab, field trips by arrangement

2. Geoscience II—Continuation of Geoscience I, with emphasis on the history of the earth including the development of the atmosphere and life, usefulness of the paleontologic record, and the origin and mobility of the major features of the earth's crust. The quarter closes with discussion of the relationship between man, earth science, and finite earth resources. Lectures, one 3-hour laboratory per week, and field trips required. A transportation fee will be charged for field trips. Prerequisite: 1.

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

4. Man's Natural Environment—A brief survey designed to instill an appreciation of man's natural environment. The earth in time and space; the science of water; the oceans; the atmosphere, world climates; organization and origin of life; evolution; varieties of life in the geological column.

3 units, Sum (Williams) MTWTh 11

5. Introduction to Environmental Earth Sciences — Geological aspects of environmental planning including climate, hydrology, landscape interpretation, weathering, erosion, sedimentation, faults, earthquakes, pollution, ground instability, and land evaluation. Field trips in the Lake Tahoe Basin and Carson Valley. September 18, 1970, to September 24, 1970, at the Stanford Sierra Camp near Lake Tahoe. In addition to the normal summer registration fee for the 2 units, a charge of $90 will cover room, board, field trips, and use of all recreational facilities at the Stanford Sierra Camp. Enrollment limited to 30. (For information about registration and other details, write to: Dean Richard H. Jahns, School of Earth Sciences, Stanford University, Stanford, California 94305).

2 units, Sum (Dickinson) September 18 to September 24

12. Field Seminar—The principal component of this course is a week-long back-pack trip through an area where rocks and earth structures are exceptionally well exposed, as the Grand Canyon. The trip, scheduled for the spring recess, will be followed by approximately two discussion sessions during spring quarter. A brief report on some aspect of the area visited will be prepared during spring quarter. Students who wish to do somewhat more extensive laboratory or library research may register for 3 units rather than 2. Transportation by private cars; trail food purchased as a group (transportation and food cost per student in 1969 was $30 for 7 days). Prerequisites: 1 and consent of instructor.

2 units, Spr (Staff) by arrangement

18. Framework of Geology — Introduction to the dimensional, physical, and chemical features and materials of the earth's crust, with analysis of some space and time relationships among geologic units and features. Emphasis is placed on developing an understanding of the kinds of problems handled by an earth scientist and the methods he uses to define, attack, and solve these problems. Laboratory and field trips are designed to provide the student with a basic appreciation of field observations, and their translation into maps, cross-sections, diagrams, and interpretations. The interrelationships among observation, experimentation, deductive, and inductive reasoning, and theoretical analysis of actual problems will be stressed throughout the course. Lectures, one four-hour laboratory or field trip per week. No formal prerequisites but Geoscience I and II are highly recommended.

5 units, Spr (Jahns and Rich) MWF 9; lab, and field trips by arrangement

100. Environmental Earth Sciences I—History and problems of urban growth, public and private planning processes, land-use determinants, land evaluation, survey of the natural environment, ecological systems, resource development, pollution. Principles
and methods are applied to field problems in the Peninsula area.

5 units, Win (Remson, Staff) MWF 10;
lab. and field work by arrangement

101. Environmental Earth Sciences II.
Given 1971–72

102. Environmental Earth Sciences III.
Given 1971–72

103. Geologic Problems—Supervised reading, written reports thereon.
1 to 10 units, any quarter (Staff) by arrangement

105. Structural Geology—Study of the nature and origin of faults, folds, structures of metamorphic and plutonic rocks, and deformation of the earth’s crust. A portion of the course will examine the mechanics of rock deformation and will apply these principles to the analysis of natural geologic structures. Prerequisites: 1 and 2. Recommended: 18.
5 units, Spr (Page and Johnson) MWF 9;
lab. and field trips by arrangement

107. Introduction to Probability and Statistics in Geology—Discrete and continuous probability theory; applications of probability to model-building; the role of probability in sampling and experimentation; statistical techniques in the analysis of sample data; statistical verification of models and statistical estimation of model parameters. Prerequisite: concurrent registration in Mathematics 22 or 42.
3 units, Spr (Switzer) MWF 3:15

119. Geology of California — General survey of the geomorphic and structural provinces, stratigraphic succession of rocks, and economic deposits of California (petroleum, nonmetallic and metallic deposits). Two discussion periods and three-hour lab. Prerequisite: 1 or equivalent.
3 units, Spr (Muller) TTh 11 and F 1:15–4:05 and field trips by arrangement

120. Field Geology—(Formerly 108 and 109) Instruction and practice in observing, recording, and reporting the field relationships of geologic features and materials. The course includes a systematic introduction to field techniques, a coordinated field study involving the mapping, description, and interpretation of an area of moderate geologic complexity, and the preparation of a comprehensive geologic report based on the observations made in the field. Field work includes observation of lithologic and structural features, measurement of stratigraphic and structural sections, application of various surveying methods, and plotting of geologic data on topographic maps and aerial photographs. The course is conducted from a tent camp at one or more localities in the western states. Departure is normally earlier than the registration day for campus courses; details of the schedule vary from year to year. The course is normally broken into segments (120A, 120B, etc.) with units of credit divided in a manner appropriate to the program for each individual summer. Details of the schedule, the course segments, and the instructor(s) for the year are given in the annual Summer Session Bulletin. With the approval of the instructor(s), students may register for selected parts of the course only. Students planning to enroll should contact the instructor(s) before February 15th of each year. The course is open to women if two or more apply. Graduate students must obtain the permission of the instructor(s) to enroll. Prerequisite: 1, 2, 18 or consent of instructor(s).
12 to 15 units, Sum (Staff)

121A. Mineralogy and Crystal Chemistry—Elementary crystallography and hand specimen mineralogy together with an introduction to the crystal chemistry of the most important rock forming minerals; emphasis is placed on the silicates. The laboratory portion of the course will focus on acquiring basic familiarity with physical properties and diagnostic techniques for recognition of the common rock- and ore-forming minerals. Prerequisites: 1 and 18 and/or chemistry 1 or 4 (may be taken concurrently).
4 units, Aut (Williams) TTh 11;
lab. TTh 1:15–4:05

121B. Petrology—Introduction to the classifications, associations, and genesis of igneous and metamorphic rocks. Topics in silicate equilibria, chemical principles of metamorphism, and fabrics of deformed rocks. Laboratory study of rock-forming minerals, textures, and structures. One or two one-day field trips to local areas that display rocks of special interest. Prerequisite: 121A or consent of instructor.
4 units, Win (Dickson) TTh 10;
lab. TTh 1:15–4:05

122A. Sedimentary Geology—Study and inquiry into sedimentary and geomorphic pro-
cesses and the petrology of sedimentary rocks. Topics explored include source provenance, relationships between sedimentary structures and their hydrodynamic origins, transport and depositional processes in modern sedimentary environments, and the relationships between the petrologic parameters of sedimentary sequences and regional tectonic history. Prerequisites: 1, 2, and 121A.

4 units, Win (Dickinson) TTh 11; lab. W 1:15-4:05 plus one lab.

by arrangement

122B. Stratigraphic Geology and Paleocology—Rudiments of interpreting and correlating sedimentary rocks with emphasis placed on the utility of integrating paleontologic, sedimentologic, stratigraphic, and geochemical evidence to reconstruct paleoenvironments. Characteristic variations of modern and ancient biofacies and lithofacies are traced in time and space. Paleontologic, radiometric, and paleomagnetic techniques of correlating sedimentary successions are scrutinized and their relative precision compared. An independent and original investigation of a modern or fossil sedimentary environment serves as a basis for a required term paper. Lectures and discussions are supplemented by extensive reading from classic and current scientific literature. Prerequisites: 1, 2, and 18.

4 units, Win (Ingle) TTh 9; fields trips and research conferences by arrangement

130. Advanced Field Geology and Senior Research—A concentrated independent investigation of a topical geologic problem in the field involving geologic mapping, description, and interpretation culminating in a formal written report. Research topics and field areas are decided in conference with an appropriate member of the faculty; the final report is read and criticized by a formal faculty committee. Prerequisite: senior standing in geology and approval of a research topic by faculty adviser.

3 units, Aut, Win, Spr (Staff); field trips and research conferences by arrangement

150A. Honors Seminar in Geology—Directed reading and discussion of fundamental geologic knowledge and theory, recent geologic research, and current geologic problems; oral and written reports. Registration by invitation only.

2 units, Aut (Staff) by arrangement

150B. Honors Seminar in Geology—Continuation of 150B.

2 units, Win (Staff) by arrangement

150C. Honors Seminar in Geology—Continuation of 150A, B.

2 units, Spr (Staff) by arrangement

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

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

200. Physical Processes of Geology—Field, laboratory, and theoretical studies of physical geologic processes such as intrusion, folding and fracturing, and flow of ice, lava, and debris. Includes application of rheology, mechanics, and boundary conditions to solutions of problems in structural geology, geomorphology, and engineering geology. Prerequisite: Calculus.

5 units, Aut (Johnson) 4 lectures and one lab. per week; research project, field trip, and seminar by arrangement

204A. Computer Applications in Earth Sciences — A course spanning two quarters which provides an introduction to use of digital computers in geology and other earth sciences, with emphasis on developing students’ 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 specific to his research interests. The course includes an introduction to FORTRAN IV programming, least-squares surface and space-fitting techniques, harmonic analysis, and numerical taxonomy methods. Emphasis is placed on the mathematical tools of simulating dynamic systems, including stochastic variables, Markov chains, materials balance accounting methods, flow and transport networks, and optimization methods. Applications used for illustrative purposes are diverse, and include petrology, structural geology, geophysics, paleoecology, sedimentology, petroleum geology, mining, and mineral exploration. Most of the mathematical techniques needed are developed within the course, but a general degree of mathematical proficiency is assumed. Work in the course consists mostly of problem solving
and involves extensive computer programming.

5 units, Aut (Harbaugh) MWF 10; discussion period T 4:15–5:05

204B. Computer Applications in Earth Sciences—Continuation of 204A: Includes a seminar in which students present results of their research.

3 units, Win (Harbaugh) MWF

205. Applications of Probability and Statistics in Geology — Formulation and description of statistical aspects of selected research problems with in-depth comparative statistical analysis applied to real data-sets. Applications are chosen for their diversity and in the past have included estimation of frequency distribution of minerals and of total ore tonnage, identification of minerals by remote sensing, design of field sampling procedures, evaluation of map accuracy. Prerequisite: 107 or consent of instructor.

3 units, Spr (Switzer) by arrangement, given 1971–72

210. Introduction to Marine Geology — General survey of the topography, structure, and geologic history of the ocean basins and submerged continental margins. Discussion of marine sedimentary processes, patterns of sediment distribution, and the interaction between sediments, water, and organisms. Relevant topics on waves, currents, and descriptive physical oceanography. Extensive reading from the current scientific literature. An independent and original investigation of a marine problem serves as a basis for a required term paper. Prerequisites: 122A, 122B, or consent of instructor.

5 units, Spr (Ingle) MWF 11; coastal and shipboard field trips and research conferences by arrangement

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. Prerequisite: 105 or equivalent.

5 units, Aut (Howard) MWF 8; lab. F 1:15–4:05; field trips by arrangement

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.

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


320. Advanced Structural Geology—Significant topics of structure and orogenesis. Examination of tectonics on land in relation to ocean floor spreading and rigid plate tectonics. Two lectures and one seminar per week, plus reading and term report. Prerequisite: an introductory course in structural geology.

3 units, Win (Page) TTh 11; seminar W 4:00–5:30

400. Research in Various Fields of Geology and Geochemistry.

Any quarter (Staff) by arrangement

MINERALOGY, PETROLOGY, AND GEOCHEMISTRY

171. Introduction to Geochemistry—Application of elementary chemical principles to geologic problems. Prerequisites: 1, Chemistry 3 or 5, and Geology 121A; the last may be taken concurrently.

3 units, Aut (Krauskopf, Parks) MWF 9

172. Geological Thermodynamics—Empirical thermodynamics applied to geological problems. The derivation and use of thermodynamic equations and concepts. The relationships between measured quantities and the thermodynamic generalizations. Topics in equilibrium, phase rule, chemical potential, homogeneous equilibria, heterogeneous equilibria. Prerequisite: 171 or Chemistry 171 or consent of instructor.

3 units, Win (Dickson) MWF 9

203A. Instrumental and Analytical Techniques in Earth Sciences—An introduction to the apparatus and applications of instrumental and analytic techniques in current use in geologic and mineralogic research. Emphasis on underlying physical and chem-
ical principles, strengths and limitations, not on use of equipment by the individual student. The goal is to develop the background of the student to the point where the appropriate techniques and instruments can be selected with respect to a specific research problem. Topics to be covered include: X-ray diffraction analysis, both single crystal and powder methods; X-ray fluorescence, including electron microprobe; electron microscopy; infra-red spectrometry of rocks and minerals; emission spectrometry; atomic absorption spectrometry and flame photometry; gravimetric analysis of rocks and minerals; stable and radioactive isotopes.

1 unit, Aut (Luth and others) T 3:15–5:00

203B. Instrumental and Analytical Techniques in Earth Sciences—A continuation of 203A.

1 unit, Win (Luth) by arrangement

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: a good course in crystallography and mineralogy and Physics 55, or equivalent.

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

222. Igneous and Metamorphic Petrology—Interpretation of igneous and metamorphic rocks based largely on features observed with the petrographic microscope. Prerequisites: 121B, 171, and 220.

6 units, Win (Luth) MW 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. Laboratory work emphasizes volcaniclastic rocks, sandstones, and limestones, but includes lutites, cherts, and phosphorites. Aspects of depositional, diagenetic, and incipient metamorphic mineralogy, texture, and fabric are treated. Auxiliary field work emphasizes bedding styles and paleocurrent indicators characteristic of different environments and mechanisms of sedimentation. Prerequisites: 122A and 220.

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

225A. Introduction to Surfaces and Interfaces—(Enroll in Mineral Engineering 225A.)

225B. Surfaces and Interfaces—(Enroll in Mineral Engineering 225B.)

227. Applied Aqueous Thermodynamics—(Enroll in Mineral Engineering 227.)

271. Geochemistry—Application of physical chemistry to geologic problems of igneous and metamorphic rocks. Distribution of chemical elements in geologic environments. Prerequisites: 121B and 171, or 1 and Chemistry 171.

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

313. Heterogeneous Equilibria in Mineral Systems—General treatment of phase relations in polycrystalline systems of petrologic significance. Emphasis on pressure, temperature, and composition as independent variables in systems with less than five components. Treatment is principally geometric, with supporting analytic development. Major topics to be discussed pertain to equilibria in silicate and silicate-volatile systems. Prerequisites: 171 and 222. Recommended: Chemistry 171.

4 units, Spr (Luth) MWF 9

323. Mineralogy of Sediments—(a) Laboratory methods for fractionating sediments or disaggregated rocks. (b) Mineral identification techniques—Fedorov stage, density determination, simple X-ray diffraction procedures. (c) Systematic study of mineral particles, with special reference to those of high density. Prerequisites: 220 and consent of instructor.

6 units, Win (Hutton) T 10; lab. TTh 1:15–4:05 and labs. by arrangement, given 1969–70 and 1971–72

325. Advanced Mineralogy—(a) Survey of methods of mineral identification employing density determination, Fedorov stage, Biot-Fresnel constructions, mineral fractionation techniques with centrifuge and Frantz separator, and X-ray diffraction powder methods. (b) Mineralogical calculations. (c) A systematic study of many of the more important rock-forming and ore minerals. Prerequisite: a thorough knowledge of optical crystallography, and consent of instructor.

7 units, Win (Hutton) TTh 10–12; lab. TTh 1:15–4:05 and lab. by arrangement, given 1970–71
327. Seminar in Igneous Petrology—Analysis of current problems in igneous petrology and closely allied fields, with emphasis on new data and concepts.

  2 units, Win (Johns) by arrangement, offered annually except 1971–72

350. Carbonate Petrology—Origin, classification, and environmental interpretation of limestones and modern carbonate sediments. The class consists of a seminar, an informal laboratory in which limestone thin sections and hand specimens are studied, and a field trip to the Shasta Lake area.

  3 units, Win (Harbaugh) by arrangement

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

  2 units, Spr (Krauskopf) by arrangement

372. Geochemistry of Organic Compounds—Course unites aspects of geology and chemistry in study of origin and occurrence and fate of organic materials in geological environments. Principles of organic geochemistry are applied to sedimentology, paleontology, petroleum geology, chemical evolution, and environmental science. One field trip and one term paper are required. There are no formal prerequisites although introductory courses in geochemistry and organic chemistry are helpful.

  2 units, Spr (Kvenvolden) by arrangement

471. Seminar in Geochemistry.

  2 units, Spr (Krauskopf) by arrangement

PALEONTOLOGY AND STRATIGRAPHY

112. Elementary Paleontology—Fossils and how they are studied; emphasis on principles. Reading and lectures on the nature of the fossil record, the use of fossils for geologic dating and correlation, the record of evolution, and the interpretation of ancient environments. Laboratory introduction to several major groups of fossil organisms. Term project or report. Prerequisites: 2 or consent of instructor.

  5 units, Spr (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, and geographic distribution, and a survey of current methods and facilities for study. A term paper is required. 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, exploring through readings and illustrated lectures the distinctive characters, specializations for particular modes of life, evolutionary history, and distribution in space and time of major vertebrate groups. Term report. No prerequisites.

  3 units, Aut (Evitt) MWF 11, given 1970

214. Advanced Invertebrate Paleontology—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—Study of microscopic marine fossils including diatoms, ostracods, and radiolarians with emphasis on foraminifers. Detailed study of principles of classification, evolutionary trends, common genera, and ecology of foraminifera. Application of planktonic and benthonic foraminifera to problems of paleoecology, paleoceanography, and correlation of marine sediments. An original quantitative investigation of fossil of a modern foraminiferal fauna serves as a basis for required term paper. Instruction in laboratory and field techniques. Prerequisites: 122B with 112 highly recommended.

  5 units, Aut (Ingle) TTh 9; two lab.-discussion periods by arrangement, alternate years, given 1971

260. Geochronology—General review of paleontologic, radiometric, and paleomagnetic methods of dating and correlation with emphasis on stratigraphic applications. Consideration of basic assumptions, utility, and resolution of techniques based on different groups of fossil organisms and on physical and chemical approaches as applied to different parts of the geologic record. Prerequisite: 122.

  3 units, Spr (Silberling) MWF 9

316. Introduction to Palynology—Study of microfossils smaller than 200 micra, especially spores, pollen, dinoflagellates, and acritarchs. Techniques of recovery and microscopy, morphology and classification, geologic distribution, application to strati-
graphic problems. Prerequisite: 112 or consent of instructor.

5 units, Win (Evitt) 3 lec. and 2 labs.
by arrangement

317. Stratigraphic Palynology — Detailed laboratory study of assemblages of microfossils smaller than 200 micra from Cambrian and younger strata, supplemented with lectures and discussions. Prerequisite: 316.

Spr (Evitt) units and hours by arrangement, given 1971

ECONOMIC GEOLOGY


219. Mine Exploration — (Enroll in Mineral Engineering 219.)

276A. Field Trip — (Enroll in Mineral Engineering 276A.)

276B. Field Trip — (Enroll in Mineral Engineering 276B.)

280. Quantitative Exploration Decision Making — (Enroll in Mineral Engineering 280.)

281A. Introduction to Ore Deposits — The nature, classification, mineral associations, and origin of ore deposits. Lectures on topics in: development of ore genesis theory, magmatic and hydrothermal processes; sources, migration, and deposition of hydrothermal minerals; paragenesis and zoning; surficial processes, including weathering and supergene enrichment. Prerequisites: 121B and 105, or consent of instructor.

2 units, Aut (Williams, Park) TTh 9

281B. Ore Deposits — Study of the principal types of ore deposits, with emphasis on economic, mineral associations, ore genesis, and controls of mineralization. Detailed analysis of selected examples of ore deposits. Laboratory studies of ore mineralogy of ore specimen suites; descriptive geometrical techniques applied to ore deposits; and megascopic studies of paragenesis. Prerequisite: 281A or consent of instructor.

4 units, Win (Park, Williams) TTh 10; two labs. by arrangement

281C. Ore Genesis — The modes of origin of ore and gangue mineral associations. Lectures on: characteristic associations of minerals; chemical factors of ore transport and deposition; genetic implications of equilibrium studies of chemical systems containing components of ore forming substances; and applications of isotopic, trace element, and other geochemical properties of ores. Prerequisite: 281B or consent of instructor.

3 units, Spr (Dickson) MWF 10

283. Laboratory Study of Ore Minerals — Use of transmitted and reflected light microscopy in the study of ore specimens, with emphasis on the properties of opaque minerals. Physical, chemical, and optical techniques, both qualitative and quantitative. Interpretation of microstructures. Paragenesis. Prerequisites: 220 and 281A, or consent of instructor.

4 units, Win (Williams) two lecs. and two labs. by arrangement

284. Engineering Geology — Application of geologic and hydrologic factors in location, design, and construction of engineering works. Emphasis on solution of real problems through effective interaction among geoscientists and engineers. Lectures, seminars, and field trips.

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

285. Hydrogeology — Theory of underground water, analysis of field data and pumping tests, geologic ground-water environments, solution of problems. Prerequisites: 1, Physics 21 or 51, and Mathematics 22. Recommended: 2 and 105.

5 units, Win (Remson) MWF 8; seminar M 2:15-4:05; lab. by arrangement

286. Development of Ground-Water Resources — Field techniques used in groundwater surveys and exploration, well development, ground-water law, chemistry of underground waters. Prerequisite: 285.

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

287. Minerals, Politics, and Economics — Role of minerals and energy in future world; where they come from and are used; how they are affected by political and economic factors.

3 units, Win (Park) MWF 9

296A. Airborne Exploration: Photogeologic Techniques — (Enroll in Mineral Engineering 296A.)

296B. Airborne Exploration: Infrared and
Radar — (Enroll in Mineral Engineering 296B.)

296C. Airborne Exploration: Geophysical Techniques—(Enroll in Mineral Engineering 296C.)

383. Studies of Metallic Ores — Advanced study of mineral suites from the district collections, with emphasis on genesis and localization control. The studies will be designed for individual needs and for independent work. Students will be encouraged to use modern methods of microscopy, X-ray diffractometry and spectrography, optical spectrography, and electron microprobe analysis. Prerequisite: 281B or consent of instructor.

6 units, Spr (Staff) seminar and 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 (Kruger) by arrangement

487. Seminar in Hydrogeology.

2 units, any quarter (Remson) by arrangement

GEOPHYSICS

Chairman: George A. Thompson
Professors: Allan V. Cox, Robert L. Kovach, George A. Thompson
Associate Professors: William C. Luth (Geochemistry), Ronald J. P. Lyon
Assistant Professors: Jon F. Claerbout, Amos M. Nur
Research Associate: John R. Booker
Research Associates (By Courtesy): Sheldon Breiner, G. Brent Dalrymple, Richard R. Doell, David G. Willis

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 Ruth Wattis Mitchell Earth Sciences Building and 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. In addition, seniors in Geophysics who expect to do graduate work are urged to take the Graduate Record Examination as early as convenient in their terminal undergraduate year.

Curriculum

<table>
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<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Quarter</th>
<th>Given</th>
<th>Units</th>
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<tr>
<td>Chemistry 1, 2, 3 or 4, 5. General Chemistry</td>
<td>Aut, Win, Spr</td>
<td>13</td>
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<td>Math. 10, 11, 21, 22, 23 and 44 or 41, 42, 43 and 44. Analytical Geometry and Calculus</td>
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<td>Math. 130. Ordinary Differential Equations</td>
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<td>Physics 110, 111. Mechanics</td>
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<td>Geology 120. Field Geology*</td>
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* A student who takes 120 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: 102, 191, Geology 106, 171, Physics 57, 58, and 121, Mathematics 131, 132, and Electrical Engineering 261H.

All students planning to continue graduate studies are strongly urged to complete an appropriate foreign language sequence.
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.

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 121 and two of the following: Physics 210, 211, or Applied Physics 213, 214, or Aeronautics and Astronautics 291A, 291B; 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. Applied Mechanics 203A and 203B are recommended for students interested in studies of theoretical wave propagation. In addition, Engineering 41 and 41A are highly recommended for students who have not previously studied applied electronics. The candidate must demonstrate by examination in the appropriate language department his ability to read German, French or Russian. Another language may be substituted upon approval of the Department chairman. His record must indicate outstanding scholarship, and deficiencies in previous training must be removed. He must pass the Departmental qualifying 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


5 units, Aut (Cox) MWF 8

115. Geophysical Materials — Aspects of geochemistry, mineralogy, and petrology of particular importance in geophysical research. Emphasis on crystal chemistry and classical thermodynamics as related to physical and chemical properties of materials. Phase equilibria at high pressures and temperatures pertinent to an understanding of sub-crustal processes. Laboratory: Identification of the common rock-forming minerals and rocks; familiarization with the polarizing microscope and X-ray diffraction techniques in characterizing naturally occurring materials. Prerequisite: Differential equations.

5 units, Aut (Luth) lec. MWF; lab. TTh by arrangement

3 units, Aut (Thompson, Cox) 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

250. Geomagnetism and Paleomagnetism—Magnetic anomaly fields; secular variation; spherical harmonic analysis of geomagnetic field; elements of rock magnetism; history of geomagnetic field. Prerequisite: Physics 53.

3 units, Win (Cox) MWF 11

280. Geophysical Time Series Analysis — The mathematical equivalence of sample data systems and wave propagation in layered media. Optimal filtering of multichannel observed waves in the presence of noise. Group velocity, causality, prediction, multichannel spectral factorization. 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, alternate years, given 1970-71

283. Computer Solution to Partial Differential Equations of Geophysics—Numerical techniques directed toward computer simulation of waves in inhomogeneous media; tearing of faults; models of convection in the earth’s mantle; and models of variation of the earth’s main magnetic field and fluid iron core. Prerequisite: Physics 120.

2 units, Win (Claerbout), TTh 9, alternate years, given 1971-72

295. 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 the interiors of the earth and terrestrial planets. Prerequisite: consent of the instructor.

3 units, Aut (Kovach) by arrangement, alternate years, given 1970–71

296. Methods of Seismology — Techniques of modern seismology. Seismograph theory; seismic ray theory and the interpretation of travel times; surface wave dispersion and normal mode theory; analyses of seismograms.

3 units, Aut (Kovach) by arrangement, alternate years, given 1971-72

301. Problems in Geophysics.

Any quarter (Staff) by arrangement


(Nur) by arrangement

327. Experimental Rock Deformation.

(Nur) 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 120. Recommended: Geology 200 and 320.

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

397. Seminar in Geophysics.

1 unit, any quarter (Staff) by arrangement

398. Seminar: Special Topics in Geophysics.

2 units, any quarter (Staff) by arrangement

400. Research in Geophysics.

Any quarter (Staff) by arrangement

MINERAL ENGINEERING

Emeriti: Welton J. Crook, Evan Just, Charles F. Park, Jr. (Professors)
Chairman: Fredrick C. Kruger
Professors: John W. Harbaugh, Fredrick C. Kruger, Norman A. Parlee
Associate Professors: Robert W. Bartlett, Ronald J. P. Lyon, George A. Parks
Assistant Professor: Arvid M. Johnson
Consulting Professor: Kenneth H. Crandall
Research Associates (By Courtesy): Weston Bourret, D. F. Hewett
The Mineral Engineering curricula are designed for the fourfold purpose of making graduates competent in the technology of exploration, 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>
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<th>University Requirements</th>
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<td>Writing Requirement</td>
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</table>

<table>
<thead>
<tr>
<th>Departmental Requirements</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 4 and 5. General Chemistry</td>
<td>8</td>
</tr>
<tr>
<td>Engr. 11 and 12. Engineering Mechanics</td>
<td>6</td>
</tr>
<tr>
<td>Engr. 21. Mechanics of Fluids (See Note 1)</td>
<td>4</td>
</tr>
<tr>
<td>Engr. 41 and 42. Circuits, Electronics, and Electromechanics</td>
<td>8</td>
</tr>
<tr>
<td>Geol. 1. Geoscience I</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 121A. Mineralogy and Crystal Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>Geol. 204A. Computer Applications in Earth Sciences or Computer Science 106</td>
<td>3</td>
</tr>
<tr>
<td>Math. 41, 42, and 43.</td>
<td>15</td>
</tr>
<tr>
<td>Min. Engr. 100. Industrial Report</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>79-81</td>
</tr>
</tbody>
</table>

MINING OPTION

Course No.  Subject                   Units

Civil Engr. 180. Elementary Structural Analysis | 4
Chem. 171, 173, 175, 176. Physical Chemistry | 12
Chem. Engr. 130B. Transport Phenomena | 3
Engr. 50. Introductory Science of Materials | 3
Geol. 220. Optical Mineralogy, or Mineral Engineering 272. Spectrochemical Analysis | 5
Math. 44. Advanced Calculus | 3
Math. 130. Ordinary Differential Equations | 3
Min. Engr. 207. Metal Refining Processes | 3
Min. Engr. 225. Surfaces and Interfaces, or Mineral Engineering 227. Applied Aqueous Thermodynamics | 3-4
Min. Engr. 233. Rate Processes in Chemical Metallurgy | 3
Electives | 13

Total | 53

CHEMICAL AND EXTRACTIVE METALLURGY OPTION

Course No.  Subject                   Units

Chem. 171. Physical Chemistry | 3
Chem. Engr. 130B. Transport Phenomena | 3
Geol. 220. Optical Mineralogy, or Mineral Engineering 272. Spectrochemical Analysis | 5
Math. 44. Advanced Calculus | 3
Math. 130. Ordinary Differential Equations | 3
Min. Engr. 207. Metal Refining Processes | 3
Min. Engr. 225. Surfaces and Interfaces, or Mineral Engineering 227. Applied Aqueous Thermodynamics | 3-4
Min. Engr. 233. Rate Processes in Chemical Metallurgy | 3
Electives | 13

Total | 44-46

Note 1.—Engineering 11 and 12 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.

RECOMMENDED ELECTIVES

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp. Sci. 106. Use of Automatic Digital Computers</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Geol. 171 and 271. Geochemistry</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Indus. Engr. 152. Introduction to Operations Research</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Stat. 110. Statistical Methods in Engineering</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Mining Option

Civil Engr. 240. Construction Planning | 2     |
Chem. 171. Physical Chemistry | 3     |
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

Candidates for the degree Master of Science in Mineral Engineering may emphasize either management or research in any engineering discipline offered by the Department. The degree is normally awarded on completion of the specific requirements listed below. The curricula are recommended; modifications are possible upon approval of a written proposal from the student.

Specific Requirements

1. Candidates must be registered in the Graduate School for at least three quarters. They must complete at least 45 units of course work, at least six but no more than 24 of which must represent independent work on a comprehensive project or research program culminating in a written report or thesis.

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.

3. Candidates must successfully complete one core curriculum from Group A below and one from Group B.

Curricula Recommended for the Master's Degree

GROUP A

Mineral Exploration

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. Engr. 215</td>
<td>Mineral Economics</td>
<td>3–4</td>
</tr>
<tr>
<td>Min. Engr. 300</td>
<td>Advanced Work</td>
<td>6</td>
</tr>
<tr>
<td>Electives from following list</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geol. 204A,B</td>
<td>Computer Applications</td>
<td>4</td>
</tr>
<tr>
<td>Geol. 205</td>
<td>Applications of Probability and Statistics in Geology</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 281A</td>
<td>Introduction to Ore Deposits</td>
<td>4</td>
</tr>
<tr>
<td>Geol. 281B</td>
<td>Ore Deposits</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 281C</td>
<td>Ore Genesis</td>
<td>3–6</td>
</tr>
<tr>
<td>Geol. 383</td>
<td>Studies of Metallic Ores</td>
<td>6</td>
</tr>
<tr>
<td>Geol. 387</td>
<td>Seminar in Ore Deposits</td>
<td>3</td>
</tr>
<tr>
<td>Geophys. 190</td>
<td>General Geophysics</td>
<td>3</td>
</tr>
<tr>
<td>Geophys. 191</td>
<td>Geophysical Field Techniques</td>
<td>4</td>
</tr>
<tr>
<td>Min. Engr. 219</td>
<td>Mine Exploration</td>
<td>3–5</td>
</tr>
<tr>
<td>Min. Engr. 280</td>
<td>Quantitative Exploration Decision Making</td>
<td>2</td>
</tr>
<tr>
<td>Min. Engr. 296A,B,C</td>
<td>Airborne Exploration</td>
<td>8–9</td>
</tr>
</tbody>
</table>

Petroleum Exploration

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.E. 215</td>
<td>Mineral Economics</td>
<td>3–4</td>
</tr>
<tr>
<td>Min.E. 300</td>
<td>Advanced Work</td>
<td>6</td>
</tr>
<tr>
<td>Electives from following list</td>
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<td></td>
</tr>
<tr>
<td>Geol. 182</td>
<td>Petroleum Geology and Subsurface Mapping</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 204A,B</td>
<td>Computer Applications in Earth Sciences</td>
<td>4</td>
</tr>
<tr>
<td>Geol. 205</td>
<td>Applications of Probability and Statistics in Geology</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 209</td>
<td>Physics of Underground Fluids</td>
<td>5</td>
</tr>
<tr>
<td>Geophys. 190</td>
<td>General Geophysics</td>
<td>3</td>
</tr>
</tbody>
</table>
SCHOOL OF EARTH SCIENCES

Geophy. 191. Geophysical Field Techniques 4
Pet.E. 150A, B, C. Formation Evaluation 8
Min.E. 280. Quantitative Exploration Decision Making 2
Min.Engr. 296A, B, C. Airborne Exploration 8–9

Mining
Min.E. 200. Introduction to Rock Mechanics 3
Min.E. 230A, B, C. Seminar 9
Min.E. 300. Advanced Work 6
Electives 9

Mineral Processing
Min.E. 203A, B. Mineral Processing 6
Min.E. 225B. Surfaces and Interfaces, or Min.E. 227. Applied Aqueous Thermodynamics 3
Min.E. 233, 234. Rate Processes in Chemical Metallurgy 6
Min.E. 236. Metallurgical Systems Engineering Seminar 3
Min.E. 240. Mineral Engineering Colloquium 1
Min.E. 300. Advanced Work 6

Chemical and Extractive Metallurgy
Min.E. 207. Metal Refining Processes 3
Min.E. 224. Physical Chemistry of Metals Seminar or 228. Extractive Metallurgy Seminar or 229. Principles of Steelmaking 3
Min.E. 233, 234. Rate Processes in Chemical Metallurgy, I and II 6
Min.E. 236. Metallurgical Systems Engineering Seminar 3
Min.E. 300. Advanced Work 6
Electives 3

GROUP B

Management
Select a minimum of 15 units from the following courses:
Bus. 200–01. Business Economics 6
Bus. 210–11. Management Accounting 6
Bus. 270. Organizational Behavior 3

Research
Select 15 or more units of courses including original research. These courses should amplify the academic base from which research is done and provide experience with the practice and techniques of research.

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>
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</thead>
<tbody>
<tr>
<td>Graduate School of Business Courses 3</td>
<td></td>
<td></td>
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<tr>
<td>Comp. Sci. 136. Use of Automatic Digital Computers 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indus. Engr. 229. Engineering Economy 2</td>
<td></td>
<td></td>
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<tr>
<td>Indus. Engr. 230. Advanced Engineering Economy 3</td>
<td></td>
<td></td>
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<tr>
<td>Indus. Engr. 252. Operations Research 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. Engr. 300. Advanced Work (Thesis) 10</td>
<td></td>
<td></td>
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<tr>
<td>Stat. 110. Statistical Methods in Engineering 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electives 16</td>
<td></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 a foreign language useful in research. The candidate for the Ph.D. may satisfy the foreign language requirement by one of the following: (1) passing a 10 level language course with a grade of B, (2) passing an examination administered by the language department, or (3) presenting evidence of having passed an equivalent language requirement at another university. A foreign student whose native language may be useful in research may satisfy the requirement with English as his “foreign language.” The language requirement must be satisfied before the written and oral examinations.

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. Prospecting, development, mine plant and equipment, and mining methods. Serves needs of engineering and geological student who seeks general knowledge of mining. Optional supplementary work on problems in mining engineering for those whose major interest is mining.

3 to 5 units, Aut (Kruger) MWF 8

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, Aut (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, Aut (Parlee) 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, Win (Staff) TTh 1:15-4:05, alternate years, given 1971–72

118. Mining Methods—Discussion, seminar, using case histories to illustrate methods, equipment, and costs. Prerequisite: 101.

2 units, Win (Kruger) TTh 8, alternate years, given 1971–72

150. Introduction to Mineral Extraction Processes—Elements of mineral extraction processes for geology and mining students and other graduate students not majoring in process metallurgy. The relationships between process technology, economics, ecology, and the mineralogical characteristics of ore deposits are stressed.

2 units, Aut (Bartlett) by arrangement

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 Geophysics 191.)

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 Geology 200 or Applied Mechanics 202A.

3 units, Win (Johnson) by arrangement

201. Principles and Methods of Crystal Growth—(Enroll in Materials Science 201.)

3 units, Spr (Staff) alternate years, given 1971–72

203A. Mineral Processing—Detailed study of mineral separation techniques and auxiliary operations with emphasis on practical use of principle or theory in process feasibility analysis. Intended for students majoring in Mineral Processing or Extractive Metallurgy. Topics include sampling, comminution, sizing, solid liquid separations, and gravity, magnetic, electrical, and flotation methods of solid-solid separation. Prerequisites: graduate standing in the Department or consent of instructor.

4 units, Aut (Parks) by arrangement

203B. Topics in Mineral Processing and Hydrometallurgy—Advanced independent study of any topic in Mineral Processing or Hydrometallurgy, including all topics listed
under 203A, and their use in integrated processes from theoretical, design, or operational points of view. May include process modeling and automation. May be repeated with credit. Open to undergraduates by consent. Prerequisite: 203A.

1 to 4 units, Aut, Win, Spr (Parks) by arrangement

204A. Computer Applications in Earth Sciences—(Enroll in Geology 204A.)
5 units, Aut (Harbaugh) MWF 10; discussion period T 4:15–5:05

204B. Computer Applications in Earth Sciences Seminar—(Enroll in Geology 204B.)
3 units, Win (Harbaugh) MWF 11

205. Applications of Probability and Statistics in Geology—(Enroll in Geology 205.)
3 units, Spr (Switzer) by arrangement, given 1971–72

207. Metal Refining Processes — 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.
3 units, Win (Parlee) by arrangement

209. Process Development — Recognition and definition of problems involving Mineral Processing or Hydrometallurgy. Planning, execution, and reporting of development projects. One or two central themes will be chosen each year for paper, laboratory, and possibly field study. Themes will be chosen from current industrial, consulting, or research projects. Prerequisite: 203A or equivalent. Recommended: skill in mineral identification and analytical methods.
3 units, Win (Parks) one lecture and two labs. 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

1 to 2 units, Spr (Parks) 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.
3 to 5 units, Win (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

222. Statistical Thermodynamics — (Enroll in Materials Science 222.)
3 units, Spr (Stevenson) MWF 9

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 1971–72

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, alternate years, given 1970–71

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. Prerequisites: 225A or equivalent and Chemistry 173 or equivalent.
3 units, Spr (Parks) 3 lecs. by arrangement, alternate years, given 1970–71
227. Applied Aqueous Thermodynamics—
Techniques of predicting probability and extent of heterogeneous chemical reactions including dissolution, precipitation, solvent extraction and ion exchange. Hydrometallurgy and geochemistry emphasized. Previous experience with chemical thermodynamics recommended. Prerequisite: Chemistry 173 or consent of instructor.

3 units, Win (Parks) by arrangement

228. Extractive Metallurgy Seminar—
Lectures, student seminars and report preparation on selected topics in extractive metallurgy designed to (a) satisfy the special interests of the student, (b) fill out areas not covered by formal courses and (c) survey the field of extractive and process metallurgy from several broad points of view.

2 to 3 units, Spr (Parlee) by arrangement, alternate years, given 1971-72

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.

3 units, Spr (Parlee) by arrangement, alternate years, given 1970-71

230A. Seminar—
Survey of recent and current improvements in mining practice.

2 units, Aut (Kruger) T evening

230B. Seminar —
Case histories in mining and exploration.

2 units, Win (Kruger) T evening

230C. Seminar—
Mining valuation, law, organization, and management.

2 units, Spr (Kruger) T evening

233. Rate Processes in Chemical Metallurgy I—
Applied 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.

3 units, Aut (Bartlett) MWF 9

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

3 units, Win (Bartlett) MWF 9

236. Metallurgical Systems Engineering Seminar—
The case method is used to study design of metallurgical processes and plants and related socio-techno-economic problems. The approach is heuristic but previous problem solving experience is essential. Recommended prerequisites: 234 and Engineering 161.

3 units, Spr (Bartlett) MW 1:15 and one hour by arrangement

240. Mineral Engineering Colloquium —
Student and guest speakers representing all aspects of Mineral Engineering.

1 unit, Win (Staff) by arrangement

267. Engineering Valuation and Appraisal of Oil and Gas Properties—
(Enroll in Petroleum Engineering 267.)

3 units, Win (Miller) S 9-12, alternate years, given 1971-72

271. Advanced Chemical Metallurgy—
Lectures and reading on selected topics in electrometallurgy, corrosion, molten salts, high temperature chemistry, and applied chemical kinetics.

3 units, Spr (Bartlett) by arrangement, alternate years, given 1970-71

276A. 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.

3 units, Spr vacation (Staff) by arrangement, alternate years, given 1971-72

276B. Field Trip —
Similar to 276A 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 1970-71

278. Applications of Underground Nuclear Explosions—
Applications of the geonuclear effects of nuclear explosions for the geological industries. Technical design, safety evaluation, and economic analysis for stimulation of oil and gas production, storage facilities, mineral recovery and in-situ mining processes, oil-shale retorting, water resource development, and geothermal effects. Pre-
SCHOOL OF EARTH SCIENCES

38

requisite: Civil Engineering 277 or consent of instructor.

2 units, Spr (P. Kruger, Staff, and Visiting Lecturers) TTh 10


4 units, Win (Harbaugh, Kruger, Crandall) TTh 11

281A. Introduction to Ore Deposits—(Enroll in Geology 281A.)

2 units, Aut (Williams, Park) TTh 9

281B. Ore Deposits — (Enroll in Geology 281B.)

4 units, Win (Park, Williams) TTh 10; two labs. by arrangement

281C. Ore Genesis — (Enroll in Geology 281C.)

3 units, Spr (Dickson) MWF 10

284. Engineering Geology—(Enroll in Geology 284.)

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

287. Minerals, Politics, and Economics — (Enroll in Geology 287.)

3 units, Win (Park) MWF 9

296A. Airborne Exploration: Photogeologic 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 (Rich, Lyon) lec. T 1:15; lab. T 2:15–4:05, Th 1:15–4:05

296B. Airborne Exploration: 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. Prerequisite: 296A or Geology 235.

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

296C. Airborne Exploration: Geophysical Techniques—Seminar on geophysical methods to be given by Staff and invited guests. Term paper for grade.

2 units, Spr (Lyon) by arrangement

299. Special Problems in Mineral Engineering.

Any quarter (Staff) by arrangement

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

Any quarter (Staff) by arrangement

308. Rock Mechanics and the Design of Underground Structures — Application of theory to laboratory studies, to determination of underground stress fields, and to design of underground structures. Prerequisites: 200 or Geology 200, or consent of instructor.

3 units, Spr (Staff or Visiting Professor) 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: Geology 320, 326, 328.

2 units (Young) by arrangement

383. Studies of Metallic Ores—(Enroll in Geology 383.)

6 units, Spr (Staff) seminar and labs. by arrangement

387. Seminar in Ore Deposits — (Enroll in Geology 387.)

2 units, Aut (Kruger) by arrangement

388. Offshore Exploration Seminar — Lectures, discussions, student papers covering geological, geophysical, and production problems of exploration for oil, gas, and solid minerals in the marine environment.

2 units, Win (Crandall) T 3–5
PETROLEUM ENGINEERING

Emeritus: Frederick G. Tickell (Professor)
Chairman: Frank G. Miller
Lecturer: Thomas D. Mueller
Research Associates (By Courtesy): Marshall B. Standing, Jacques Naar

OFFERINGS

The study programs of the Department of Petroleum Engineering are designed to train 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 room, a computing room, and office study space for graduate students. Faculty and departmental offices are in the new Mitchell Earth Sciences Building. Laboratories and additional student study rooms are also located in the Mitchell Building.

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 the fields of mathematics, chemistry, physics, and earth sciences 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. General Chemistry (Quantitative Treatment)</td>
<td>13 or 8</td>
</tr>
<tr>
<td>Chem. 171.</td>
<td>Physical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>Math. 10, 11, 21, 22, 23, 44. Analytical Geometry and Calculus</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>English 1, 2, 3.</td>
<td>Freshman English</td>
<td>9</td>
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<tr>
<td>History 1, 2, 3.</td>
<td>History of Western Civilization</td>
<td>12</td>
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<tr>
<td>Physics 51, 53, 55. Mechanics, Sound, Electricity, Light, and Heat</td>
<td>12</td>
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<tr>
<td>Physics 52, 54, 56. Laboratory</td>
<td>3</td>
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<tr>
<td>Engr. 11. Engineering Mechanics (Statics)</td>
<td>4</td>
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<tr>
<td>Engr. 12. Engineering Mechanics (Dynamics)</td>
<td>4</td>
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<tr>
<td>Engr. 21. Mechanics of Fluids</td>
<td>4</td>
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<tr>
<td>Engr. 31. Elementary Engineering Thermodynamics</td>
<td>5</td>
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<tr>
<td>Engr. 41. Circuits, Electronics, and Electromechanics</td>
<td>4</td>
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<tr>
<td>Geol. 1. Geoscience I</td>
<td>3</td>
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<tr>
<td>Geol. 2. Geoscience II</td>
<td>5</td>
<td></td>
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<tr>
<td>Geol. 51. Petrology</td>
<td>5</td>
<td></td>
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<tr>
<td>Geol. 105. Structural Geology</td>
<td>5</td>
<td></td>
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<tr>
<td>Pet.E. 151A. Petroleum Reservoir Fluids</td>
<td>3</td>
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<tr>
<td>Pet.E. 151B. Fluid Behavior in Reservoir Rocks</td>
<td>3</td>
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<tr>
<td>Pet.E. 151C. Drilling Fluids</td>
<td>3</td>
<td></td>
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<tr>
<td>Pet.E. 151D. Petroleum Reservoir Fluids Laboratory</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Pet.E. 151E. Core Analysis Laboratory</td>
<td>3</td>
<td></td>
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<tr>
<td>Pet.E. 152. Development and Production Technology</td>
<td>3</td>
<td></td>
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<tr>
<td>Pet.E. 160. Report on Oil Field Training</td>
<td>1</td>
<td></td>
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<tr>
<td>Pet.E. 172. Natural Gas Engineering</td>
<td>3</td>
<td></td>
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<tr>
<td>Social Sciences* (General Studies Requirement)</td>
<td>10</td>
<td></td>
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<tr>
<td>Humanities (General Studies Requirement)</td>
<td>8</td>
<td></td>
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<tr>
<td>Technical Electives from the following: **</td>
<td>12</td>
<td></td>
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<tr>
<td>Comp. Sci. 105. Introduction to Programming</td>
<td>3</td>
<td></td>
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<tr>
<td>Comp. Sci. 106. Introduction to Computer Science</td>
<td>3</td>
<td></td>
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<tr>
<td>Civil Engr. 20. Elementary Surveying</td>
<td>3</td>
<td></td>
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<tr>
<td>Geol. 25. Elementary Mineralogy and Crystallography</td>
<td>5</td>
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</tbody>
</table>

* Economics 1 is recommended for partial fulfillment of the Social Sciences requirement.
** Students transferring from another curriculum may substitute other approved courses for these technical electives.
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 and no more than 9 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>
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</tbody>
</table>

† The series of courses consisting of Mathematics 131, Partial Differential Equations, Mathematics 132, Partial Differential Equations, and Statistics 110, Statistical Methods in Engineering may be used to substitute for the series A.M. 250, A.M. 251, and A.M. 252.

* Electives are to be selected with the approval of the student’s adviser.

ENGINEER

The objective is to round out the student’s training through additional work in engineering and related sciences and by additional specialization.

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 in
engineering and closely allied fields must be
taken in advanced work, that is, work be-
yond the Master's degree requirements and
in addition to research (Pet.E. 360). These
may be taken from the list below for the
Ph.D. degree or may be other approved
courses. 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 Uni-
versity Committee of the Graduate Division.

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, as a registered
student at Stanford. The candidate must
complete 90 units of course work including
all the course requirements of the Depart-
ment's Master's degree except 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 under-
graduate training. The candidate is required
to take a minimum of 36 units in Engineer-
ing and the Graduate School of Business.

These may be selected from the following:

- Bus. 300–201. Business Economics
  I and II 3 ea.
- Bus. 210–211. Management Accounting
  I and II 3 ea.
- Bus. 220–221. Business Finance
  I and II 3 ea.
  I and II 3 ea.
- Bus. 261–262–263. Operations and
  Systems Analysis I, II, and III 3 ea.
- Bus. 321. Investment Analysis 4
- Bus. 330. Business Forecasting 4
- Bus. 366. Electronic Data Processing 4
- Ind. Eng. 229. Engineering Economy 2
- Ind. Eng. 230. Capital Budgeting 3

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 on a combined engineering and eco-

Science

Chem. 171. Physical Chemistry 3
Geol. 203. Instrumental and Analytical
  Techniques in Earth Sciences 1
Geol. 372. Geochemistry of Organic Compounds 2
Geoph. 190. General Geophysics 3
Min.E. 225A. Introduction to Surfaces and
  Interfaces 3
Min.E. 388. Offshore Geological and Geophysical Exploration  

_School of Earth Sciences_  

**Engineering**  

Chem.E. 120. Equilibrium in Thermodynamic Systems  
Chem.E. 130A. Transport Phenomena: Momentum Transport  
Chem.E. 130B. Transport Phenomena: Energy Transport  
Civil Engr. 284. Ocean and Coastline Engineering  
Civil Engr. 288. Mechanics of Flow Through Soils  
Engr. 290A,B. Engineering Teaching  
Ind. Eng. 229. Engineering Economy  

**General**  

Geol. 287. Minerals, Politics and Economics  
Engl. 29 or 59 (limit of 6 units)  
Engl. 129. Scientific Writing  
Min.E. 280. Quantitative Decision Making in Exploration  

His record must indicate outstanding scholarship. He must pass the Departmental qualifying 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 qualifying 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**—Continuation of 150A: Lectures, problems. 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. Prerequisite: 103.  

3 units, Aut (Miller) MWF 9  


3 units, Win (Ramey) MWF 10  

**151C. Drilling Fluids**—Lecture, laboratory. Colloidal behavior and rheology of drilling fluids.  

3 units, Spr (Marsden) MW 1:15; lab. MW 2:15-5:05, offered every year except 1970-71  

**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.  

3 units, Aut (Marsden) M 2:15; lab. WF 2:15-5:05, offered every year except 1970-71  

**151E. Core Analysis Laboratory**—Porosity, permeability, capillary pressure, relative permeability, formation resistivity factor, analog models. Prerequisite: 151B or concurrently.  

3 units, Win (Marsden) T 1:15; lab. TTh 2:15-5:05, offered every year except 1970-71  

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

2 units, Spr (Miller) T 9–11, alternate years, given 1970–71

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 8


Any quarter (Staff) by arrangement


3 units, Win (Miller) S 9–12, alternate years, given 1971–72


3 units, Aut (Miller) MWF 9


3 units, Win (Miller) MWF 9

270C. Applications of Oil Reservoir Engineering—Lectures and problems. Continuation of 270B.

2 units, Spr (Miller) Th 9–11

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

3 units, Spr (Mueller) by arrangement

272. Advanced Natural Gas Engineering—Lectures, problems. Transient flow of gas in reservoirs, testing of gas wells. Gas reservoir material balances, water-drive gas reservoirs, production matching and forecasting, reserve estimation, gas storage reservoirs. Prerequisite: 172 or consent of instructor.

3 units, Spr (Ramey) MWF 10


Any quarter (Staff) by arrangement


3 units, Aut (Staff) MWF 9


3 units, Win (Miller) S 9–12, alternate years, given 1971–72

280. Modern Fluid Injection — Lectures, problems. Chromatographic transport of mass and heat through porous media. Specific applications to immiscible and miscible displacement of oil. Includes water flooding, gas injection, thermal oil recovery methods, and other modern fluid injection methods. Prerequisite: 270A.

3 units, Win (Ramey) MWF 11

281. Applied Mathematics in Petroleum Engineering—Lectures, problems. Philosophy of solution of engineering problems, solution of partial differential equations, op-
erational calculus, numerical integration, application of statistics to petroleum engineering. Prerequisites: Applied Mechanics 250 or Mathematics 131, and consent of instructor.

3 units, Spr (Ramey) MWF 8

360. Advanced Work in Petroleum Engineering—Graduate level work in either experimental, computational or theoretical research. Advanced technical report writing.

Any quarter (Marsden, Miller, Ramey)

by arrangement
Emeriti: A. John Bartky, W. H. Cowley, Paul R. Hanna, Ernest R. Hilgard, Maud M. James, Lucien B. Kinney, Maud L. Knapp, Henry B. McDaniel, Quinn McNemar, Daniel M. Mendelowitz, Jesse B. Sears (Professors); Margaret Barr, Ernest P. Hunt (Associate Professors)

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


Acting Assistant Professor: John C. Bock

Lecturers: Guy H. Browning, James B. Lyon, Frank J. Moore, 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 degrees offered by the School of Education with which credentials 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.)
Degree Credential
A.M. Standard Teaching Credential (Secondary)
Standard Designated Services Credential with a Specialization in Pupil Personnel Services
Standard Supervision Credential (requires two years of postgraduate education)

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 Secretary of the Committee on Advanced Graduate Degrees, Room 24.

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 faculty advisers relevant to his field of concentration 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.

Administrative Studies
Comparative and International Development Education
Curriculum and Instruction, with concentrations in any of the following fields:
  Art
  Language Arts or English
  Mathematics
  Modern European Languages
  Music
  Physical Education for Men
  Reading
  Science
  Social Studies
  Speech

Humanistic Studies:
  History of Education
  Philosophy of Education

Mathematical Methods in Educational Research
Political and Economic Studies
Psychological Studies:
  Child Development
  Counseling Psychology
  Educational Psychology

Sociological and Anthropological Studies
Teacher Education

Other possible fields of concentration may be arranged for applicants with the approval of the Committee on Advanced Graduate Degrees.

Application for formal admission into the
doctoral programs is expected during the fourth 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.)
- Counseling and Guidance
- Social Foundations of Education

Other possible fields of concentration may be arranged for individual advanced graduate applicants when approved by 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 36 units of graduate study is required. At least 30 units must be completed at Stanford. Eighteen units of the program must be in the School of Education. In no case will the degree be granted unless the student has been registered at Stanford University for three full quarters, or the equivalent, after the conferring of the Bachelor's degree. Evaluation of residence is based on tuition payments. One full-time quarter (a minimum of 12 units) is required. The remainder of the work may be carried on a part-time basis.

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 maintain at least a 2.75 grade point average in the program of courses approved by his adviser for the Master of Arts degree.

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, if not already on file in the School of Education.
   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 recommen-
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.

**MAJOR 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. Transcripts of all academic work previously taken must be submitted to the Master of Arts Secretary in the School of Education, if not already on file.

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 (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.

*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.
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.

MASTER OF EDUCATIONAL ADMINISTRATION

The Master of Educational Administration (MEA) degree is awarded jointly by the Graduate School of Business and the School of Education. To be awarded the MEA degree a candidate must have satisfactorily completed core courses in the Graduate School of Business and the School of Education. At least 45 units of credit must be taken in the Graduate School of Business. Only candidates accepted and enrolled in the Joint Doctoral Program in Educational Administration will be eligible for the MEA. It will be to the candidate's advantage to select courses that meet requirements for the doctoral degree. Usually all of the course work taken to satisfy requirements for the MEA degree, including courses in the Graduate School of Business, is transferable to meet the requirements for the doctorate in the School of Education.

There are no thesis or language requirements for the MEA.

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 108 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 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 advisers relevant to 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 Secretary of the Committee on Advanced Graduate Degrees, Room 24, School of Education.

Foreign Language Requirement — In some specializations in Education foreign language competence is required. Applicants should inquire about this from the specialization chairman.

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.

Research Traineeship Program — The School of Education administers an interdepartmental Research Traineeship Program. Traineeships are awarded to doctoral students in the School of Education and also in such departments as Sociology, Statistics, the Graduate School of Business, etc. Selection is based on evidence of ability, research interest, and relevance of the student's research interest to educational problems. For U.S. citizens and permanent residents, a limited number of financial awards are available; these provide full tuition and a stipend of $2400 per year or more, for three years. Inquiries regarding details of the program and application procedures should be addressed to Director, Research Traineeship Program, School of Education, Stanford University, Stanford, California 94305.

The trainee pursues the regular doctoral program of his department or his concentration within the School of Education. In addition, he is provided special opportunities for joint research with faculty members and independent but supervised research. An applicant to any concentration of the School of Education program will be considered for a traineeship if his principal objective is training for research. The RTP program is organized to provide awards in five areas; students from several concentrations may fall within one of the administrative rubrics of RTP.

The administrative areas are:

Humanistic Studies. Training emphasizes either historical or philosophical methods of research.

Mathematical Studies. Students specialize in statistics and psychometrics, use of mathematical models of learning and social behavior, or economic analysis of educational systems.

Organizational Studies. Students are trained to apply techniques of one or more social sciences to the investigation of educational planning and administration.

Psychological Studies. Students are trained in psychological research relevant to education.

Curriculum and Instruction. Students may emphasize curriculum development and instructional research in one of the school subjects or may prepare for research on general curriculum problems.

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.*

**Standard Supervision Credential Requirements**

1. Two years of acceptable postgraduate education including a Master’s degree or other acceptable postgraduate degree requiring not less than five years of education. If the Master’s or other postgraduate degree is not in an academic subject matter area, the two years of postgraduate education shall include 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 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) An acceptable Doctor’s degree. If the Doctor’s degree is not in an academic subject matter area, the three years of acceptable postgraduate course work must include 36 quarter units of upper division or graduate course work in an academic subject matter area or areas.
2. The possession of a valid basic credential.
3. A minimum of five years of successful full-time classroom teaching experience in public 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, or
   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 credential:

*Standard Teaching Credential (Secondary), which authorizes the holder to teach elementary education.*

*Stanford does not offer training at this time for the credential in elementary education.*
in grades 7 through 12 any subjects named as majors or minors on the credential.

**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, or History 151 or 152.
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.

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 first 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 (Apptitude Test, and in some areas 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. A personal interview with the applicant, by a Stanford staff member at the University or in the candidate's locality, is generally required of those candidates who have reached the final stages of the selection procedures. These interviews will be held early in March. Arrangements will be initiated by the STEP program for those applicants who are unable to come to Stanford.

5. Notice of admission. Candidates will be notified of their acceptance into the program no later than April 1, 1971. Candidates must reply within two weeks, or no later than April 15, if they wish to have a place in the 1971 class.

6. Teaching internship. Each intern must successfully complete a year of teaching at a local cooperating secondary school under the supervision of a Stanford teacher-supervisor and a resident supervising teacher. 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). Every effort is made to secure placement for an intern that reflects his preferences and
that provides an income. No guarantee is made, however, that an intern will receive a placement of his first choice or that the internship will be a salaried position. Placement for internship is planned to take into consideration area of academic specialization, type of student population, intern preferences, and proximity to Stanford University.

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 and 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. 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, 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.

How the Program is Organized—

Summer Quarter—Full-time residence at Stanford University. Courses in the teaching major and in professional education; foundations of education, curriculum and instruction in the teaching major, secondary education, and micro-teaching.

Academic Year — Part-time teaching responsibilities. Additional course work in the academic major; course work in education to include additional work in the foundations of education, curriculum and instruction, and secondary education; teaching internship.

In light of continuing program development these requirements are subject to revision.

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>Educ. 223</td>
<td>Public School Law</td>
<td>3</td>
</tr>
<tr>
<td>Educ. 231</td>
<td>Developmental Guidance: Group Procedures</td>
<td>3</td>
</tr>
<tr>
<td>Educ. 232</td>
<td>Developmental Guidance: Research</td>
<td>2</td>
</tr>
<tr>
<td>Educ. 233</td>
<td>Decision Making: Basic Principles and Theory</td>
<td>3</td>
</tr>
<tr>
<td>Educ. 235</td>
<td>Decision Making: Evaluation of Guidance Information Sources</td>
<td>1</td>
</tr>
<tr>
<td>Educ. 236</td>
<td>Behavior Modification: Introduction</td>
<td>2</td>
</tr>
<tr>
<td>Educ. 237</td>
<td>Behavior Modification: Research and Practice</td>
<td>2</td>
</tr>
<tr>
<td>Educ. 238A,B,C</td>
<td>Practicum in Guidance or Internship in Guidance</td>
<td>12</td>
</tr>
<tr>
<td>Stat. 160</td>
<td>Introduction to Statistics</td>
<td>4</td>
</tr>
<tr>
<td>Psych. 255</td>
<td>Principles of Personality Change II</td>
<td>3</td>
</tr>
<tr>
<td>Educ. 239A,B,C</td>
<td>Observation of Study Skills and Developmental Reading in College, or</td>
<td>4</td>
</tr>
<tr>
<td>Educ. 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 238A,B,C, Practicum in Guidance, or 338A,B,C, Internship 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 Educational 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., 250A,B, Statistical Analysis in Educational Research I
- 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

**Graduate**

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

- 108. Seminar in Education and Politics in Europe—(Same as Political Science 127B.) 5 units, Spr (Weiler) W 2:15–4:05
- 111. Developmental Psychology — (Enroll in Psychology 111.)
- 113. Development of Cognition and Language—(Enroll in Psychology 113.)
- 150. Elements of Statistical Analysis in Education — Introduction to statistical description and inference in the study and conduct of educational research. No previous college mathematics necessary. This or a more advanced course in the field required of all doctoral candidates. Students planning to continue with 250A,B should elect Statistics 160. 3 units, Aut (Coladarci) MWF 10
160. Introduction to Statistical Methods I—
(Enroll in Statistics 160, formerly Statistics 107.) Especially designed as a nonmathematical study of statistical methods used in the social sciences, behavioral sciences, biological sciences, and other disciplines. Organization of data and methods of summarization, including averages and measures of variability and association. Statistical inference based on a brief introduction to probability theory, including tests of hypotheses, estimation and confidence intervals.

4 units, Aut (Anderson) MTWThF 3:15

190. Directed Reading in Education.
2-4 units, any quarter (Staff) 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, Aut (Grommon) Th 4:15–6:05

190. Directed Research in Education.
2-4 units, any quarter (Staff) by arrangement

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 (Gross) W 7–10 p.m.
4 units, Sum (Gross) MTWTh 1:15 and by arrangement

201. History of Education in the United States—Analysis of selected turning points in education in relation to such topics as political socialization, race relations, immigration, and urbanization.

3 units, Win (Tyack) Th 7–10 p.m.
4 units, Sum (Tucker) MTWTh 10 and by arrangement

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, Aut (Waks) MTWTh 9
Spr (Thomas) TTh 1:15–3:05

205. Philosophies of Education—The epistemology, axiology, and metaphysics of contemporary philosophies compared for their significance in guiding educational policy and research.

4 units, Aut (Thomas) TTh 1:15–3:05

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

4 units, Spr (Moore) TTh 2:15–4:05

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

4 units, Sum (Moore) TTh 2:15–4:05

210. Social Foundations of Education—
(Students planning to take this course during the winter will take Education 310/210; see description under Educ. 310/210.) Topics include influence of social structure on schools, school systems; American cultural values and their influence on education; school system as formal organization in mass society.

4 units, Win (Baldrige) MW 9–11
Sum (Baldrige) MTWTh 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 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 (Staff) 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: 211A.

3 units, Aut (Staff) M 4:15–6:05 and W 4:15

211C. Foundations of Education: Social—Application of sociological and social-psychological theories and research to teaching,
learning, classroom interaction and the organization of the school.

3 units, Win (Cohen) Section 1: M 4:15–6:05, W 4:15–5:05
(Hawkinshire) Section 2: M 4:15–6:05, and W 4:15–5:05
(Hawkinshire) Section 3: M 9–10, and W 9–11

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 (Cronbach) TTh 3:15–5:05

216A. Individual Differences in Cognitive Processes—Differential cognitive variables of relevance to intellectual development are examined, together with antecedent conditions. Research approaches and educational implications are explored. Prerequisites: Statistics 160 or equivalent and Psychology 111 or equivalent, or consent of instructor.

3 units, Win (Sieber) MWF 11

216B. Early Learning—The development of a learning process to age six is examined. Relevant theories, research paradigms and educational implications are discussed. Prerequisites: Statistics 160 or equivalent and Psychology 111 or equivalent, or consent of instructor.

3 units, Spr (Sieber) MWF 11

217. Development of Scientific Explanation in Children—Examination of studies of children’s explanations of scientific phenomena and of conceptions guiding the study designs.

3 units, Aut (Bridgham) Th 3:15–5:05

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

3 units, Win (Byrd) MWF 11

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 10

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, Win (——) T 7–10 p.m.

4 units, Sum (——) MTWThF 11

223. 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 (Staff) M 7–10 p.m.

224. 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

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 Super-
vision 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

229. Administration of School Health Program—Significant problems in school health facing school personnel. (May be taken in lieu of Education 218.)
3 units, Spr (Byrd) W 7–10 p.m.

230. Developmental Guidance: Basic Principles and Practices — Principles, practices and program organization in guidance. Organizing educational environments to develop student potentialities, to prevent and ameliorate student problems relevant to guidance. Prerequisite: consent of instructor.
3 units, Aut (Thoresen) Th 3:15–5:05 and by arrangement
4 units, Sum (—) MTWThF 9

230A. Guidance in Elementary Schools — Review of modern guidance practices. Particularly directed to needs of teachers, administrators, guidance workers.
3 units, Spr (Sears) alternate years, given 1971–72

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. Prerequisite: consent of instructor.
3 units, Win (Thoresen) 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. Prerequisite: consent of instructor.
2 units, Spr (Krumholtz) by arrangement

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. Prerequisite: consent of instructor.
3 units, Aut (Krumholtz) by arrangement

3 units, Win (Krumholtz) M 3:15–5:05 and by arrangement

235. Decision Making: Evaluation of Guidance Information Sources—Criteria for assessing sources of educational and vocational information. Supervised experience in finding, using and evaluating information relevant to educational and vocational decisions. Prerequisite: consent of instructor.
1 unit, Spr (Staff) by arrangement

236. Behavior Modification: Introduction—(Same as Psychology 192.) Counseling techniques for altering client behaviors in a variety of settings. Research studies, case studies, and technique demonstrations involved. Prerequisite: consent of instructor.
3 units, Aut (Thoresen) by arrangement

237. Behavior Modification: Research and Practice—Research in developing and evaluating a variety of therapeutic techniques for altering client behaviors. Prerequisite: consent of instructor.
3 units, Aut (Thoresen) by arrangement

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 Education 230–237. Consent of instructor required.
4 units, Aut, Win, Spr (Krumholtz, Thoresen, Staff) 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. Limited to Secondary Interns.

3 units, Sum (Staff) 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 (Staff) Th 5:15


2 units, any quarter (Staff) 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 (Koff) 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

247. Social Issues and Curriculum Development—An inquiry into difficult problems of choice concerning public education within the context of selected social issues: for example, church and state; freedom, loyalty, and dissent; civil rights; and the emergence of a counter culture. An appraisal of the functions of public schools in an increasingly pluralistic culture with special emphasis on implications for curriculum development and teacher role.

3 units, Win (Tucker) MWF 10

248. Directed Teaching in the Junior College.

3 to 6 units, Win, Spr (Grommon) 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


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

250C, D. Statistical Analysis in Educational Research II—Continuation of Education 250B: Emphasis on analysis of multiple variables and applications. Topics include multivariate normal distribution, multiple regression, partial and multiple correlations; linear and non-linear models, analysis of covariance. Prerequisites: 250B or equivalent and consent of instructor.

3 units, Aut, Win, alternate years, given 1971-72

251. Laboratory Methods in Educational Research—Introduction to psychological methods of experimentation as applied to problems in education. Research topics will include process areas (perception, memory, verbal and concept learning, cognition) with examples from selected content areas (e.g. reading, mathematics). A basic laboratory course designed for majors outside of Psychological Studies with no background in experimental educational psychology, or for first-year Psychological Studies majors with a deficiency in experimental methods. Prerequisite: consent of instructor. Enrollment limited to 20, with preference given to first- and second-year students.

3 units, Aut (Calfee) MWF 11

252. Introduction to Test Theory—(Same as Psychology 248.) Concepts of reliability and
validity; mathematical models underlying commonly used procedures for test analysis. Test scales and norms. Prerequisites: Statistics 160 or equivalent.

3 to 4 units, Aut, alternate years, given 1971–72

255. Human Abilities — (Same as Psychology 155.) The nature, development, and measurement of intellectual abilities. Prerequisites: Psychology 1 and Statistics 160 or equivalent.

3 units, Spr (Snow) MWF 10

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 4:15–6:05

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 (——) 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 (——) T 4:15–6:05


263A. 3 units, Sum (——) MTWTh 3:15
263B. 1 unit, Aut (——) T 4:15–6:05
263C. 1 unit, Win (——) T 4:15–6:05


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


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

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 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 (Bridgham) T 4:15–6:05
267C. 1 unit, Win (Bridgham) T 4:15–6:05
267D.* 1 unit, Spr (Bridgham) 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 (Gross) MTWTh 3:15
268B. 1 unit, Aut (Tucker) T 4:15–6:05
268C. 1 unit, Win (Tucker) T 4:15–6:05
268D.* 1 unit, Spr (Gross and/or Tucker) T 4:15–6:05

269A,B,C,D. Curriculum and Instruction in
Secondary School Speech and Drama — Theory, practice in curriculum and instruction in speech and drama.

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) by arrangement

282. Linguistics and the Teaching of English—(Same as Linguistics 321.) Linguistic aspects of the problems of teaching English. Attention will be paid to English as a foreign language, standard English for dialect speakers, and English as subject matter for native speakers. Prerequisite: English 208 or Linguistics 267.

3 units, Spr (Wanat) MWF 10

283. Spanish Linguistics—(Same as Spanish 190.)

3 units, alternate years, given 1971–72

288. Methods of Teaching French—(Same as French Teacher Training 288.)

3 units, Win (Politzer) M 4:15–6:05 and by arrangement

291. Methods of Teaching German—(Same as German 302.)

2 units, Aut (Lohnes) MWF 11

292. Methods of Teaching Spanish—(Same as Spanish 210 and Language Laboratory 215.)

2 units, Aut (Petersen) TTh 10

295. Language Laboratory Techniques — (Same as Language Laboratory 215.)

2 units, Spr (Lam) TTh 1:15

298. Practice Teaching in Foreign Languages in the Elementary School.

1 to 2 units, any quarter (——) 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 4:15–6:05 and by arrangement

COURSES FOR EXPERIENCED TEACHERS OR ADVANCED GRADUATE STUDENTS

302. The Structure of Knowledge and Education—Methods for analyzing knowledge claims of any discipline. Focus on reliable and relevant ways to characterize the variable "what is taught."

4 units, Aut (——) TTh 2:15–4:05

303A,B,C. Colloquium: Philosophy of Education — Meetings of the colloquium will consider: 1) papers presented by students and staff of the philosophy of education program; 2) papers presented by philosophers and philosophers of education from the vicinity; 3) papers and discussions of educational research of relevance to the philosophy of education presented by other professors of education; and 4) bibliographical reports on recent educational and philosophical literature. The colloquium is strongly recommended for graduate students in philosophy of education during their first two years in residence. It will be open to other graduate students in philosophy and education by consent of instructors.

2–5 units, Aut, Win, Spr (Thomas, Waks) F 11–1

304. Philosophy and Empirical Research—An exploration of conceptual problems in empirical research in education and the contributions of systematic philosophizing to controlled inquiry. Prerequisite: 204 or 205 or consent of instructor.

4 units, Win (Thomas) TTh 1:15–3:05

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) MW 1:15–3:05

306A. Education and Sociocultural Change — 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 to 5 units, Aut (Staff) T 2:15–4:05 and by arrangement

306B. Education and Political Development—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 to 5 units, Win (Weiler) T 2:15-4:05
and by arrangement

306C. Education and Economic Development—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 to 5 units, Spr (Carnoy) T 2:15-4:05
and by arrangement

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

3 to 5 units, Aut (Staff) Th 2:15-4:05
and by arrangement

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

3 to 5 units, Win (Weiler) Th 2:15-4:05
and by arrangement

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

3 to 5 units, Spr (Carnoy) Th 2:15-4:05
and by arrangement


Win, Spr (——) by arrangement

306S. 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.

3 units, Aut (Carnoy) M 11:00-1:05
and by arrangement

310/210. Sociology of Education—A course for both doctoral and master’s level students. Lectures are the same, but assignments and discussion sections are separate. Master’s degree students enroll for 210, doctoral students for 310. Doctoral students with no previous background in behavioral science research will do both sets of assignments (310 and 210) and will be given 6 units of credit instead of 4.

Lectures: The lectures will cover the evaluation and potential usefulness of research literature in the sociology of education to problems of educational practice and policy. The student should gain an overall picture of the research process. Sociological topics to be considered include professionalization, analysis of power relations, evaluation and influence processes, status and stratification.

Sections: The students will be expected to develop the ability to evaluate and criticize available research literature in the sociology of education to problems of educational practice and policy. The student should gain an overall picture of the research process. Sociological topics to be considered include professionalization, analysis of power relations, evaluation and influence processes, status and stratification.

4 units (6 units for doctoral students
doing both kinds of assignments)
Win (Baldridge) MW 9-11

311. Socialization of Pre-Adults in Contemporary U.S. Society—(Same as Psychology 245.) 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 with economic-political-social development in selected Asian countries. Consent of instructor required.

Win, Spr (——) by arrangement
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

312A. The Low Status Student: Race and Social Class — (Same as Sociology 148A.) This course provides an attack on a problem of great contemporary interest in education from the point of view of sociological theory, research, and analysis. The relationship of research to policy formulation will be stressed. Relevant sociological theory and research will be covered from the areas of stratification, socialization, and race relations. Applications to "education for the disadvantaged" will be made. Because students must be prepared to contribute analyses and research formulations in class presentations, Education 310 or its equivalent is a prerequisite.

4 units, Aut (Cohen) TTh 3:15-5:00

312B. Interaction Processes in Education — (Same as Sociology 148B.) With increased use of group work as a classroom technique and the new developments in team teaching, the educational researcher can benefit from selected theory and research by sociologists and social psychologists in the small group setting. Topics will include the social processes of evaluation, influence, and role differentiation. The student should acquire skills in selecting theory and research from a heterogenous behavioral science area that have some promise for problems in the educational setting. Methods for studying interaction in educational settings will be included. The course will involve some field work in observation and scoring of small groups in the educational setting. Because students must be prepared to contribute analyses and research formulations in class presentation, Education 310 or its equivalent is a prerequisite.

4 units, Spr (Cohen) TTh 3:15-5:00

313A,B. Economics of Education — Major attention devoted to the "production," distribution, and financing of education; contribution of education to economic growth and development; and the organization of the education industry. Prerequisites: economic theory and quantitative methods, and consent of instructor.

313A. 3 units, Win (Carnoy, Levin) by arrangement

313B. Spr (Carnoy, Levin) by arrangement

314. Seminar in Citizenship Education — A seminar for experienced teachers, administrators, curriculum workers, and other school personnel. Includes a topical consideration of projects and research related to the problems of educating responsible citizens for a free society.

3 units, Aut (Gross) TTh 2:15-3:45

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.

5 units, Aut (Spindler) M 7-10 p.m.

4 units, Sum (______) TTh 3:15-5:05

316. Advanced Educational Psychology: Basic Processes—Review of research on perception, learning, and memory processes. Emphasis on research procedures and analysis of problems of school learning. For doctoral students in Psychological Studies. Open to other students with consent of instructor.

3 units, Win (Calfee) MWF 9

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 students in Psychological Studies. Open to other students with consent of instructor.

4 units, Win (Gage) M 3:15-5:05 and by arrangement

319. Motivation in the Educational Process — Research findings on attentional and motivational processes, including pupil traits and situational determiners. For doctoral students in Psychological Studies. Open to other students with consent of instructor.

2 to 3 units, Spr (Sears) by arrangement

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

320A. Organization 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 organization of the elementary school. Prerequisite: 221 or equivalent or consent of instructor.

3 units, Spr (Staff) M 7–10 p.m.

322A, B. Joint Seminar in Administration: Business and Education—Relates the analytical tools and concepts in the MBA core curriculum to the administration of educational organizations. Emphasis on decision theory, linear programming, and systems analysis. Prerequisite: consent of instructor.

3 units, Win, Spr (Kirst and Staff) M 2:15–4:05

323A. Education and Public Policy: Cities and Suburbs—Empirical political theories and political systems analysis are used to consider the government of elementary and secondary education at the local level.

4 units, Aut (Kirst) TTh 2:15–4:05

323B. Education and Public Policy: Federal and State—An introduction to the educational policy-making process at the federal and state level including consideration of federalism and selected national policy issues.

4 units, Win (Kirst) TTh 2:15–4:05

324. Current Issues in Higher Education—Analysis of historical background, emergent characteristics, and alternate resolutions of principal issues facing colleges and universities.

3 units, Aut (Mayhew) W 3:15–6:05

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) F 3:15–6:05

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) F 3:15–6:05


3 units, Spr (MacConnell, Staff) F 3:15–6:05

326A. School Finance—Principles and problems involved in financing public schools. Major emphasis is placed upon developing a relevant set of analytical techniques from economics and political science that will enable the student to conceptualize and solve problems in school finance.

3 units, Aut (Levin) TTh 4:15–5:45

326B. Financial Decision Making for the Schools—This course emphasizes the use of modern decision-making tools for allocating resources within the schools. Attention will be devoted to the concepts of educational production functions, resource markets, prices, cost-effectiveness analysis, instructional technology, and program-planning and budgeting systems. Consent of instructor required.

3 units, Win (Levin) TTh 4:15–5:45

326C. Workshop in School Finance—Independent research in school finance will be undertaken by students, and research design, implementation, and results will be discussed in class. Consent of instructor required.

3 units, Spr (Levin) by arrangement

327. Internship in Secondary School Ad-
ministration and Supervision—Field experience as secondary school administrator—intern in office of secondary school principal.

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

by arrangement

329. Fundamentals of Organization Theory—(Same as Sociology 203.) Focuses on basic concepts and theories about the operation of complex organizations. Special attention given to the organizational dynamics of educational systems.

4 units, Aut (Baldridge) MTW 10

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

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

338A,B,C. Internship in Guidance—Intensive supervised field experience in local school districts will be designed to provide the intern with opportunities to design individualized learning environments for the purpose of improving children’s decision-making abilities, overcoming maladaptive behavior patterns, and preventing problems. Consent of instructor required.

1-6 units, Aut, Win, Spr (Krumboltz, Thoresen, Staff) 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.

3 units, Win (Eisner) TTh 1:15-3:05


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

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.

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

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 (Mayhew) M 3:15-6:05

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 and various methodological approaches relevant to research problems. For doctoral students not majoring in Psychological or Mathematical Studies. Consideration given to particular concerns relating to doctoral dissertations. Prerequisite: consent of instructor.

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

351A,B. Advanced Statistical Analysis in Educational Research—Applied multivariate analysis including multiple regression, canonical analysis, discriminant analysis, factor analysis, cluster analysis. Prerequisites: Statistics 220 or equivalent and consent of instructor.

3 units, Aut, Win (Elashoff) MWF 1:15, alternate years, given 1970-71

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 (Sears) by arrangement, alternate years, given 1970-71
353. Problems in Measurement—(Same as Psychology 249.) 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: 250B and 252, or Psychology 152 and 248, or equivalent.

3 to 4 units, Spr (Cronbach) MW 2:15–4:05, alternate years, given 1970–71

354. Curriculum Evaluation—Functions of evaluation, outcomes to be measured, design of evaluation programs, qualities desired in evaluation instruments. For advanced doctoral students concerned with curriculum research. Consent of instructor required.

3 to 4 units, Win (Cronbach) MTWTh 10, alternate years, given 1970–71

355. Instrumentation Workshop — For students developing achievement tests, ability tests, questionnaires, or other instruments. Each student pursues his own project and participates in critical review of the projects of others. Prerequisite: consent of instructor.

1 to 4 units, Aut (Cronbach) by arrangement


4 units, Sum (Eisner) MTW 10–12

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, Spr (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) M 4:15–6:05 and by arrangement
4 units, Sum (——) MWTh F 11 and by arrangement

388. Foreign Language Education and Bilingual Education in the Elementary School — Discussion of the rationale, curriculum, methods, and materials of foreign language instruction and of bilingual education in the elementary school. Problems of organization of bilingual curricula and of articulation of foreign language and bilingual curricula with the high school.

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

389. Experimental Psychology of Reading — Review of research literature on the reading process, and acquisition of reading. Emphasis on critical evaluation of process research, and on interaction of psychological, linguistic, and educational aspects of reading. Prerequisite: consent of instructor.

3 units, Spr (Calfee) TTh 10:00–11:30

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, alternate years, given 1971–72

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 (——) by arrangement
1 to 3 units, Sum (——) 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 (Hurd, Bridgham) TTh 1:15–3:05

- 3 units, Win (Staff) alternate years, given 1971-72
- 4 units, Sum (Tucker) MTWTh 8 and by arrangement


- 4 units, Aut (Shaftel) MW 2:15-4:05
- Sum (Shaftel) MW 2:15-4:05


- 3 units, Aut (Iverson) W 4:15-6:05 and by arrangement

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 4:15-6:05 and by arrangement
- 4 units, Sum (——) MTWThF 9

SEMINARS AND SPECIAL COURSES FOR ADVANCED GRADUATE STUDENTS

400. Seminar in History of Education — A seminar examining selected issues, topics, and sources in the history of education outside of the United States.

- 3 units, Win (Gross) TTh 2:15-3:45

401A-B. Seminar in the History of American Education—Topical seminar, focusing in 1971 on American urban education. 401A offers an analysis of relevant literature and research methods (may be taken separately). In 401B students write and discuss seminar papers. Prerequisite: consent of instructor.

- 401A. 4 units, Win (Tyack) by arrangement
- 401B. 4 units, Spr (Tyack) by arrangement

403. Methods of Conceptual Research — A discussion of approaches to disciplined inquiry in education using procedures other than experimental.

- 4 units, Spr (——) TTh 4:15-6:05

404. Seminar in the Philosophy of Education — Intensive study of student-selected topics. Emphasis may shift between epistemology and value theory each quarter, to be announced one quarter in advance. Prerequisite: 204 or 205 or consent of instructor.

- 3 units, Win (Woks) T 7-10 p.m.
- Spr (Thomas) W 7-10 p.m.

405. Philosophy, Education, and Society—(Same as Philosophy 215.) A detailed philosophical examination of some aspects of the relationship between school and society. Topics may include, but will not be restricted to, the following: the school as a community; social freedom and education; anarchist theories of education; social aims of education.

- 4 units, Win (Waks) given 1971-72

406A. Research Seminar on Education and the Process of Rural to Urban Transformation—First of a sequence in which students will work on individual or group research projects. Discussion will focus on the effects of varying educational inputs upon the modernization of rural life and the preparation of rurally enculturated people for urban life, given particular demographic and resource situations, and particular political, economic, and sociocultural settings.

- 3 units, Aut (——) M 8-10

406B. Research Seminar on Education and Political Development — 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.

- Win (Weiler) by arrangement

406C. Research Seminar on Education and Economic Development — 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 sec-
ond-year SIDEc doctoral students. Others by consent of instructor.

3 units, Win (Carnoy) W 2:15–4:05

406H. International Development Education Colloquium—A continuing colloquium for the discussion of research proposals and projects of students and faculty in Comparative and International Development Education. Required for first- and second-year students in that concentration; others invited to participate. Consent of instructor required for students outside the concentration.

3 units, Aut, Win, Spr (Staff) W 12

and by arrangement

409. Seminar on Problems of Development Education in Latin America—This course is intended primarily to give common focus to students in the International Development Education Fellowship Program and is required for them. Others may participate with the consent of the staff.

The seminar will be carried on throughout the year. It will deal with a topic of broad common interest to the fellows and will lead to the preparation of background papers for the annual fellowship program conference.

3 units, every quarter (Moore) T 12–1 and

by arrangement

410. Seminar on Theories of Socialization—(Same as Psychology 244.) 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


1 to 3 units, Aut, Win, Spr (Staff) 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: 310. Consent of instructor required.

3 units, Spr (Cohen) M 7–9 p.m. and

by arrangement

413A,B. Research Problems in Organizational Behavior—(413B same as Sociology 204.) Designed for advanced students interested in organizational and administrative problems. This is a special topic seminar, and the content varies from year to year. Specific descriptions will be available from the professor at registration. Generally the course will focus on research design on a special organizational topic in the winter and on field research methods with practical experience in the spring. Usually the course will focus on universities and colleges as the subject organizations. Prerequisite: 329. Recommended: research methods course and elementary statistics.

413A. 4 units, Win (Baldridge) T 7–10 p.m.

413B. 4 units, Spr (Baldridge) T 7–10 p.m.

414. Research Seminar in Economic Evaluation of Instructional Technology—Evaluation of various instructional technologies in achieving particular educational objectives. Emphasis will be on micro-economics of educational investment in a cost-effectiveness or cost-benefit framework. Prerequisite: consent of instructor.

3 units, Aut (Carnoy, Jamison, Levin, Suppes) by arrangement

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

2 to 4 units, any quarter (Staff) by arrangement

4 units, Sum (Coladarci) by arrangement

416. Advanced Educational Psychology: Complex Processes—Continuation of Education 316. Emphasis on research into cognitive and language processes. Prerequisite: Education 316 or consent of instructor.

3 units, Spr (Calfee) MWF 11

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 4:15–6:05 and by arrangement

420. Seminar in Educational Administration—Advanced seminar in general educational administration. Analysis of current research and of problems and opportunities emerging from field work and internship assignments. 2 units, Aut, Win, Spr (Odell and Staff) by arrangement

423. Seminar in Education and Public Policy—Advanced seminar in educational policy development and interrelationships at local, state, and federal levels; including stress on urban policy. 3 units, Spr (Kirst) by arrangement

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

424A. 3 units, Win (Mayhew) W 3:15–6:05

424B. 3 units, Spr (Mayhew) W 3:15–6:05

425A,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: 325 or equivalent, or consent of instructor.

425A. 3 units, Aut (MacConnell, Strand) Th 3:15–6:05

425B. 3 units, Win (MacConnell, Strand) Th 3:15–6:05

425C. 3 units, Spr (MacConnell, Strand) Th 3:15–6:05

431. Guidance Seminar — Designed for all doctoral candidates in guidance and related areas. Analysis of professional problems in guidance and personnel work. May be repeated for credit. Prerequisite: consent of instructor.

1 unit, any quarter (Krumboltz, Thoresen) T 7:30–9:30 p.m., biweekly

440. Seminar in the School Curriculum — Designed for doctoral students in the field of education interested in the development of curriculum theory and curriculum research. Students will develop and present theoretical models and proposals for the empirical study of curriculum problems. Prerequisite: 340.

4 units, Spr (Staff) TTh 3:15–5:05

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.

2 to 5 units, Win (Shaftel) MW 1:15–3:05 and by arrangement

446. Seminar in Secondary Education for Doctoral Candidates — Enrollment 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.

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


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 — For advanced graduate students.

By arrangement


2-4 units, Spr (Politzer) M 4:15–6:05 and by arrangement

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)
490. Directed Research — For advanced graduate students.

M 3:15 and 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

493. Seminar in Applied Statistics—Discussion and continuing practicum on research problems.

1 to 3 units, Aut, Spr (Elashoff, Olkin) 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.

2 units, Aut, Win, Spr (Hurd, Bridgham)

Th 7:30-9:30 p.m.


496A. The historical development of social studies education; analysis of the social, curricular, and instructional theories of the various contemporary schools of thought in the social studies.

3 units, Aut (Tucker) Th 7-10 p.m.

496B. 3 units, Win (Gross) W 7-10 p.m.

496C. The identification of researchable problems in the social studies and the development of an appropriate design for conducting the research.

3 units, Spr (Gross, Tucker)

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 Teacher Education Program (Internship) in order to qualify for the California Standard Teaching Credential in secondary education. Course work in this credential program in physical education may begin in the junior year, continuing through the senior and first graduate years. 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 requirements of the intern credential program, see the section "Teaching Credential (Secondary)," in the Education introductory material.

Successful completion of the M.A. degree program qualifies the candidate for the Standard Teaching Credential, Junior College, with a major in Physical Education.

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. Women students interested in physical education teaching as a career may enroll in selected courses with consent of the instructor.

155. Elementary Analysis of Body Movement—Introduction to anatomical and mechanical aspects of human movement. Enrollment by consent 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. 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 or sophomores.

A total of 12 units of registration in Education 171 is required during the junior and senior years. This course will be offered on a continuing basis until the 12-unit requirement is fulfilled, at which time a grade will be recorded on the student's transcript for the entire 12-unit block.

The distribution requirement for specific courses is:

**Required:** Aquatics and gymnastics.

**Elective:** Any four: Adapted physical education, athletic training and conditioning, baseball, basketball, combatives, football, golf, tennis, track and field, and volleyball-soccer-speedball combined.

See Professor John E. Nixon or Professor Wesley K. Ruff for information concerning time schedule and instructors for these courses.

*2–12 units*

**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.

*3 units, Aut (——-) lec. T 10-12; lab. Th 10-12 and one hour by arrangement*

**179. Kinesiology**—Application of anatomy, physiology, laws of mechanics to human motion. Prerequisite: Anatomy 213.

*4 units, Spr (Ruch) MWF 1:15–3:05*

**277. Human Physical Performance Research**—Emphasizes relevant literature and laboratory research experience. Prerequisite: 177 or equivalent.

*3 units, Win (——) lec. TTh 1:15–3:05; lab. by arrangement*

**356. Seminar in Physical Education Research** — Critique of selected recent literature and research.

*3 units, Aut (Nixon) MWF 10*

*4 units, Sum (Nixon) MTWThF 9*

**357. Seminar on 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, ———) 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: 177 and 277, or equivalent.

*4 units, Spr (——-) TTh 1:15–3:05*

**459. Seminar on Physical Education Issues** —Selected issues and problems in physical education.

*3 units, Win (Nixon) M 7–10 p.m.*

*2 units, Sum (Nixon) MT 8 and by arrangement*
SCHOOL of ENGINEERING

Dean: Joseph M. Pettit
Associate Deans: James M. Gere (Undergraduate Programs), L. Farrell McGhie, William R. Rambo (Research), Lauress L. Wise (Student Relations)
Assistant Dean: Alfred D. Kirkland
Secretary of the Faculty: Michel Boudart

The School of Engineering offers four-year undergraduate programs leading to the degree of Bachelor of Science; comprehensive five-year programs leading to a Bachelor of Science degree; five-year programs leading to both Bachelor of Science and Master of Science degrees; others leading to a Bachelor of Science with a Bachelor of Arts in a field of humanities or social science; dual degree programs with certain other colleges; and graduate curricula leading to the degrees of Master of Science, Engineer, and Doctor of Philosophy.

The School includes ten academic departments: Aeronautics and Astronautics, Applied Mechanics, Chemical Engineering, Civil Engineering, Electrical Engineering, Engineering-Economic Systems, Industrial Engineering, Materials Science, Mechanical Engineering and Operations Research. These departments are responsible for graduate curricula, research activities, and the departmental components of the undergraduate curricula. In research, where faculty interest and competence embraces both engineering and the supporting sciences, there are not only numerous programs within the School, but also there are several inter-School activities, including the Microwave Laboratory, the Center for Materials Research, the Institute for Plasma Research, and the Radio Astronomy Institute.

Instruction in engineering is offered during the autumn, winter, and spring quarters of the regular academic year. During the summer quarter a few undergraduate and graduate courses are offered.

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 discussed under “Undergraduate Programs of Study.” 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 given for courses taken elsewhere whenever the courses are equivalent or substantially similar to Stanford courses. 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 UNDERGRADUATE COUNCIL

Responsibility for undergraduate curricula and for courses designated “Engineering” has been delegated by the faculty of the...
School of Engineering to its Undergraduate Council. The Council is made up of faculty members with special interests in undergraduate education, most of whom teach undergraduate courses and advise undergraduate students. The Council approves curricula, supervises course offerings, initiates new courses, and recommends students for the degree of Bachelor of Science in Engineering. A roster of Council members is available from the office of the Dean of Engineering.

**Undergraduate Programs of Study**

The principal objective of the undergraduate engineering curriculum is to provide opportunity for personal maturity and intellectual growth, for the attainment of professional competence, and for the development of social responsibility. The curriculum is quite flexible and decisions on individual courses, in general, are left to the student and his adviser. For a student with a well-defined educational goal, there is a great deal of latitude.

As an aid in program planning, the curriculum is described in terms of 10 components: Writing, Humanities and Fine Arts, Social Sciences, Technology and Society, Mathematics, Science, Engineering Breadth, Engineering Depth, Free Electives, and Functional Balance. By planning these components carefully and taking full advantage of the available advising services, a student can arrange a strong program to meet any one of a wide variety of educational objectives. Engineering majors are offered in three categories: Departmental Majors, Interdisciplinary Majors, and Innovative Majors. A Technology and Society program is offered for those seeking a broad integration of engineering, science, and societal subjects.

Engineering students are subject to the University requirements outlined in the first pages of this bulletin. The requirements in the areas of mathematics, natural sciences, and technology will be satisfied automatically by the engineering program. Students who qualify for advance placement will be held to correspondingly fewer units in the math and sciences areas.

**Writing**

Two courses of instruction in written composition are required by the University for graduation, except that some students may be exempt from all or part of this requirement (see the first section of this bulletin for details).

**Humanities and Fine Arts**

Three courses (minimum) are required by the University for graduation (see the first section of this bulletin for details).

**Social Sciences**

Three courses (minimum) are required by the University for graduation (see the first section of this bulletin for details).

**Technology and Society**

Every engineer needs to have an appreciation of the role of technology in society. While this appreciation is gained in many ways, every engineering student is expected to take at least two courses specifically directed to the problems of technology and society (equivalent directed study or work outside the University is acceptable). A partial list of courses and seminars in this category is available from the Office of the Dean of Engineering.

**Mathematics (21 units minimum)**

Engineering students need a solid foundation in the calculus of continuous functions, an introduction to discrete mathematics, training in the use of computers, and understanding of statistics or probability theory. The minimum preparation should probably include work to the level of Mathematics 43, some competence in computer programming, and a basic knowledge of statistics. The ability to deal with ordinary differential equations and with matrices is important in many areas of engineering, and students are encouraged to select additional courses in these topics.

**Science (24 units minimum)**

A strong background in the basic concepts and principles of physical science such as physics, chemistry, and biology is essential for engineering. The basic physics sequence Physics 51 to 56 (14 units) will normally be chosen by engineering students.

The additional science courses should be selected by the student with some consideration of his probable engineering program. Chemistry 4 and 5 are of particular importance to students anticipating programs in the general areas of chemical engineering.
applied thermodynamics, and materials science. Additional courses in organic chemistry are desirable for chemical engineers. Physics 57 to 58 will be of interest to students interested in areas of engineering relying heavily on quantum physics, such as materials science and electrical engineering. Biology 10 to 12 will be of interest to students anticipating programs in environmental engineering, biotechnology, and related fields. Geology 1 is of importance to those interested in the design of civil engineering structures and construction.

**Engineering Breadth (30 units minimum)**

Every engineering student should include in his preparation course work selected from a variety of disciplines in order:

1. to obtain a look at the principles and techniques of the several branches of engineering as an aid in career selection;
2. to gain a general viewpoint by seeing basic principles in a variety of forms as they find application in diverse disciplines;
3. to secure protection against the hazards of too much specialization too early; and
4. to gain an introductory knowledge of several of the engineering sciences as preparation for work on complex problems.

In accordance with this viewpoint, each student is expected to select at least 30 units of courses from not fewer than five of the eight categories listed below. To ensure breadth, the courses selected in at least three of the five chosen categories should lie in areas not directly related to his major program of study as defined by the Engineering Depth sequence. *(Note—Even though more units may be listed, no more than 10 units in any one category can be counted toward satisfaction of this breadth requirement.)*

There are many introductory courses offered by various departments which are suitable for this purpose. Students are urged to consider all the various possibilities before making definite course selections.

1. **Mechanics of Solids and Fluids**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engr. 11.</td>
<td>Applied Mechanics: Statics and Stress Analysis</td>
<td>4</td>
</tr>
<tr>
<td>Engr. 21.</td>
<td>Mechanics of Fluids</td>
<td>4</td>
</tr>
<tr>
<td>Physics 110, 111.</td>
<td>Intermediate Mechanics</td>
<td>3, 3</td>
</tr>
</tbody>
</table>

2. **Electric Circuits and Devices**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engr. 41, 41A, 42, 42A.</td>
<td>Circuits and Devices</td>
<td>4, 1, 4, 1</td>
</tr>
<tr>
<td>Physics 105.</td>
<td>Introductory Electronics</td>
<td>3</td>
</tr>
<tr>
<td>Physics 120, 121, 122.</td>
<td>Intermediate Electricity and Magnetism</td>
<td>3, 3, 3</td>
</tr>
</tbody>
</table>

3. **Thermodynamics**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engr. 31.</td>
<td>Engineering Thermodynamics</td>
<td>5</td>
</tr>
<tr>
<td>Physics 170.</td>
<td>Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 171.</td>
<td>Physical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>Chem. Engr. 120.</td>
<td>Chemical Engineering Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>Mat.Sci. 181.</td>
<td>Thermodynamics and Phase Equilibria</td>
<td>4</td>
</tr>
<tr>
<td>Mech. Engr. 131A.</td>
<td>Thermosciences: Thermodynamics</td>
<td>5</td>
</tr>
</tbody>
</table>

4. **Materials Science and Properties**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engr. 50.</td>
<td>Science of Materials</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engr. 118.</td>
<td>Materials Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 121.</td>
<td>Organic Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>Mat.Sci. 185.</td>
<td>Mechanical Behavior of Solids</td>
<td>3</td>
</tr>
<tr>
<td>Mat.Sci. 188.</td>
<td>Electrical, Optical and Magnetic Properties of Materials</td>
<td>3</td>
</tr>
<tr>
<td>Mech. Engr. 111.</td>
<td>Failure Prevention</td>
<td>3</td>
</tr>
</tbody>
</table>

5. **Logic and Computer Systems**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phil. 3.</td>
<td>Introduction to Logic</td>
<td>5</td>
</tr>
<tr>
<td>Indus. Engr. 141.</td>
<td>Utilization of Computers</td>
<td>3</td>
</tr>
<tr>
<td>Elect. Engr. 204.</td>
<td>Introduction to Brain Theory</td>
<td>3</td>
</tr>
<tr>
<td>Comp. Sci. 106.</td>
<td>Introduction to Computing</td>
<td>3</td>
</tr>
<tr>
<td>Comp.Sci. 111.</td>
<td>Introduction to Computer Organization</td>
<td>3</td>
</tr>
</tbody>
</table>

6. **Systems Analysis and Control**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engr. 104.</td>
<td>Dynamic Response</td>
<td>3</td>
</tr>
<tr>
<td>Engr. 105, 106.</td>
<td>Control System Analysis and Design</td>
<td>3, 3</td>
</tr>
<tr>
<td>Engr. 155.</td>
<td>Industrial Control Systems</td>
<td>3</td>
</tr>
<tr>
<td>Indus. Engr. 108.</td>
<td>Work Design and Measurement</td>
<td>3</td>
</tr>
<tr>
<td>Indus. Engr. 161, 102.</td>
<td>Design of Production Systems; Scheduling and Control of Production Systems</td>
<td>3, 3</td>
</tr>
<tr>
<td>Engr.-Econ. Sys. 201A,B,C.</td>
<td>Introduction to Systems Analysis</td>
<td>3, 3, 3</td>
</tr>
</tbody>
</table>
SCHOOL OF ENGINEERING

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Engr.-Econ. Sys. 221. Probabilistic Systems Analysis 3

7. TRANSFER AND RATE PROCESSES
Chem. Engr. 116B. Heat and Mass Transfer Laboratory 1
Chem. Engr. 130A,B. Transport Phenomena 3, 3
Mat.Sci. 182. Rate Processes in Materials 3

8. DECISION PROCESSES, ENGINEERING ECONOMY, AND DESIGN
Engr. 102. Optimization 3
Engr. 161. Engineering Economy 3
Indus. Engr. 100. Industrial Organization and Behavior 4
Mech. Engr. 103. Manufacturing Technology 4

Engineering Depth (36 units minimum)
The rapid advance in scientific knowledge and technological achievement requires even higher technical proficiency in the engineer. The undergraduate should select a coordinated series of courses to gain mastery of the important principles and techniques in a well-defined field and some experience in their application to significant problems.

There are three ways in which a student may satisfy the depth requirement. (1) Departmental Majors. He may complete the sequence of courses recommended by one of the engineering departments (Chemical Engineering, Civil Engineering, Electrical Engineering, Industrial Engineering, Materials Science, and Mechanical Engineering). (2) Interdisciplinary Majors. He may complete one of the sequence of courses suggested by the Undergraduate Council. (3) Innovative Majors. He may, with the help of his adviser, propose a combination of courses to meet his particular career goals; such a program will be approved by the Undergraduate Council if it satisfies the spirit of the depth requirements. These three possibilities are described later in more detail under the heading, “Engineering Majors.”

Free Electives
Enough additional courses to bring the total to 180 units or more, typically between 30 and 40 units.

Functional Balance
Every engineering student should obtain experience in analysis, synthesis, experimentation, and communication. Analysis is concerned with the formulation and solving of mathematical models, primarily by use of deductive reasoning. Synthesis places emphasis on problem definition, ideation, inductive reasoning, and optimization. Experimentation involves the innovative applications of experimental equipment and techniques to discover relations and to answer questions. Communication skills include oral, written, and graphical expression, with emphasis on communication for a purpose. All these skills are essential in the successful practice of engineering.

The Engineering Breadth and Depth components of the curriculum will ensure adequate experiences in analysis. To round out his program, each student is expected to include the equivalent of at least 9 units each of synthesis, experimentation, and communication. It is not expected that this will require additional course work; instead, each student should keep in mind the necessity for functional balance while selecting courses in the Science, Engineering Breadth, Engineering Depth, and Elective components of the curriculum.

Accreditation
The Engineers Council for Professional Development (ECPD), an organization formed by the several professional societies, accredits college engineering programs on a nationwide basis. Accreditation is important in many areas of the engineering profession; students wishing more information about accreditation should consult their Departmental Office or the Office of the School of Engineering.

In addition to standards of quality, ECPD criteria for accreditation include approximately one year of work in the basic sciences and mathematics, approximately one year of study in the engineering sciences, and at least one half year of concentrated study in some specialty. The departmental and inter-departmental programs should meet these criteria through the basic science and mathematics, engineering breadth, and engineering depth requirements.

The following undergraduate curricula are accredited: Chemical Engineering, Civil Engineering, Electrical Engineering, Engineering Science, Industrial Engineering, Materials Science, and Mechanical Engineering. An Aeronautics and Astronautics curriculum is accredited at the Master's degree level. The following Interdisciplinary Majors are

Stanford also has provided for accreditation of Innovative programs and other Interdisciplinary Majors via a curriculum designated General Engineering. Majors and programs which meet the intent of the ECPD accreditation criteria will be designated General Engineering. Innovative or other programs which, in the opinion of the Undergraduate Council, do not meet the ECPD accreditation criteria will be designated simply as Engineering.

Finally, a non-accredited program is offered and described below under the heading “Technology and Society Program.”

ENGINEERING MAJORS

The 36-unit engineering depth requirement permits the student to select a major course of study and obtain a limited amount of specialization.

Departmental Majors

Satisfaction of the engineering depth requirement by completion of one of the departmental course sequences constitutes a major in that branch of engineering. A student wishing to deviate slightly from one of the departmental depth programs may submit his proposed program to the department for approval. Modified programs recommended by a department will normally be approved by the Undergraduate Council.

Chemical Engineering

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Chem. 122</td>
<td>Organic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 123</td>
<td>Organic Preparations</td>
<td>3</td>
</tr>
<tr>
<td>Chem. 173, 175</td>
<td>Physical Chemistry</td>
<td>6</td>
</tr>
<tr>
<td>Chem. 176</td>
<td>Physico-Chemical Measurements</td>
<td>3</td>
</tr>
<tr>
<td>Chem. Engr. 12</td>
<td>Chemical Computations</td>
<td>2</td>
</tr>
<tr>
<td>Chem. Engr. 115C</td>
<td>Unit Operations</td>
<td>3</td>
</tr>
<tr>
<td>Chem. Engr. 116C,D</td>
<td>Chemical Engineering</td>
<td>4</td>
</tr>
<tr>
<td>Chem. Engr. 128</td>
<td>Process Kinetics</td>
<td>3</td>
</tr>
<tr>
<td>Restricted Electives</td>
<td></td>
<td>9</td>
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<td></td>
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<td>36</td>
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</table>

Civil Engineering

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<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>4</td>
</tr>
<tr>
<td>C.E. 138</td>
<td>Specifications and Contracts</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 150</td>
<td>Transportation Engineering</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 160</td>
<td>Water Resources Engineering</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 170</td>
<td>Man and His Environment</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 180</td>
<td>Elementary Structural Analysis</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 190</td>
<td>Soil Mechanics and Foundations</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 197</td>
<td>Engineering Synthesis; or Civil Engr.</td>
<td></td>
</tr>
<tr>
<td>198</td>
<td>Senior Report, 1 unit plus 3 units of</td>
<td></td>
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<tr>
<td>Restricted Electives</td>
<td></td>
<td></td>
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</tbody>
</table>

Electrical Engineering

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>E.E. 101, 102, 103</td>
<td>Circuits and Networks</td>
<td>9</td>
</tr>
<tr>
<td>E.E. 111, 112, 113</td>
<td>Electronics</td>
<td>9</td>
</tr>
<tr>
<td>E.E. 121, 122</td>
<td>Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>E.E. 141, 142</td>
<td>Electromagnetics and Waves</td>
<td>6</td>
</tr>
<tr>
<td>E.E. 126, 139, or 274</td>
<td>Laboratory or Project</td>
<td>3</td>
</tr>
<tr>
<td>Restricted Electives</td>
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<td></td>
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</tbody>
</table>

Industrial Engineering

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mech. Engr. 101</td>
<td>Manufacturing Technology</td>
<td>4</td>
</tr>
<tr>
<td>I.E. 100</td>
<td>Industrial Organization and Management</td>
<td></td>
</tr>
<tr>
<td>I.E. 108</td>
<td>Work Design and Measurement</td>
<td>3</td>
</tr>
<tr>
<td>I.E. 120</td>
<td>Quality Control</td>
<td>3</td>
</tr>
<tr>
<td>I.E. 133</td>
<td>Industrial Accounting</td>
<td>4</td>
</tr>
<tr>
<td>I.E. 141</td>
<td>Utilization of Computers</td>
<td>3</td>
</tr>
<tr>
<td>I.E. 161</td>
<td>Design of Production Systems</td>
<td>3</td>
</tr>
<tr>
<td>I.E. 162</td>
<td>Systems Planning and Control</td>
<td>3</td>
</tr>
<tr>
<td>I.E. 199</td>
<td>Senior Seminar</td>
<td>3</td>
</tr>
<tr>
<td>Restricted Electives</td>
<td></td>
<td></td>
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</table>

Materials Science

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math. 45</td>
<td>Advanced Calculus</td>
<td>3</td>
</tr>
<tr>
<td>Math. 130, 131</td>
<td>Differential Equations</td>
<td>6</td>
</tr>
<tr>
<td>Mat.Sci. 180</td>
<td>Atomic Arrangements in Solids</td>
<td>5</td>
</tr>
<tr>
<td>Mat.Sci. 181</td>
<td>Thermodynamics and Phase Equilibria</td>
<td>4</td>
</tr>
<tr>
<td>Mat.Sci. 182</td>
<td>Rate Processes in Materials</td>
<td>3</td>
</tr>
<tr>
<td>Mat.Sci. 185</td>
<td>Mechanical Behavior of Solids</td>
<td>3</td>
</tr>
<tr>
<td>Mat.Sci. 188</td>
<td>Electrical, Optical and Magnetic Properties of Materials</td>
<td>3</td>
</tr>
<tr>
<td>Mat.Sci. 188L</td>
<td>Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>Restricted Electives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mechanical Engineering

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.E. 101</td>
<td>Visual Thinking</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 103</td>
<td>Manufacturing Technology</td>
<td>4</td>
</tr>
<tr>
<td>M.E. 107</td>
<td>Mechanical Systems</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 111</td>
<td>Failure Prevention</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 113</td>
<td>Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 131A,B,C</td>
<td>Thermosciences</td>
<td>15</td>
</tr>
<tr>
<td>Engr. 104</td>
<td>Dynamic Response</td>
<td>3</td>
</tr>
<tr>
<td>Restricted Electives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Interdisciplinary Majors

The Undergraduate Council is responsible for specialties that cross departmental lines. Additional information regarding these majors may be obtained from the office of the Dean of Engineering.
### Aeronautics and Astronautics
- Engr. 104. Dynamic Response
- A.A. 100. Introduction to Aeronautics and Astronautics
- A.A. 131. Experimentation in Aeronautics and Astronautics
- Civil Engr. 114. Mechanics of Materials
- Mech. Engr. 131A. Thermosciences: Thermodynamics
- A.A. 200A. Engineering Analysis of Flight Vehicles
- A.A. 192. Vector Analysis and Cartesian Tensors
- Math. 130. Ordinary Differential Equations
- A.A. 210A. Fundamentals of Compressible Flow
- A.A. 298. Seminar in Aerospace Technology
- Restricted Electives

### Applied Science*
A plan of courses in Mathematics, Science, Computation, and Engineering which form a coherent program satisfying a well-defined career objective. (It is expected that normal programs in Applied Science will contain at least 36 of their 180 units in Engineering courses.)

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math. 130, 131 or 45, 46.</td>
<td>6</td>
</tr>
<tr>
<td>Restricted electives in Engineering Science</td>
<td>21</td>
</tr>
<tr>
<td>Restricted electives in Basic Science</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

### Engineering Science*
Math. 130, 131 or 45, 46.
Restricted electives in Engineering Science
Restricted electives in Basic Science

### Product Design
- Mech. Engr. 103. Manufacturing Technology
- Mech. Engr. 115A,B. Introduction to Product Design and Environmental Design
- Art 40. Basic Drawing and Painting
- Art 50. Basic Sculpture
- Art 60. Basic Design
- Art 180. Design 1

### Resource Strategy
<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthr. 131. Comparative Social Systems</td>
<td>4</td>
</tr>
<tr>
<td>Civil Engr. 150. Transportation Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engr. 160. Water Resources Engineering</td>
<td>4</td>
</tr>
<tr>
<td>Civil Engr. 170. Man and His Environment</td>
<td>3</td>
</tr>
<tr>
<td>Econ. 118. Underdeveloped Economies</td>
<td>5</td>
</tr>
<tr>
<td>Educ. 206A. Comparative Education</td>
<td>3</td>
</tr>
<tr>
<td>Indus. Engr. 50. Human Values in a Technological Society</td>
<td>2</td>
</tr>
<tr>
<td>Indus. Engr. 100. Industrial Organization</td>
<td>4</td>
</tr>
<tr>
<td>Restricted electives</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

### Environmental Engineering
The list of courses for a major in Environmental Engineering is available from the office of the Dean of Engineering. This major is recommended for engineering students interested in problems of environmental planning, urban design, pollution control, water resources, transportation, and related subjects. Students with a particularly specialized interest should propose an Innovative Major.

Other programs for Interdisciplinary Majors, such as Medical Engineering, Environmental Design, Urban Planning, and Ocean Engineering, may be developed as required. Consult the Office of the Dean of Engineering, Stanford University, Stanford, California 94305.

### Innovative Majors
Any student, with the help of his adviser, may propose a unique combination of courses to meet his particular career goals. Such a program should be submitted to the Undergraduate Council during the junior year, but in any case not later than the end of the fifth week of the third quarter preceding graduation. A coordinated sequence of courses that provides mastery of the important principles and techniques in a well-defined field will ordinarily be approved.

### Technology and Society Program
The increased complexity of social and scientific problems is such that an undergraduate program reflecting the interrelation of engineering, science, and societal subjects forms a desirable basis for many careers. The School of Engineering offers the Technology and Society Program to meet this need.

The following requirements are prescribed for the Technology and Society Program: Writing (two courses, unless a student is exempt from all or part of this requirement); Humanities and Fine Arts (three courses minimum); Social Sciences (three courses minimum); Mathematics (21

* Students in Applied Science and Engineering Science must obtain approval of their programs by the Undergraduate Council. Petitions requesting admission to these majors should be submitted not later than the end of the fifth week of the third quarter preceding graduation, and should contain a statement describing a well-defined educational objective, the program of Depth in Applied or Engineering Science satisfying this objective, and the approval of the student's adviser.
units); Science (24 units); a plan of courses in Technology and Society forming a coherent program to satisfy a well-defined educational objective (64 units, of which at least 36 units must be in courses in engineering); Functional Balance; Free Electives (sufficient for a total of 180 units—typically between 40 and 50 units). Special advisers and a brochure to assist students in course planning are available through the Office of the Dean of Engineering.

Students who elect the Technology and Society Program must obtain approval of their programs by the Undergraduate Council. Petitions requesting admission to the Technology and Society Program should be submitted not later than the end of the fifth week of the third quarter preceding graduation, and should contain a statement describing a well-defined educational objective, the program of courses relevant to this objective that meets the requirements listed above, and the approval of the student's adviser. Students in this Program who wish to pursue graduate studies in engineering may require more than three quarters to complete departmental Master's degree requirements.

Engineering in Biology and Medicine*

The bioengineer is one who can apply technology to the solution of biological and medical problems. To do this he must have a mastery of some branch of technology. For this reason, we recommend that engineering undergraduates interested in biomedical problems major in one of the established fields of engineering, while using their electives to build up a basic background in the biological sciences and the interconnection between engineering, man, and his environment. A worthwhile strategy for the bioengineering undergraduate may thus be to supplement his major in some branch of engineering with basic courses in biology and chemistry, such as:

- Biol. 1. Introductory Biology
- Biol. 21, 22, 23. Principles of Biology
- Human Biology 1. Man and Nature
- Human Biology 2A. Cells, Organisms, and Societies
- Human Biology 2B. Behavior as Adaptation
- Chem. 1, 2, 3 or 4, 5. General Chemistry (Note that pre-medical students are usually required to have a full year of chemistry.)
- Chem. 121. Organic Chemistry

The student with further free electives might then choose from such courses as:

- Engr. 104. Dynamic Response (Cannon)—Its prerequisites provide basic engineering background
- Elec. Engr. 204. Introduction to Brain Theory (Arbib)
- Biol. 153. The Physiological Basis of Behavior (Wilson) — Its prerequisites provide basic biological background, but the course should be accessible for non-biologists after they have taken Elec. Engr. 204
- Aero. and Astro. 29. Biomedical Mechanics (Anliker)

* Write for full brochure from the Dean’s Office, School of Engineering.

Program Planning

An engineering curriculum provides a cumulative educational experience, and attention must be paid to course prerequisites. The study of mathematics should begin in the freshman year. Physics is a prerequisite for many engineering courses and should be started in the Winter Quarter of the freshman year. The engineering breadth courses may be spread over the first three years. The engineering depth sequences ordinarily require at least two years for their completion and should be started no later than the third year. Sample programs are available in the office of the Dean of Engineering.

In selecting courses for his undergraduate curriculum, each student should take into consideration his plans for graduate study. Many graduate programs of study have undergraduate courses as prerequisites; students who enter graduate programs without these prerequisites may have to spend extra time making up deficiencies. Consult your adviser if you have any questions about admission to graduate study.

In addition, some students may eventually seek professional engineering registration; consult your adviser as to desirable courses to take in preparation for the Engineer-in-Training and the Professional Registration examinations.

Combined A.B. and B.S. Degree Programs

A Stanford undergraduate may work simultaneously toward the A.B. and B.S. degrees (for example, an A.B. in Economics and a B.S. in Civil Engineering). The degrees may be awarded in the same quarter or in different quarters. Usually five years will be needed for the combined program.
To qualify for both degrees a student must:

1. file a petition of intent during his tenth or eleventh quarter, endorsed by appropriate representatives of the two departments in which he expects to receive degrees;

2. complete the stated University requirements as well as the School of Engineering requirements for each degree, and

3. complete 15 full-time quarters or 3 quarters after completing 180 units.

Co-Terminal B.S. and M.S. Degree Programs in Engineering

A Stanford undergraduate in the School of Engineering may work simultaneously toward the B.S. and M.S. degrees. The purpose is to permit taking some graduate level courses that apply toward the M.S. degree while still an undergraduate and to defer some undergraduate requirements to what would normally be the M.S. year. Both degrees may be granted simultaneously or at the conclusion of different quarters.

To qualify for both degrees, a student must:

1. apply after the beginning of his eighth quarter and before the end of his eleventh quarter, or during the second quarter before he would normally receive his B.S. degree;

2. include with his application a proposed B.S.-M.S. program of courses;

3. be admitted by the school or department in which he seeks the M.S.;

4. complete 15 full-time quarters or the equivalent, or three full quarters after completing 180 units;

5. take the Graduate Record Examination before completing his M.S. program, but not necessarily before applying for admission to the combined B.S.-M.S. program;

6. complete all requirements for the B.S. program; and

7. complete the requirements for the M.S. program.

Consult the Office of the Dean of Engineering for procedural details.

Comprehensive Five-Year B.S. 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.

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.

A minimum of six quarters of residence at Stanford is required for dual-degree (3+2) transfer students. Thus, such students may not receive the Stanford B.S. degree until at least 6 quarters of study have been completed here. However, 3+2 students also have the option of entering the combined B.S.-M.S. program if they meet the requirements, in which case they may receive the Master's degree as soon as all appropriate requirements are met, but not sooner than at the end of 6 quarters of study at Stanford.

Inquiries concerning this "three-two" program may be addressed to the Dean of Engineering at Stanford or to the above listed colleges. For a description of the four-two program, see the section titled "Master of Science."

Foreign Study

In addition to the regular opportunity available to all Stanford engineering students for study at one of the Stanford overseas campuses, a special opportunity exists whereby engineering students may spend their junior year in residence at the Instituto Tecnologico 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 Ecole Nationale Superieure de Mechanique of Nantes, to which substantially the same remarks apply.

**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 Chairman 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 follow procedures for registration as listed in the *Time Schedule*. Adviser assignments can be obtained from the Department office.

**Graduate Programs of Study**

Departments and divisions of the School offer graduate curricula, as follows:

**Aeronautics and Astronautics**
- Aerodynamics
- Aeroelasticity
- Aerophysics
- Aerospace Systems Design
- Aircraft, Missile, and Spacecraft Structures
- Astrodynamics
- Dynamics and Vibrations
- Elastic and Inelastic Solids
- Experimental Methods
- Guidance and Control
- Life Sciences-Biomechanics
- 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, Instabilities (elastic, plastic, dynamic)
  - Stress Waves in Solids
- Experimental Stress Analysis
- Dynamics
  - Rigid Bodies, Space Dynamics, Vibrations (linear and nonlinear)
- Fluid Mechanics
  - Dynamics of Ideal Fluids and Gases
  - Viscous Flow
  - Geophysical and Astronomical Fluid Mechanics
- Applied Optimal Control
  - Optimal Trajectories, Feedback, Control, Filtering, and Smoothing

**Engineering in Biology and Medicine**
- Biomathematics
- Biomechanics
- Biophysics and Biomaterials
- Biostatistics
- Design for Medical Applications
- Water Quality Control
- Information Processing for Biomedical Systems
- Information Processing in Biological Systems
- Integrated Circuits for Medical Electronics

**Chemical Engineering**
- Adsorption
- Heterogeneous Catalysis
- Interfacial Stability
- Heat, Mass, and Momentum Transfer in Laminar or Turbulent Flow Systems
- Non-Newtonian Fluid Mechanics
- Optimization Theory
- Thermodynamics
- Surface Reactivity

**Civil Engineering**
- Civil Engineering Materials
- Construction Management
- Engineering-Economic Planning
- Transportation
- Water Resources
- Environmental Design
- Urban Design
- Environmental Engineering
- Engineering-Economic Planning
- Pollution Control
- Transportation
- Water Resources
- Hydraulic Engineering
Hydromechanics
Hydrology
Nuclear Civil Engineering
Sanitary Engineering
Soil Mechanics and Foundations
Structural Engineering
Structural Mechanics

**ELECTRICAL ENGINEERING**
Automatic Control and Vehicle Guidance
Biological Systems and Cybernetics
Digital Computer Systems
Statistical Theory of Communication
and Control
Microwave Electronics and Microwave
Physics
Network Theory
Quantum Electronics and Optics
Signal Processing Systems
Space Science and Engineering
Solid State Devices and Systems
Solid State Phenomena and Materials

**ENGINEERING SCIENCE**
Bioengineering
Nuclear Engineering

**ENGINEERING-ECONOMIC SYSTEMS**
Applied Economics
Decision Analysis
System Analysis
Long Range Planning
Public Decision-Making

**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
Plasma Gasdynamics
Engineering Design
Kinematics, Control Systems
Product Design
Nuclear Engineering

**OPERATIONS RESEARCH**
Applied Probability
Control Theory, Dynamic Programming,
and Mathematical System Theory
Inventory, Queueing, and Reliability
Theory
Linear, Nonlinear, and Integer Pro-
gramming
Networks, Graphs, and Combinatorial
Theory

**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. 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, Stanford University, Stanford, California 94305.

**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 chairman of the appropriate department or division.

**The Honors Cooperative Program**

A number of industrial firms, government laboratories, and other organizations participate in the Honors Cooperative Program (HCP), a plan which permits qualified professional employees to register for graduate Stanford courses on a part-time basis. Most of the students in the HCP are in the School of Engineering, though several departments in related fields also offer graduate degree programs under this plan. The HCP is now augmented by the Stanford Instructional Television Network, a multichannel closed-circuit link that permits students to take courses in remote classrooms located at their company plants. Further details can be obtained from the School of Engineering.

**ENGINEERING**


**Associate Professors:** James L. Adams, Paul Kruger, Bruce B. Lusignan, William D. Nix, Bernard Roth, William Weaver, Jr.

**Assistant Professor:** John R. Manning

The “Engineering” courses deal with subject areas within engineering which are, in their essential nature, broader than the confines of any particular branch of engineering. These courses are taught by professors from the several departments of the School of Engineering, and are listed above.
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 (Smith) TTh 11 and T 1:15–3:05

2. Peopledynamics Laboratory—Technology is power, but power carries responsibilities. Consequently, an engineer insensitive to human needs or unaware of his own drives and prejudices can be dangerous. This course studies methods by which the engineer can identify the human nontechnical components of a problem. The methods are demonstrated in a laboratory setting, the data for learning being the behavior, feelings, and reactions of the members of the class. The well-known experiments to be performed are intended to sharpen perception, develop the ability to face emotional situations, focus misdirected energy, identify manipulation, develop accurate intuition and judgment, improve communications, and illuminate such interpersonal issues as inclusion, control, and cooperation. This is not a therapy group, but rather a laboratory course for studying techniques now used in industrial, service, and government institutions for developing their members’ potential talents. Because of their possible dangers, certain powerful methods will only be discussed rather than demonstrated. Although attendance at all labs is mandatory, participation in the experiments is up to the individual.

   2 units pass/fail Aut, Win, Spr (Wilde, Roth) T 1:15–5:05

10. Aeronautics and Astronautics — The principles of flight of airplanes, missiles, satellites, and spacecraft are explained physically, with a minimum amount of mathematics. The history of the development of these vehicles is sketched and biographic information is given on the great inventors, scientists, engineers, designers, pilots, and industrialists who have contributed to the growth of aeronautics and astronautics. Open to all students who have taken some mathematics and physics in high school.

   3 units, Spr (Hoff) TTh 11:00–12:15

11. Applied Mechanics: Statics and Stress Analysis—Equilibrium and energy methods applied to the solution of engineering problems; introduction to stress and strain analysis of linearly elastic materials; analysis of simple structures; implementation on digital computer. Prerequisites: Mathematics 42 and Physics 51.

   4 units, Aut (Weaver) MWF 9; computer session by arrangement
   Win (Staff) MWF 9; problem session by arrangement
   Spr (Staff) MWF 9; problem session by arrangement


   4 units, Aut (Ashley, Staff) MWF 11;
   problem session by arrangement
   Win (Ashley, Staff) MWF 11;
   problem session by arrangement
   Spr (Ashley, Staff) MWF 11;
   problem session by arrangement

21. Mechanics of Fluids — Statics and dynamics of incompressible ideal fluids; viscosity, fluid friction, laminar and turbulent flow. Laboratory exercises. Prerequisite: 11 and 12, or consent of instructor.

   4 units, Aut (Staff) MWF 9;
   lab. M or T, 1–4
   Win (Staff) MWF 9;
   lab. M or T, 1–4
   Spr (Staff) MWF 9;
   lab. M or T, 1–4

29. Biomedical Mechanics — The application of mechanics to various problems in medicine is described in the context of current research in cardiovascular dynamics, respiration, sensation of motion and sound, the mechanics of bones, and other areas. Recommended for advanced undergraduates and first-year graduate students.

   3 units, Spr (Anliker) MW 7:30–8:45 p.m.

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. Prerequisite: Mathematics 43. Recommended: elementary fluid mechanics.

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


41. 4 units, Aut (Staff) MWF 9, plus 2 hour problem session
Win (Staff) MWF 10, plus 2 hour problem session
Spr (Staff) MWF 9, plus 2 hour problem session

42. 4 units, Aut (Staff) MWF 10, plus 2 hour problem session
Win (Staff) MWF 9, plus 2 hour problem session
Spr (Staff) MWF 10, plus 2 hour problem session

41A. Laboratory I—To accompany 41.
1 unit, Aut, Win, Spr (Staff) one 3 hour lab. by arrangement

42A. Laboratory II—To accompany 42.
1 unit, Aut, Win, Spr, Sum (Staff) 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 (Shyne) MWF 9
Win (Huggins) MWF 11
Spr (Nix) MWF 10

102. Optimization—Mathematical ways of finding the best values of design, decision, or operating variables. Nonlinear and polynomial optimization under constraint. Direct optimum-seeking methods. Dynamic programming and partial optimization of large systems. Prerequisite: elementary differential calculus.

3 units, Win (Wilde) MWF 11


3 units, Aut (Staff) MWF 11
Win (Staff) MWF 11


3 units, Aut (J. Manning) MWF 10 and 1:15
Win (Staff) MWF 8
Spr (Staff) MWF 11


3 units, Win, Spr (Franklin) MW 1:15 and one three-hour lab. weekly by arrangement

114. Philosophy of Design—An introduction to the philosophy of comprehensive design. A discussion of the attitudes and viewpoints of the designer and an investigation of the techniques of analysis, synthesis, and evaluation that he uses. Emphasis will be placed on understanding the creative process and the factors that influence it. Limit-
ed registration. Prerequisite: undergraduate standing.

3 units, Win (Adams) W 2:15–5:05


3 units, Spr (Wilde) MWF 1:15

161. Engineering Economy—Economic decision making for alternative engineering designs. 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. Several methods are employed for analysis of multiple alternatives, simple risk, retirement, replacement, resource allocation, and public works projects. May be taken by freshmen. Recommended for sophomores.

3 units, Aut, Win (Ireson) TTh 10, and one hour by arrangement
Spr (——) TTh 11 and one hour by arrangement
Sum (——) MTWTh 10


3 units, Aut (Staff) MWF 9

172. Nuclear Science—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 29 or 57.

3 units, Win (P. Kruger) TTh 11

175. Radiation 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 registration in 171, or 172, or consent of instructor.

3 units, Aut, Win (Staff) lab. one afternoon by arrangement

177. 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.

3 units, Spr (P. Kruger) TTh 1:15 and one lab. by arrangement

199. Special Studies in Engineering—Special studies, laboratory work, or reading under the direction of a faculty member. By consent only.

1 or more units, any quarter (Staff) by arrangement

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.

3 units, Spr (P. Kruger) MWF 11

211. The Laboratory Plasma — Methods of forming laboratory plasmas. Collision processes, velocity distributions, the Boltzmann transfer equation, concepts of temperature and pressure, nonequilibrium velocity distributions. Macroscopic averages of the Boltzmann equation. DC and rf breakdown and avalanche phenomena, the effect of a magnetic field, the positive column at low pressure and medium pressure, ambipolar diffusion, the plasma sheath, and thermal plasmas. Recommended: Electrical Engineering 243 or equivalent.

3 units, Win (Wilde) MWF 9

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 (Buneman) M 4:15

215. Experimental Plasma Physics Laboratory — Comprehensively equipped teaching laboratory facilities are available for students wishing to carry out directed studies in experimental plasma physics. An extensive set of experiments has been developed
which introduce the student to selected basic plasma phenomena. These emphasize the characteristics and methods of production of various laboratory plasmas, and involve dc, rf, and optical diagnostic techniques. Alternative experiments may be proposed for consideration. Prerequisite: consent of instructor.

1 or more units, any quarter (Staff) by arrangement

235A,B. Engineering Systems Design — Forty to sixty students mostly from engineering and science, but also from business, political science, law, etc., form a team to prepare a preliminary design of a complex system. Systems designed in previous years include: satellites to explore Mars, to monitor the earth’s weather and natural resources, and to provide educational TV to developing countries; ocean systems to develop the sea’s resources; and plans for developing urban housing and resources have also been designed. Over 20 speakers from government and industry provide the necessary background. At the end of the second quarter the class gives a verbal presentation to a government and industry group and publishes a final report on the system.

235A. 3 units, Win (Lusignan) T 1:15–3:05, Th 1:15 and two hours by arrangement

235B. 3 to 5 units, Spr (Lusignan) TTh 1:15–2:05 and two hours by arrangement

290. The Historical Context of Engineering —By looking at the past an attempt is made to understand the mutual interaction of technological change and the course of society in general. Reading is selected from the history of technology, the history of ideas, the philosophy of history, and whatever else seems pertinent. The course is conducted as a colloquium with discussion based on the reading; the writing of a moderate-length paper is expected. Intended for graduate or senior undergraduate students in engineering; enrollment limited to 15. Pass-fail grade only.

3 units, Spr (Vincenti) by arrangement, next given in 1971–72

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

298. Seminar in Fluid Mechanics —Interdepartmental seminar on problems in all branches of fluid mechanics, with talks by visitors, faculty, and students. Graduate students may register for one unit, without letter grade; a letter grade is given for students presenting talks.

1 unit, Aut, Win, Spr (Staff) T 4:15

299. Special Studies in Engineering —Special studies, laboratory work, or reading under the direction of a faculty member. By consent only.

1 or more units, any quarter (Staff) by arrangement

ENGINEERING in BIOLOGY and MEDICINE

School of Engineering Advisory Committee on Engineering in Biology and Medicine: J. L. Adams, Mechanical Engineering; M. Anliker, Aeronautics and Astronautics; M. A. Arbib, Electrical Engineering, Information Systems Laboratory (Chairman); J. W. Bellville, Anaesthesiology; G. B. Dantzig, Operations Research; R. Eliassen, Civil Engineering; P. C. Hana- walt, Biophysics; T. R. Kane, Applied Mechanics; J. D. Meindl, Electrical Engineering, Solid State Laboratory; R. G. Miller, Jr., Biostatistics; G. M. Pound, Materials Science; R. D. Smallwood, Engineering-Economic Systems; D. A. Thompson, Industrial Engineering

Stanford has a great deal of research and teaching related to engineering in biology and medicine, even though it has no department of bioengineering. A brochure is available which lists faculty from many depart-
ments whose research and teaching interests may prove helpful to the engineering student interested in approaching the medical and biological sciences in his studies, as well as indicating many of the relevant courses scattered across the departments and schools of this University. This brochure can be obtained from the School of Engineering office or from the Chairman of the Committee.

There are nine themes around which such research has become organized: Biomathematics; Biomechanics; Biophysics and Biomaterials; Biostatistics; Design for Medical Applications; Environmental Engineering; Information Processing for Biomedical Systems; Information Processing in Biological Systems; and Integrated Circuits for Medical Electronics. For example, in the Biomechanics program, research is being conducted on cardiovascular mechanics, respiratory mechanics, bone elasticity, mechanical behavior of the vestibular apparatus, and dynamics of the eye. Laboratory facilities are being used at the National Aeronautics and Space Administration’s Ames Research Center. The program in Integrated Circuits for Medical Electronics has a superb facility for the application of modern integrated circuit technology to medical electronics.

The research and courses available should satisfy many of the needs of students wishing to confront biology and technology in their studies, though, of course, there are other programs which may be better for some students than any of the opportunities listed here—some students may wish to join the Artificial Intelligence project of the Computer Science Department, while others may wish to take an M.D. and commit themselves to clinical work. Students are advised to consider their career plans in structuring their studies.

At present, there is no graduate Engineering degree in Biology or Medicine per se. Instead, students are advised to enter the Department with the research that is of most interest to them. The requirements for the Master’s Degree and for the Ph.D. qualifying exam are then those of the student’s major department, though the student will work with his advisers to make his course sequences as relevant to biological and medical engineering as possible, using suggestions made below. Students should also be aware of the possibility of obtaining an M.S. in Engineering Science.

It is suggested that, by the end of his first year, a Ph.D. candidate request the formation of a committee, probably interdepartmental, of three or four faculty, to help him choose appropriate advanced courses both within and without the School of Engineering, and steer him in directions in which his particular talents — engineering, biological, and medical, can be used most effectively.

In rare cases where a student’s background makes it unrealistic for him to satisfy a departmental Ph.D. qualifying requirement, a faculty committee can be formed to supervise an appropriate qualifying and research program, as a Graduate Division Special Program.

National Institute of Health Fellowships are available to support graduate study in health-related fields, while National Science Foundation Fellowships are available for students in Science and Engineering. These are competed for on a national basis. In addition, departments of the School of Engineering have a certain number of fellowships and teaching or research assistantships, while the Dean’s Office has a limited supply of funds for the support of bioengineers entering the Engineering Science program.

Students accepted into the Biophysics program may choose to develop their specialization in the area of biomedical engineering and to work for the Ph.D. in Biophysics.

Students accepted into the Statistics program may choose to develop their specialization in the area of biostatistics. A limited number of traineeships are available for the support of students who enroll in the Biostatistics program. Close cooperation is maintained between the Biostatistics Division of the School of Medicine and the Department of Statistics.

A student wishing to earn the M.S. in Engineering while pursuing the M.D. degree must apply separately for admission to both schools. If he is admitted to both, each school will encourage his pursuit of the other degree. The Medical School curriculum is now so flexible that a medical student can devote half of his first two years of study to Engineering. Such students are usually advised to take technical science and engineering courses rather than to concentrate on bioengineering courses, since much of the biology will be treated in greater depth in their medical studies.
AERONAUTICS and ASTRONAUTICS

Emeriti: Irmgard Flügge-Lotz, Alfred S. Niles (Professors)
Chairman: Nicholas J. Hoff
Vice Chairmen: Daniel Bershader, Jean Mayers
Associate Professors: Donald Baganoff, Benjamin O. Lange (on leave 1970–71), Charles R. Steele
Acting Assistant Professors: R. Stephen Devoto, Sotiris Koutsoyannis, Samuel C. McIntosh
Senior Research Associate and Lecturer: Daniel B. DeBra

OFFERINGS

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

Aerophysics
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 Magnetooaerodynamics
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 Magnetooaerodynamics
Attitude Control and Instrumentation for Space Vehicles and Aircraft
Astrodynamics—Orbit Perturbations
Contactor Control—Optimal Control
Biomechanics—Hemodynamics

FACILITIES FOR INSTRUCTION AND RESEARCH

The work of the Department is centered in the new William F. Durand Building for Space Engineering and Science, completed and occupied in early 1969. This 120,000
square foot building houses advanced research and teaching facilities and concentrates 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.

Included among the present and planned facilities in the new building are structural laboratories for demonstrating and studying the behavior of high strength and stiffness, lightweight structures under programmed static, dynamic and thermal loads. In conjunction with the computing facilities available both in the new building and the Stanford Computation Center, test data are obtained and reduced through automatic data acquisition and processing systems. Recent experimental studies of structural behavior have been centered on the effects of creep on stress distribution and structural stability, the buckling and postbuckling phenomena in high quality cylindrical and spherical shells obtained through the electroforming process and the development of techniques for obtaining ultra-small measurements of deformation in conjunction with the buckling process in thin-walled shells.

The guidance and control laboratories include a wide spectrum of specialized facilities for making and testing novel instruments of extremely high precision. The facilities include active table-leveling (0.1 arc sec); low-level accelerometer evaluation chamber (10^{-4} to 10^{-10} g); spacecraft thruster test stand with 10 kHz bandwidth; spherical gyro rotor alignment facility (optical-to-principal-axis alignment less than 1 arc sec); air cushion vehicle to simulate the Stanford Drag-Free Satellite in an orbital dynamic environment to 275 km altitude; air-bearing simulator for spinning-spacecraft attitude control to a few arc secs; plus facilities for a number of inertial instrument test stands on an isolated test pad having visual access to Polaris. Clean facilities, ultra-precision machining, and advanced electronics design and fabrication capability support the guidance, control, and instrumentation experiments using these facilities. Elaborate new cryogenic gyro test facilities are available in the nearby Varian Physics Building, and Electrical Engineering's Integrated Circuit Fabrication Facility is adjacent. Three laser-research laboratories and the fluid controls laboratory also participate in the guidance and control programs. Testing of certain systems in Earth orbit is expected to begin this year.

The radiative gas dynamics laboratory houses a research facility to study the coupling between radiant energy and wave production in gases. The gas kinetics laboratory group conducts a program to study velocity distributions and spectral line shapes of selected levels and transitions in gases with the aid of a tuneable laser. The spectrointerferometric laboratory is being outfitted to study resonant refractivity in shock-heated gasses to obtain information on kinematic processes involving excited states. Additional facilities include a 250,000 joule condenser bank for plasma acceleration work, and a special concrete housing for studies of explosively driven shocks. There is also a specially designed laboratory for studies of aerodynamic noise. Several student instructional laboratories include facilities to study supersonic jets, flame temperature by line reversal, supersonic flow fields with schlieren techniques, refractive index of gases with interferometer equipment, shock-wave development with a shock tube, blunt-body flow with ballistic free-flight range equipment, and hot-wire application with a small low-turbulence air-flow apparatus. Nearly completed is a continuous low-speed tunnel with an 18" x 18" working section and speeds to 200 feet per sec. Also available in the old Guggenheim Laboratory is a zirconium oxide pebble-heater blow-down tunnel particularly for investigations of structural problems at hypersonic speeds and temperatures to 3,000°F.

Also adjacent is the interdepartmental Institute for Plasma Research whose aerophysics laboratory is operated by Aeronautics and Astronautics faculty, staff and students. Its main facility is a high-pressure, high Mach number shock tube for the production of high density partially ionized plasmas under highly defined conditions. A major measurement technique is high-speed rotating mirror interferometry.

Service facilities in the new building include a full machine shop, standards laboratory, chemistry laboratory, an expanded aeronautics library, several conference rooms, extensive digital and analog computer equipment, including several time sharing terminals. Attached to the building is a modern classroom building equipped
for televising lectures and containing a lecture theater.

The University's Computation Center is complemented by a "satellite" computer facility on the lower level of the new building, which is readily available to Department researchers and students. From this area there are direct tie-lines to the IBM 360-67 Computer (in the University's campus facility) and to an IBM 360-50 computer (at the nearby Stanford Medical Center) for on-line evaluation of experimental data. Terminals provide for individual on-line, time-shared computation with either of the two IBM 360's, and laboratory data may be collected and transmitted directly to the IBM 360-50 through conduits provided throughout the laboratory area of the building for this purpose. A digital and several analog computers are also located in this 2,500 square foot area. This computer facility is contiguous to the major lecture hall, permitting classroom exhibition of computer results.

The Department sponsors a student branch of the American Institute of Aeronautics and Astronautics which holds periodic meetings including comprehensive faculty research-area seminars and conducts visits to nearby research, government, 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 would 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, aerospace, structures, dynamics, guidance and 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 Engineering Curriculum, 9 units of mathematics, 9 units of advanced courses chosen from a list of physical science subjects, 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.

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 Magnetohydrodynamics, (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 min-
imum 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 additional 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, Gift Funds, Ford Foundation, 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 with the minimum 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**

An interdisciplinary program leading to the Bachelor of Science degree in Engineering (with option in Aeronautics and Astronautics) is available in the form of 38 units of electives to constitute the engineering depth requirement for the B.S. degree.

**Courses**

10. Aeronautics and Astronautics — (Enroll in Engineering 10.) The principles of flight of airplanes, missiles, satellites, and spacecraft are explained physically, with a minimum amount of mathematics. The history of the development of these vehicles is sketched and biographic information is given on the great inventors, scientists, engineers, designers, pilots, and industrialists who have contributed to the growth of aeronautics and astronautics. Open to all students who have taken some mathematics and physics in high school.

3 units, Spr (Hoff) TTh 11:00–12:15

29. Biomedical Mechanics — (Enroll in Engineering 29.) The application of mechanics to various problems in medicine is described in the context of current research in cardiovascular dynamics, respiration, sensation of motion and sound, the mechanics of bones, and other areas. Recommended for advanced undergraduates and first-year graduate students.

3 units, Spr (Anliker) MWF 7:30–8:45 p.m.

100. Introduction to Aeronautics and Astronautics — Explanation of principles of flight and propulsion. Concise discussion of the creation of lifting forces, aerodynamic performance, trajectories outside the atmo-
sphere, and the problems of reentry. Remarks on the history of aeronautics and astronautics. Prerequisites: Mathematics 43 or Engineering 21.

3 units, Aut (Hoft) TTh 11:00-12:15


3 units, Aut (Staff) 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.

3 units, Win (Billingham, Klein, Ogden, Oyama, Young) TTh 3:15-4:30

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 Laboratory — (Enroll in Engineering 215.) Comprehensively equipped teaching laboratory facilities are available for students wishing to carry out directed studies in experimental plasma physics. An extensive set of experiments has been developed which introduces the student to selected basic plasma phenomena. These emphasize the characteristics and methods of production of various laboratory plasmas, and involve dc, rf and optical diagnostic techniques. Alternative experiments may be proposed for consideration. Prerequisite: consent of instructor.

1 or more units, any quarter (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 (Koutsoyannis) 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: 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 con-
sideration 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, inter-
ceptor dynamics, lifting reentry, variable geometry, and problems of flight at very
low speed. Prerequisite: 200B.

3 units, Spr (Ashley) MWF 9

201. Aerodynamic Sound—Sound propagation in homogeneous and inhomogeneous,
stationary and moving fluid media; nature of sound sources (simple and multi poles);
reflection, refraction, interference, diffraction, scattering, and absorption of sound;
noise and its characteristics; sound generation by solid surfaces; aerodynamic sound
generation; specific problems in aerodynamic sound: aeolian tones; vortex noise;
jet noise; boundary layer noise; turbulence and noise; propeller and helicopter
noise; noise from rotating machinery (compressors, turbines, fans); sonic boom;
introduction to sound propagation in solids; introduction to non-linear acoustics. Prereq-
quisite: 210B.

3 units, Spr (Karamcheti, Koutsoyannis)
MWF 11

206A. Mathematical Hydro- and Aerody-
manics—(Enroll in Applied Mechanics 242.)
Introduction to mathematical analysis of
motion of an ideal inviscid incompressible
homogeneous fluid. Eulerian equations of
motion. Bernoulli's theorem and Helmholtz-
Kelvin laws of vortex motion. Darcy's law
and flow through porous media. Separation
of variables solutions with application to sur-
face waves and selected two- and three-di-
mensional steady and unsteady flows. En-
ergy and apparent mass concepts. Confor-
mal mapping. Airfoil theory. Vortex motion.
D'Alembert's and other paradoxes of inviscid
fluid mechanics. Free-streamline flow. Pre-
requisite: Engineering 21.

3 units, Aut (Spreiter) TTh 2:15-3:30

206B. Mathematical Hydro- and Aerody-
manics—(Enroll in Applied Mechanics 243.)
Continuation of 206A: Introduction to math-
ematical analysis of effects of compressibil-
ity, rotation, and density stratification on mo-
tion of an inviscid fluid. Subsonic, transonic,
and supersonic flows with application to
nozzles, the solar wind, thin wings, and slen-
der bodies. Reciprocity and flow reversal
theorems of acoustics and linearized com-
pressible flow. Equilibrium, stability, waves,
and flows of rotating and stratified fluids
with applications to problems of engineer-
ing, geophysical, and astronomical interest. Prerequisite: 206A.

3 units, Win (Spreiter) TTh 2:15-3:30

207. Mechanics of Viscous Flow—(Enroll in
Applied Mechanics 244.) Derivation of
Navier-Stokes equations. Plausible hypothe-
ses and paradoxes of viscous flow theory.
Exact solutions for incompressible steady
and unsteady unidirectional and circular
flows. Ekman layer at a boundary in a ro-
tating fluid. Dynamical similarity and Rey-
olds number. Flow fields with small inertia
forces with application to lubrication, per-
colation through porous media, and low
Reynolds number flow around moving bod-
ies. Boundary layer theory for high Reynolds
number flow. Exact and approximate meth-
ods for the solution of two-dimensional and
axisymmetric laminar boundary layer equa-
tions. Separation. Stability and transition to
turbulent boundary layer. Drag. Boundary
layer control. Introduction to turbulent
boundary layer theory. Introduction to ef-
tects of compressibility on laminar boundary
layers. Energy dissipation in wave motion,
with application to damping of sound and
surface waves. Prerequisite: 206A.

3 units, Spr (Spreiter) TTh 2:15-3:30

208. Transonic Flow Theory — (Enroll in
Applied Mechanics 245.) Description and
mathematical analysis of flows in which both
subsonic and supersonic velocities occur.
Aeronautical application to nozzles, wings,
odies, and wing-body combinations. Dis-
cussion of shock-wave boundary-layer inter-
action, and of wind-tunnel wall interference
effects in transonic testing. Astronomical ap-
plication to the solar wind, and the accre-
tion and mass loss of stars. Prerequisites:
Applied Mechanics 242 and 243.

2 units, Spr (Spreiter) TTh 9, alternate
years, given 1971-72

209. Dynamics of Viscous Fluids and Its
Application to Hemodynamics — Modern
theories of viscous flow and their application
to biomechanical problems. General conser-
vation laws and constitutive equations. Lam-
inar and turbulent flows of Newtonian and
non-Newtonian flows in pipes. Pulsatile flows
through elastic and viscoelastic tubes. Pulse wave propagations and reflections. Dynamics of fluids containing small solid particles, liquid drops and gas bubbles. Theory of Brownian motion and statistical treatment of fluid-mechanical problems. Examples will be chosen from hemodynamics and biophysics.

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 (Koutsouyannis) MWF 10
3 units, Win (Devoto) MWF 8

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: 192 and 210A (or Mechanical Engineering 131B).

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 (C. Kruger) 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 (Baganoff) 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 (Koutsouyannis) MWF 9

213. Flow Past Paraboloids — A survey of analytical and numerical techniques in a number of branches of fluid mechanics, based upon the calculation of flow past one simple family of bodies. Elliptic paraboloids (including as special cases the parabola, flat plate, and paraboloid of revolution) in subsonic, transonic, supersonic, and hypersonic streams with small and large viscosity.

3 units, Spr (Van Dyke) MWF 8, alternate years, given 1971-72

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 nonequilibrium 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; so-
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, Win (Vincenti) MWF 3:15, alternate years, given 1971–72

217. Geophysical Fluid Dynamics—(Enroll in Applied Mechanics 248.) Introduction to fluid flow and wave phenomena in the atmosphere, oceans, and interior of the Earth, and their mathematical representation. Effects of rotation, stratification, gravity, and electromagnetic forces. Application to general circulation, mountain lee waves, and Rossby waves in the atmosphere, surface and internal gravity waves and wind-driven circulation of the oceans, hydromagnetic dynamo processes in the liquid core, and possible slow convection of the “solid” mantle of the Earth. Prerequisite: 206B.

2 units, Spr (Spreiter) TTh 9, alternate years, given 1970–71

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 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 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. and lab. Th 1:15–5:05

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, alternate years, given 1971–72

222. Modern Optical Methods in Gas Dynamics—Interaction of radiation and matter with emphasis on the behavior of high temperature gases and plasma, and on experimental methods. Attention will be paid to the use of radiative and refractive properties, including the potentialities of spectral interferometry. Fundamentals of laser action in gases, and the growing use of the laser as an important diagnostic tool for interferometric, scattering, and holographic studies will be treated as well.

3 units, Aut (Bershader) T 2:15–3:05 and Th 2:15–4:05, alternate years, given 1970–71

223. Spectroscopy of Hot Gases—Observed features of atomic and molecular radiation; spectroscopic instruments; theory of hydrogen atom; spin; addition of angular momentum; L-S and other coupling schemes; Thomas-Fermi and Hartree theories of multielectron atom; spin-orbit interactions; intensity of spectral lines; Lorentz model of radiation and f-values; Einstein A and B coefficients; perturbation theory of transition
probabilities; Bates-Damgaard and Thomas-Fermi schemes for computation of f-values; natural, Doppler, and collisional broadening of spectral lines; structure of diatomic molecules, and analysis of vibration-rotation bands.

3 units, Win (Devoto) MWF 2:15

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 and dissociation.

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 of the planetary system. Modern developments, quasars, pulsars. Techniques and technical problems.

2 units, Spr (Herbig) S 10–12

227. Space Physics — (Enroll in Applied Mechanics 240.) Introduction to selected topics of geophysics and astronomy with emphasis on conditions in the solar and terrestrial atmospheres, interplanetary space, and solar-terrestrial relations. Properties of principal objects in the solar system. Elements of gravitational theory and orbital mechanics with application to determination of density of the upper atmosphere and the shape and internal structure of the Earth. Properties, time variations, and theoretical representation and interpretation of the upper atmosphere, ionosphere, magnetic field, and magnetosphere of the Earth, the photosphere, chromosphere, and corona of the sun, and the solar wind in interplanetary space. Theory of motion of a charged particle in electric and magnetic fields with application to Van Allen particles and cosmic rays. Outline of the principal features of the interaction of the solar wind with the Earth and other objects in the solar system. Prerequisites: Physics 55 and familiarity with vector analysis.

2 units, Win (Spreiter) TTh 2:15–3:30

228. Interplanetary Gasdynamics — (Enroll in Applied Mechanics 249.) Review of observations supporting the use of continuum fluid models to represent conditions in the interplanetary medium. Physical concepts, equations, and fundamental properties of solutions for hydromagnetic flow, waves, and discontinuities of finite amplitude including shock waves. Theory of spherically symmetric steady solar wind, and its interaction with the Earth, Moon, planets, comets, and the interstellar medium. Transient effects and relation to geomagnetic storms and other solar-terrestrial phenomena. Prerequisites: 206A, and either 206B or 210A.

2 units, Win (Spreiter) TTh 9, alternate years, given 1971–72

229A. Physiology for Engineers and Physical Scientists — Bioenergetics, circulation, renal function, gaseous exchanges. Neuromuscular 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 consent of instructor.

5 units, Win (——–) 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 consent of instructors.

3 units, Spr (Anliker, Chang) TTh 2:15–3:30

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. Engineering Systems Design — (Enroll in Engineering 235A,B.) Forty to 60 students mostly from engineering and science, but also from business, political science,
law, etc., form a team to prepare a preliminary design of a complex system. In previous years, satellites to explore Mars, monitor the earth’s weather and natural resources, and provide educational TV to developing countries, and Ocean Systems to develop the sea’s resources have been designed. Over 20 speakers from government and industry provide the necessary background. At the end of the second quarter the class gives a verbal presentation to government and industry and publishes a final report on the system.

235A. 3 units, Win (Lusignan) T 1:15–3:05, Th 1:15 and two hours by arrangement
235B. 3 to 5 units, Spr (Lusignan) TTh 1:15–2:05 and two hours by arrangement


239A. 3 units, Aut (——) TTh 11:00–12:15
239B. 3 units, Win (——) TTh 11:00–12:15

240A. Analysis of Aerospace Structures— 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 non-uniformity of loading and sectional properties. Prerequisite: Civil Engineering 114.

240B. Analysis of Aerospace Structures— 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.

240C. Analysis of Aerospace Structures— 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. Influence coefficients; use of finite difference, finite-element, and matrix methods. Prerequisite: 240B.

241A. Introduction to Aerospace Systems Synthesis and Analysis— The interaction of structures, 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, reliability, 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); 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.

241B,C. Introduction to Aerospace Systems Synthesis and Analysis — Application of the elements of systems synthesis and analysis to the preliminary design of a hypothetical aeronautical system subject to compromise between cost, schedule and performance; utilization of advanced applied aerodynamics and structural analysis theories, methods, and techniques to effect design definition of major structural assemblies taking into account the influences on aerodynamic and structural idealizations of fabrication processes, tolerances, material anisotropy, eccentricities, misalignments, subsystem interactions, and substructure joints and fit-
tings (boundary conditions). Prerequisite: 241A.

241B. 3 units, Win (Shevell, Ashley, Mayers) MWF 11

241C. 3 units, Spr (Shevell, Ashley, Mayers) MWF 2:15

242A. Continuum Mechanics: Classical Dynamics—Acceleration and rotation reference frames. Kinematics of rigid body motion; Euler angles. D’Alembert’s principle, equations of motion. Inertia properties of rigid bodies. Dynamics of coupled rigid bodies. Lagrange’s equations and their use. Dynamic behavior and simple stability, including small departures from equilibrium or steady motion, are considered throughout the course. Prerequisite: Engineering 12 or equivalent.

3 units, Aut (Breakwell) MWF 12


242B. 3 units, Win (Chao, Van Dyke) MWF 8

242C. 3 units, Spr (Chao, Van Dyke) MWF 8


3 units, Aut (Chao) TTh 7:35-8:50

244A. Structural Dynamics — Eigenvibrations and dynamic response of elastic systems including beams, membranes, plates, and shells. Discussion of approximate methods for analyzing complex built-up structures, such as collocation, lumped parameters, and finite elements. Free vibration and normal coordinates. Forced response to various types of excitations. Applications to fundamental flight-vehicle structures. Prerequisites: 243, 240C, or equivalents.

3 units, Aut (McIntosh) MWF 3:15

244B. Aeroelasticity — Presentation of the field of aeroelasticity from a unified viewpoint applicable to all types of flight vehicles. Introduction to aeroelastic operators and unsteady aerodynamics. Forced response, static and dynamic eigenvalues of a simplified system. Aeroelastic analysis of representative one-dimensional and two-dimensional structures. Prerequisite: 244A or equivalent.

3 units, Win (Ashley, McIntosh) MWF 3:15, alternate years, given 1970-71

244C. Aeroelasticity — Continuation of 244B. The unrestrained elastic flight vehicle. Modern unsteady aerodynamic theory. Experimental aeroelasticity. Special topics of current interest such as aeroelastic optimization and new developments in unsteady aerodynamic theory. Prerequisite: 244B.

3 units, Spr (Ashley, McIntosh) MWF 3:15, alternate years, given 1970-71


3 units, Aut (Herrmann) MWF 9


3 units, Win (Herrmann) MWF 10

245C. Advanced Theory of Elasticity—(Enroll in Applied Mechanics 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 (Herrmann) TTh 11

246. Theory of Plates—(Enroll in Applied
Mechanics 207.) Analysis of stress, deformation in plates bent by transverse loads. Applications to circular, rectangular, other shapes. Vibrations of plates. Prerequisite: Civil Engineering 114.

3 units, Win (Hetényi) MWF 9


3 units, Spr (Hetényi) MWF 9


3 units, Aut (Steele) MWF 1:15


3 units, Win (Steele) MWF 1:15


3 units, Spr (Steele) TTh 11:00-12:15, alternate years, given 1970-71

248D. Thin Shell 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 1971-72

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 1971-72

250. Thermal Effects in Structures — Heat transfer from boundary layer to surface of structure in supersonic airflow, analysis of distribution of temperature in structure. Prerequisite: Civil Engineering 114 or equivalent.

2 units, Win (Hoff) TTh 10, alternate years, given 1970-71


253A. 3 units, Win (Chao) M 3:15-4:05, W 3:15-5:05

253B. 3 units, Spr (Chao) M 3:15-4:05, W 3:15-5:05

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 1970-71

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, photographic 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, Win (——)


3 units, Win (Hetényi) TTh 2:15-4:05


3 units, Spr (DeBra) MWF 1:15

271B. Automatic Control of Space and Aerospace Vehicles—Study in further depth of the systems introduced in 271A; attitude control system design comparing modern and classical techniques. Space vehicle gyrocompassing, aircraft stability and response in three axes. Autopilot design and autolandingsystems. Prerequisite: 271A. Recommended: 200B and 278A.

3 units, Aut (DeBra) MWF 1:15


3 units, Win (Staff) TTh 11:00-12:15


3 units, Spr (Staff) TTh 11:00-12:15


275A. 3 units, Win (Lange) MWF 8, given 1971-72

275B. 3 units, Spr (Lange) MWF 8, given 1971-72


3 units, Aut (Bryson) MWF 11

back controllers in the presence of uncertainty. Prerequisite: Applied Mechanics 235A.

278C. On-Off Control Logic, Singular Optimization Problems, and Differential Games

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.

279B. Advanced Space Mechanics I—Hamilton’s principle and elements of calculus of variations; Hamilton-Jacobi Theory; canonical perturbation theory; application to non-linear oscillations; resonances affecting gravity-gradient stability; second-order perturbation of earth-satellite orbits; methods of Brouwer and Vinti; critical inclination; resonances with longitudinal harmonics; lunar and planetary orbiters. Prerequisite: 279A.

279C. Advanced Space Mechanics II—Effects of several centers of attraction; restricted three-body problem; Lagrangian libration points; Encke’s method for accurate orbit computation; orbit determination from measurements; expansion matching for lunar and interplanetary orbits; periodic solutions of restricted three-body and restricted four-body problems. Prerequisite: 279A.

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 Mechanical Engineering 131A, or consent of instructor.

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.

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.

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 284 or Electrical Engineering 141, or consent of instructor.

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 Engineering 171 or Mechanical Engineering 271A.

Simple illustrative examples. Prerequisite: familiarity with elementary electricity and magnetism and vector analysis.

3 units, Win (Chang) MWF 10


3 units, Spr (Chao, Chang) MWF 10

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

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, Chang) T9 and Th 9:00–10:40


3 units, Spr (Chao, Chang) T9 and Th 9:00–10:40


3 units, Win (Lee) TTh 11:00–12:15, alternate years, given 1971–72


3 units, Spr (Lee) MWF 10, alternate years, given 1971–72

295. Seminar in Solid Mechanics — (Enroll in Applied Mechanics 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 3:45

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 Fluid Mechanics**—(Enroll in Engineering 298.) Interdepartmental seminar on problems in all branches of fluid mechanics, with talks by visitors, faculty, and students. Graduate students may register for one unit, without letter grade; a letter grade is given for students presenting talks.

1 unit, Aut, Win, Spr (Staff) T 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 (Buneman) M 4:15

**300. Thesis**—Thesis for degree of Engineer.

2 to 15 units, any quarter (Staff) by arrangement

**301. Thesis**—Dissertation for degree of Doctor of Philosophy.

2 to 15 units, any quarter (Staff) by arrangement

### APPLIED MECHANICS


Chairman: Arthur E. Bryson

Professors: Max Anliker, Arthur E. Bryson, George Herrmann, Miklós Hetényi, Thomas R. Kane, Erastus H. Lee, John R. Spreiter

Assistant Professor: David M. Barnett

Affiliated Faculty


Associate Professors: Byrne Perry, Robert L. Street (on leave 1970–71)

### Offerings and Facilities

Provisions are available for one, two, or three years of advanced training in solid and fluid mechanics, dynamics, automatic control, and biomechanics leading to career opportunities in industrial and governmental research establishments, in technical development in industry, and in 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; analysis, synthesis, and control of systems; flow dynamics of liquids and gases; and biomechanics.

### 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 curricula of the Departments of Civil and Mechanical Engineering.

#### Master of Science

The University's basic requirements for the Master's degree are discussed in the sec-
tion "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 four areas: (1) Advanced Dynamics, (2) Elasticity and Plasticity, (3) Fluid Mechanics, and (4) Mathematics. Students wishing to specialize in Automatic Control may substitute approved courses in that area for one of the areas (2) and (3). Similarly, students wishing to specialize in the Mechanical Behavior of Materials may substitute courses in Materials Science for one of the areas (1) and (3). 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 needed 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 3.0 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 Department 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. Admission to candidacy for the Ph.D. degree in Applied Mechanics (in contrast to admission to graduate standing in the University) requires (a) demonstration of reading proficiency in French, German, or Russian, (b) passing an oral examination given by the Department, and (c) approval of the complete study program by the Department. A cumulative grade point average of 3.25 in all graduate technical courses taken at Stanford is required to be admitted to the oral examinations. The language requirement can be satisfied by passing one of the courses French 10, German 10, or Russian 10 with a grade not lower than C. Credit for equivalent preparation may be requested by petition. Other languages will be considered by the Department upon petition. The oral examination is given in January and in May of each year. Students are advised to take it no later than May of their second graduate year, preferably even in May of the Master's year. An admitted candidate is then required to submit an acceptable dissertation, and to pass a final University Oral Examination. The academic year following the M.S. is normally devoted to further courses in preparation for dissertation research, reserving some time in the Winter or Spring quarter specifically for making a start on the research. 90 units beyond the M.S. degree are required; 45 of these units may be for the dissertation. All Ph.D. candidates are expected to participate in one of the following seminars: Solid Mechanics A.M. 295, Fluid Mechanics A.M. 298, Systems Theory A.M. 297, or Flight Control and Guidance A.A. 297.

**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 the Department of Applied Mechanics.

**COURSES**

**29. Biomedical Mechanics—(Enroll in Engineering 29.)** The application of mechanics to various problems in medicine is described in the context of current research in cardiovascular dynamics, respiration, sensation of motion and sound, the mechanics of bones, and other areas. Recommended for advanced undergraduates and first-year graduate students.

3 units, Spr (Anliker)

MW 7:30–8:45 p.m.

3 units, Aut (Herrmann) MWF 9


3 units, Win (Herrmann) MWF 10


203A. 3 units, Win (Chao) M 3:15-4:05 and W 3:15-5:05

203B. 3 units, Spr (Chao) M 3:15-4:05 and W 3:15-5:05

204. Advanced Theory of Elasticity—Topics from stress concentration, crack propagation, contact stress, thermal stress, instability and finite deformation, selected in relation to current research. Prerequisites: 202A, B or equivalents.

2 units, Spr (Herrmann) TTh 11


3 units, Win (Hetényi) TTh 8; 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: Civil Engineering 114 and Mathematics 130 or equivalents.

2 units, Aut (———) TTh 11, alternate years, given 1971–72

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 (———) TTh 11, alternate years, given 1971–72

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 (———) TTh 11, alternate years, given 1971–72

207. Theory of Plates—Analysis of stress, deformation in plates bent by transverse loads. Applications to circular, rectangular, other shapes. Vibrations of plates. Prerequisite: Civil Engineering 114.

3 units, Win (Hetényi) MWF 9


3 units, Spr (Hetényi) MWF 9


3 units, Aut (Lee) MWF 10


3 units, Win (Lee) 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: 202A.

3 units, Win (Lee) TTh 11:00–12:15, alternate years, given 1971–72

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. Prerequisite: 214A.

3 units, Spr (Lee) MWF 10, alternate years, given 1971–72

216A. Strength and Microstructure — (Enroll in Materials Science 205.) Mechanical properties of solids as viewed by the materials scientist or physical metallurgist. Basic aspects of dislocation theory and the role of dislocations and other defects on mechanical behavior of solids. The elastic, anelastic, and plastic properties of solids, stressing the relation between the internal structure of solids and the corresponding mechanical properties. Methods of hardening materials and mechanisms of hardening. Specific mechanical properties such as fracture, fatigue, and creep. Application of the concepts developed will be made to materials useful in technology. The course is directed towards non-materials science majors.

3 units, Aut (Sherby) TTh 11:00–12:15

216B. Fracture of Solids—(Enroll in Materials Science 238.) 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: 216A.

3 units, Win (Barnett) MWF 8


3 units, Aut (Lee) MWF 2:15


3 units, Win (Lee) MWF 2:15

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 10 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 10 and Th 9–11

223. Dynamics — Initial value problems, constraint forces and forces of interaction, impulsive motions. Momentum 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 10 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 Aeronautics and Astronautics 242B.

3 units, Spr (Kane) T 2:15–4:05 and Th 2:15, alternate years, given 1971–72


3 units, Aut (Chao) TTh 7:35–8:50

226. Kinematic Synthesis of Mechanisms—(Enroll in Mechanical Engineering 222.) The rational design of linkages is the central theme of this course. The problem of determining linkage proportions to fulfill various design requirements is treated analytically. Topics include: three- and two-dimensional displacements and motions, the theory of higher plane curves, higher-order path-
curvature analysis, circle and center-point theory. Prerequisite: Mechanical Engineering 107.

3 units, Spr (Roth) MWF 12

227. Advanced Kinematics—(Enroll in Mechanical Engineering 223.) Discussion of kinematics from both the mathematical and engineering viewpoints. Introduction to algebraic geometry. Application of matrix, tensor, and dual-quaternion methods to kinematic analysis and synthesis. A survey of current research and unsolved problems in kinematics. Prerequisite: Mechanical Engineering 222.

3 units, Aut, Win, or Spr (Roth) by arrangement


3 units, Win (Kane) W 2:15–4:05 plus one hour by arrangement, alternate years, given 1970–71


3 units, Spr (Kane) W 2:15–4:05 plus one hour by arrangement, alternate years, given 1970–71


3 units, Win (Kane) T 2:15–4:05 plus one hour by arrangement, alternate years, given 1971–72


3 units, Win (Bryson) MWF 11


3 units, Win (Bryson) MWF 11


3 units, Spr (Bryson) MWF 11

240. Space Physics—Introduction to selected topics of geophysics and astronomy with emphasis on conditions in the solar and terrestrial atmospheres, interplanetary space, and on solar-terrestrial relations. Properties of principal objects in the Solar System. Elements of gravitational theory and orbital mechanics with application to determination of density of the upper atmosphere and the shape and internal structure of the Earth. Properties, time variations, and theoretical representation and interpretation of the upper atmosphere, ionosphere, magnetic field, and magnetosphere of the Earth, the photosphere, chromosphere, the corona of the Sun, and the solar wind in interplanetary space. Theory of Motion of a charged particle in electric and magnetic fields with application to Van Allen particles and cosmic rays. Outline of the principal features of the interaction of the solar wind with the Earth and other objects in the Solar System. Prerequisites: Physics 55 and familiarity with vector analysis.

2 units, Win (Spreiter) TTh 9, alternate years, given 1970–71

3 units, Aut (Spreiter) TTh 2:15–3:30

243. Mathematical Hydro- and Aerodynamics—Continuation of 242: Introduction to mathematical analysis of effects of compressibility, rotation, and density stratification on motion of an inviscid fluid. Subsonic, transonic, and supersonic flows with application to nozzles, the solar wind, thin wings, and slender bodies. Reciprocity and flow reversal theorems of acoustics and linearized compressible flow. Equilibrium, stability, wave motion and flow of rotating and stratified fluids with applications to problems of engineering, geophysical, and astronomical interest. Prerequisite: 242.

3 units, Win (Spreiter) TTh 2:15–3:30


3 units, Spr (Spreiter) TTh 2:15–3:30


2 units, Spr (Spreiter) TTh 9, alternate years, given 1971–72

248. Geophysical Fluid Dynamics—Introduction to fluid flow and wave phenomena in the atmosphere, oceans, and interior of the Earth, and their mathematical representation. Effects of rotation, stratification, gravity, and electromagnetic forces. Application to general circulation, mountain lee waves, and Rossby waves in the atmosphere, surface and internal gravity waves and wind-driven circulation of the oceans, hydromagnetic dynamo processes in the liquid core, and possible slow convection of the "solid" mantle of the Earth. Prerequisite: 243.

2 units, Spr (Spreiter) TTh 9, alternate years, given 1970–71

249. Interplanetary Gasdynamics—Review of observations supporting the use of continuum fluid models to represent conditions in the interplanetary medium. Physical concepts, equations, and fundamental properties of solutions for hydromagnetic flow, waves, and discontinuities of finite amplitude including shock waves. Theory of spherically symmetric steady solar wind, and its interaction with the Earth, Moon, planets, comets, and the interstellar medium. Transient effects and relation to geomagnetic storms and other solar-terrestrial phenomena. Prerequisites: 242 and 243.

2 units, Win (Spreiter) TTh 9, alternate years, given 1971–72


3 units, Aut (Leonard) MWF 11
251. Mathematical Methods in Applied Mechanics — Study of engineering applications leading to partial differential equations and the concept of the mathematical model. Development of characteristic properties of equations and of methods of solution based on ordinary differential equation theory. Introduction to generalized infinite series solutions, special functions, the method of characteristics and approximation theory. Prerequisite: Mathematics through 44 or equivalent, or consent of instructor.

3 units, Win (Leonard) MWF 8


3 units, Spr (Street) TTh 8 and one hour by arrangement, given 1971-72


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.

1 unit, Aut, Win, Spr (Kane, Lee) Th 3:45

297. Seminar on the Theory of Systems—(Enroll in Electrical Engineering 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: Electrical Engineering 363A or equivalent.

1 unit, Aut, Win, Spr (Bryson, Franklin)

298. Seminar in Fluid Mechanics—(Enroll in Engineering 298.) Interdepartmental seminar on problems in all branches of fluid mechanics, with talks by visitors, faculty, and students. Graduate students may register for one unit, without letter grade; a letter grade is given for students presenting talks.

1 unit, Aut, Win, Spr (Staff) T 4:15


Aut, Win, Spr (Staff) by arrangement


Aut, Win, Spr (Staff) by arrangement

CHEMICAL ENGINEERING

Chairman: David M. Mason

Professors: Andreas Acrivos, Michel Bouard, David M. Mason, Douglass J. Wilde.

Consulting: Pierre Van Rysselberghen

Assistant Professors: John E. Lind, Jr., Robert J. Madix

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

The B.S. Chemical Engineering program, supplemented with courses in chemistry, physics, mathematics, and engineering, pro-

* The curriculum leading to the B.S. degree in Chemistry is described elsewhere in this bulletin.
vides 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 other engineering programs, or from chemistry or physics, can be made without loss of time or credit during the first three years. Transfer from mathematics, statistics, and biology during the third year can usually, but not always, be accomplished smoothly.

A balanced program of minimum requirements for graduation in 12 quarters is given below. Roman numerals refer to Engineering Breadth categories recommended.

The best time to go overseas is Spring and Summer quarters of the second and third years, but other times can also be arranged. Detailed 12 quarter overseas programs are available from Chemical Engineering advisers and from the School of Engineering office.

### First Year

<table>
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<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
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<tbody>
<tr>
<td>Math. 41, 42, 43. Analytical Geometry and Calculus</td>
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<tr>
<td>Physics 51, 52, 53, 54. Mechanics and Electricity</td>
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<tr>
<td>Humanities and Social Sciences</td>
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### Second Year

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<tr>
<td>Chem. 4, 5. Chemistry</td>
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<tr>
<td>Engr. Breadth II</td>
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<td>Engr. Breadth V</td>
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<td>Math. 24 or 44. Calculus</td>
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<td>Physics 55, 56. Light and Heat</td>
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<td>Stat. 27. Introduction to Probability Theory or Stat. 118. Theory of Probability</td>
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<tr>
<td>Electives* and Humanities and Social Sciences</td>
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* Recommended elective: Math 130 (Win).

### Third Year

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<tbody>
<tr>
<td>Ch.E. 12. Chemical Computations</td>
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<tr>
<td>Ch.E. 115C. Unit Operations: separation processes</td>
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<tr>
<td>Ch.E. 116C. Unit Operations Laboratory</td>
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### Fourth Year

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<tr>
<td>Ch.E. 116D. Special Projects Laboratory</td>
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<tr>
<td>Ch.E. 160. Process Design or Ch.E. 190. Research</td>
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<td>Engr. Breadth IV</td>
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<tr>
<td>Chem. 122, 123. Organic Chemistry and Laboratory</td>
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<tr>
<td>Engr. Breadth IV</td>
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<tr>
<td>Electives*</td>
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* The total of 42 elective units must include 2 of the following courses: Ch.E. 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, Chemical Engineering 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, Chemical Engineering 290, is normally taken by the M.S. candidate. Although no formal thesis is required, satisfactory completion of Chemical Engineering 290 involves a formal written discourse which must be approved by the research adviser and graduate com-
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 February 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

12. Chemical Computations — Stoichiometry of chemical production. Prerequisite: college calculus, physics, and chemistry.

2 units, Aut (Wilde) TTh 1

102. Optimization—(Enroll in Engineering 102.) Mathematical ways of finding the best values of design, decision, or operating variables. Nonlinear and polynomial optimization under constraint. Direct optimum-seeking methods. Dynamic programming and partial optimization of large systems. Prerequisite: elementary differential calculus.

3 units, Win (Wilde) MWF 11

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. Prerequisite: Calculus and physics.

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. Prerequisite: 115A or equivalent.

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 multistage extraction and distillation processes, simplified graphical and computer design
methods; chromatographic separations, thermal diffusion, reverse osmosis, zone refining. Prerequisite: 120 or equivalent.

3 units, Spr (Acrivos) MWF 9

116A. Fluid Mechanics Laboratory — Experiments in fluid mechanics. To be taken concurrently with 115A.
1 unit, Aut (Staff) by arrangement

116B. Heat and Mass Transfer Laboratory — Experiments in heat and mass transfer. To be taken concurrently with 115B.
1 unit, Win (Lind) by arrangement

116C. Separations Processes Laboratory — Experiments in separations processes. To be taken concurrently with 115C.
1 unit, Spr (Acrivos) by arrangement

117. 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, Win, Spr (Staff) TTh 1:15–5:00

120. Equilibrium in Thermodynamic Systems—The second law; general conditions of equilibrium in non-ideal thermodynamic systems; phase and chemical equilibrium. Applications to engineering systems. Prerequisite: a basic course in thermodynamics or the consent of instructor, Chemistry 171 or equivalent.
3 units, Win (Staff) by arrangement

3 units, Spr (Boudart) MWF 10

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. Prerequisite: 115A or equivalent.
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 non-isothermal systems; heat transfer in fluids in turbulent flow. Radiative heat transfer. Prerequisite: 130A or equivalent.
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. Prerequisite: 115A,B; Chemistry 171, 173.
3 unit, Spr (Mason) TTh 2:15

3 units, Spr (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. Prerequisite: 12, 115C.
2 units, Win (Staff) 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.
3 units, Win (Wilde) MWF 11

3 units, Aut (Staff), given 1972-73

204. 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, Win (Boudart) MWF 10

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 concentration 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)

207. Classical Thermodynamics — A rigorous formulation of classical thermodynamics, including the analysis of stability of single and multiple component systems.

3 units, Aut (Lind) MWF 10, given 1970-71

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, given 1970-71

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: 210.

3 units, Win (Acrivos) MWF 8

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. Surface Reactivity (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

298. Seminar in Fluid Mechanics—(Enroll in Engineering 298.) Interdepartmental seminar on problems in all branches of fluid mechanics, with talks by visitors, faculty, and students. Graduate students may register for one unit, without letter grade; a letter grade is given for students presenting talks.

1 unit, Aut, Win, Spr (Staff) T 4:15

CIVIL ENGINEERING

Emeriti: Wilhelm Flügge, Eugene L. Grant, Alfred S. Niles, Stephen P. Timoshenko, James B. Wells, Harry A. Williams, Dono-
van H. Young (Professors); Eugene V. Ward (Lecturer)

Chairman: James M. Gere
Vice Chairmen: Joseph B. Franzini, Robert L. Street


Associate Professors: James Douglas (on leave autumn quarter), En Y. Hsu, Paul Kruger, Henry W. Parker, Byrne Perry, Vincent J. Roggeveen, Haresh C. Shah, Robert L. Street (on leave 1970-71), William Weaver, Jr.

Assistant Professors: Kaare Höeg. Acting: James O. Leckie

Lecturers: John W. Alltucker, John A. Blume, Paul Eller, Ben C. Gerwick, Jr., Grant P. Gordon, Charles J. Heyler, Richard R. Kennedy, Robert R. Matheu, Robert W. Medearis, Bennet L. Raffin

PROGRAMS OF STUDY

The undergraduate Civil Engineering Major provides a preprofessional program stressing the fundamentals common to many special fields of civil engineering. Free elective units, plus the proper selection of courses for the requirements in Technology and Society, Mathematics, Science, and Engineering Breadth, permit the student to obtain either a broad general civil engineering education or a more specialized education in a specific branch, such as construction, environmental design, highways, hydraulics, public works administration, or structures. Laboratory facilities are available in fluid mechanics, sanitary engineering, civil engineering materials, soil mechanics, and experimental stress analysis. At least one year of graduate study is essential for the professional practice of civil engineering and is strongly recommended. Students who contemplate advanced study at Stanford should discuss their plans with their advisers early in the 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 Management

Environmental Engineering
Engineering-Economic Planning
Pollution Control
Transportation
Urban Design
Water Resources
Hydraulic Engineering
Hydromechanics
Hydrology
Nuclear Civil Engineering
Sanitary Engineering
Soil Mechanics and Foundations
Structural Engineering
Structural Mechanics

Research work under these programs is carried out in four major facilities—the hydraulics laboratory, the George Havas Building which houses water quality and sanitary engineering 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.

ENVIRONMENTAL ENGINEERING

Environmental Engineering is a broad and unique program in the Civil Engineering Department directed towards conservation and management of major resources and enhancement of the urban environment. The impact of man and his technological and economic activities on the environment is emphasized. Engineering, social, political, and economic principles of resource management and pollution control are stressed. The faculty and course offerings feature special strength in engineering-economic planning, pollution control, water resources, transportation, and urban design. Course offerings are scheduled to permit either intensive study in a single area or interrelated study between areas. Environmental Engineering seminars meet frequently and provide a broad coverage of environmental problems.

The Department welcomes applicants with backgrounds in all areas of engineering and science who are interested in applying their specialized abilities to the solution of environmental problems. Comprehensive introductory courses in each major area of study are given to provide a common basis of understanding among those with dissimilar backgrounds. Programs of study are highly flexible to allow for diversity and to
encourage the development of either intensive or broadened abilities. The Program in Engineering-Economic Planning is directed toward preparation for planning and management positions in the public works area.

DEGREES

BACHELOR OF SCIENCE

Students who major in Civil Engineering must complete the requirements for the BS degree given previously under the heading "Undergraduate Programs of Study." Suggested courses to be taken in satisfaction of the requirements in Technology and Society, Mathematics, Science, and Engineering Breadth are available from the Civil Engineering Department office or from the office of the Dean of Engineering. Free elective units may be used in any way the student desires, including additional studies in civil engineering. Because the undergraduate engineering curriculum is designed to insure breadth of study, students who intend to enter the professional practice of civil engineering must obtain their professional education at the graduate level.

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 Management, Engineering-Economic Planning, Environmental Design, Environmental Engineering, Hydraulic Engineering, Nuclear Civil Engineering, Sanitary Engineering, Soil Mechanics and Foundations, Structural Engineering, and Structural Mechanics. 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 all students desiring more graduate education than is provided by the Master's degree, especially for those 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 3.0 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 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 $6,000. In addition, several Federal Water Pollution Control Traineeships, which provide tuition plus at least $200 per month, are available for students with an interest in water pollution aspects of Environmental Engineering.

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 the 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**

40. **Elementary Surveying** — Care and use of instruments; leveling; topographic surveying; triangulation; horizontal and vertical curves; engineering astronomy.

4 units, Spr (Douglas) TTh 11; lab. TTh 1:15-5:05

107. **Mechanics of Fluids** — Dimensional analysis and principles of similarity, open channel flow, elementary hydrodynamics. Prerequisite: Engineering 21.

3 units, Aut (Hsu) MWF 8

116. **Plain Concrete**—Physical properties of concrete and its constituents. (Limited to 24 students.)

3 units, Aut (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 11 and 50, and Chemistry 4.

3 units, Win (Richards) TTh 10; lab. M 1:15-4:05

130. **Transportation Engineering**—Planning and design of all modes of transportation. Includes functions, relationships to land use, analysis of demand, choices between modes, location, design of physical facilities including interfaces, engineering economy, and concepts of operation. Interrelationships with institutional, economic, financial, environmental, and social settings.

3 units, Aut (Richards) MWF 11

131. **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

140. **Advanced Surveying** — Additional study of surveying for students who desire it.

3 or more units, Spr (Douglas) by arrangement

143. **Specifications and Contracts** — Principles of contract law as applied to civil engineering; legal problems in preparing and administering construction contracts; varieties of construction contracts; specification organization and interpretation; engineering ethics. Prerequisite: junior standing.

3 units, Aut (Oglesby) TTh 11:00-12:15 Win (Fondahl) MWF 11

144. **Construction Estimates and Costs** — Estimates, costs from viewpoint of contractor, construction engineer; details of esti-
mating, emphasis on labor, material, equipment, overhead costs.

3 units, Aut (Staff) 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 131.)

3 units, Aut (Parker) TTh 8;
lab. M 1:15–4:05
Spr (Parker) TTh 9;
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, Engineering 161.

4 units, Win (Franzini) MWF 9 and
T 2:15–4:05

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, Win (Eliassen) MWF 9
Spr (Eliassen) MWF 9

170X. Environmental Planning — Problems and issues in urban and regional planning. Resource and industrial growth potentials in new areas. Population forecasts and study of causes and effects of population migration to megalopolitan areas. Urban renewal vs. urban redevelopment. New cities and their needs—economic, social, cultural, industrial, commercial, transportation, and other engineering considerations. Land use planning. Recreation needs and their role in planning. The waste plan for urban and regional areas and the enforcement of planning by zoning and other regulations.

3 units, Spr (Eliassen and Staff) MWF 11


3 units, Win (Staff) MWF 9

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 29 or 57.

3 units, Win (P. Kruger) TTh 11

175. Radiation Measurements Laboratory — (Enroll in Engineering 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 (Staff) and lab. one afternoon by arrangement

177. Radioactivation Analysis — (Enroll in Engineering 177.) 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.

3 units, Spr (P. Kruger) TTh 1:15 and
lab. one hour by arrangement

178. 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 29, or equivalent with consent of instructor.

3 units, Aut (P. Kruger) TTh 11

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 11.

4 units, Aut (Staff) 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, Win (Staff) MWF 10

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, Spr (Staff) MWF 10

190. Soil Mechanics and Foundations—Fundamentals of soil mechanics; principle of effective stress; seepage; settlements and slope stability; application of soil mechanics to foundation design. Course includes design-type laboratory projects. Prerequisite: Engineering 11.

4 units, Aut (Hoeg) MWF 9 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, Win (Douglas, Staff) TTh 1:15–2:05 plus two hours by arrangement

198. Senior Report—Practice in execution of a simple engineering investigation, preparation of a written report on the investigation. Required of all candidates for the Bachelor’s degree who do not take 197. Must be taken during either of the last two quarters before graduation.

1 unit, Win, Spr (Staff) by arrangement

199. Directed Reading and Special Studies in Civil Engineering—Open to senior students by consent.

1 or more units, any quarter (Staff) by arrangement

COURSES PRIMARILY FOR GRADUATE STUDENTS

205. Environmental Fluid Mechanics — Principles and engineering applications. Review of hydraulics of pipelines and equations of fluid motion, plus selected topics from the following list: Dynamics of estuaries—tides, river inflows, diffusion of saltwater and wastes; study of ocean outfalls—pipeline manifolds, jet diffusion, the ocean environ-

ment; hydraulic models—fluid mechanics and diffusion modelling parameters, study of actual models; water distribution systems—pipeline network analyses; thermal pollution—examples, principles, and laboratory demonstrations for air and water. Course includes basic theory, study of real cases, applications using numerical computations. Prerequisites: fundamental knowledge of fluid mechanics (e.g., Engineering 21), basic science background (e.g., B.S. degree), basic computational ability, or consent of instructor.

4 units, Win (Staff) TTh 1:15–3:05

207. Open Channel Hydraulics and Sedimentation Problems — Uniform, gradually-varied, and rapidly-varied flow in engineered channels; hydraulic jump, channel transitions. Gravity flow systems for waste water removal. Erosion, transport and deposition of sediment. Regimen of rivers, design of stable channels, reservoir sedimentation. Environmental effects of watershed management and engineering control works. Prerequisite: 107 or equivalent.

4 units, Spr (Franzini) MWF 9 and W 2:15–4:05


3 units, Win (Hetényi) TTh 1:15–2:05 plus two hours by arrangement


3 to 6 units, Spr (Hetényi) by arrangement

216. Mechanical Properties of Materials—Elastic, inelastic behavior of structural materials; yield criteria; material damping; viscoelastic behavior; creep; rheological models. Effects of internal structure on properties. Prerequisite: 114 or equivalent.

3 units, Spr (Richards) TTh 10 and one lab. by arrangement

218. Building Materials Seminar—Discussion of research problems in building materials. Prerequisite: consent of instructor.

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: graduate standing.
   3 units, Spr (Linsley) TF 2:15–3:30

   3 units, Spr (Roggeveen) MWF 10

225. Institutional Setting of Public Works—The roles and interactions of all institutional factors affecting public works. Government, including organization, legislation, and operation at the federal, state, and local levels. Interest groups, technical experts, and the public.
   3 units, Win (Roggeveen) TTh 11:00–12:15

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, Aut (Staff) T 1:15–3:05 and one hour by arrangement

229. Problems in Engineering Economy — Independent study or research of a selected problem in engineering economy of public utilities or public works. Prerequisite: Engineering 161 or Industrial Engineering 229, and consent of instructor.
   2 or more units, Aut, Win, Spr (Staff) by arrangement

230. Transportation Planning — Selected topics, depending on student interests, related to planning and design of all modes of transportation. Includes functions, relationships to land use, analysis of demand, choices between modes, location, design of physical facilities including interfaces, engineering economy, and concepts of operation. Interrelationships with institutional, economic, financial, environmental, and social settings. Prerequisite: graduate standing.
   3 units, Spr (Roggeveen) MWF 1:15

231. Highway Planning — A study of the decision process in highway planning as influenced by engineering, economic, political and social problems. Prerequisite: Engineering-Economic Systems 211 or consent of instructor.
   3 units, Spr (Oglesby) MWF 9

232. Transportation Problems — Individual investigation. Prerequisite: 150 or equivalent, and consent of instructor.
   2 or more units, Aut, Win, Spr (Staff) 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. Prerequisite: graduate standing.
   3 to 4 units, Win (Shah) TTh 9 and W 1:15–2:05

236. Stochastic Processes and Decision Statistics for Civil Engineers—Description of stochastic processes; transportation models; hydrologic models; structural dynamics models; harmonic analysis of stochastic processes; application of Markov chain models to civil engineering problems; statistical decision theory; Bayes’ theorem; utility functions; optimization of decisions under uncertainties; economic analysis; system analysis. Prerequisites: a course in statistics and 233.
   4 units, Spr (Shah) MWF 10 and one hour by arrangement

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. Spe...
CIVIL ENGINEERING

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 and computer programming.

3 units, Win (Douglas) TTh 9 and T 10

243. Construction Administration — Business and management aspects of construction: licensing, bonding, insurance, financing, labor relations, legal problems, and cost control. Prerequisites: 143, 144, and 145.

4 units, Win (Fondahl) MWF 9 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

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: 143 and 144. Graduate standing in construction option.

3 units, Spr (Staff) by arrangement

247. Problems in Land Development—Study of the interrelationships between marketing research, land development, engineering feasibility studies and financial planning as it involves land acquisitions and land development up to the time of construction. Enrollment limited to 15. Prerequisites: graduate standing and consent of the instructor.

2 units, Spr (Medearis) M 7:30-8:50 a.m.

248. Human Factors in Construction and Engineering Management—Seminar dealing with the problems of working and communicating with individuals and groups. Enrollment limited to 15 students per section with preference to those from the graduate construction and Engineering Economic Planning Programs.

2 units, Win (Oglesby) TW 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 (Fondahl) by arrangement

252. A Seminar on Legal Problems in Construction—Introduction to legal analysis of construction disputes through selected case study of California Public Works Law; documentation and preparation of claims; attorney-contractor relationship. Prerequisite: graduate standing.

1 unit, Spr (Heyler) F 8

253. Seminar in Marine and Foundation Construction—Using the case method, the following subjects will be covered: the design and construction of large, difficult foundations, heavy marine works and foundations, and precast and prestressed concrete projects. Prerequisite: graduate standing and consent of instructor.

1 unit, Win (Gerwick) by arrangement

254. Construction with Nuclear Explosions—Applications of the geonuclear effects of
nuclear explosions for civil construction. Technical design, safety evaluation, and economic analysis for construction of railroad and highway passes, navigational channels, canals and harbors, dams, water resources development, and other large construction works. Prerequisite: 277.

2 units, Spr (Parker, P. Kruger) TTh 11

255. Applications of Underground Nuclear Explosions—(Enroll in Mineral Engineering 278.) Applications of the geonuclear effects of nuclear explosions for the geological industries. Technical design, safety evaluation, and economic analysis for stimulation of oil and gas production, storage facilities, mineral recovery and in-situ mining processes, oil-shale retorting, water resource development, and geothermal effects. Prerequisite: 277 or consent of instructor.

2 units, Spr (P. Kruger, Staff, and Visiting Lecturers) TTh 10

260A,B,C. Advanced Hydrology — Engineering hydrology as applied to water project planning, illustrated by hydrologic analysis of an actual project. Covers meteorology, hydrologic data, precipitation, evapotranspiration, streamflow, runoff relationships, unit hydrographs, flood routing, frequency analysis and computer simulation. The relation of hydrology to project purposes and economic analysis is considered. Course is continuous for three quarters.

4 units, Aut (Staff) MWF 9; lab. Th 1:15-4:05
4 units, Win (Linsley) MWF 10; lab. T 1:15-4:05
4 units, Spr (Linsley) TTh 10; lab. by arrangement

261. 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, Spr (P. Kruger) TTh 9 and W 1:15

264. Ocean and Coastline Engineering—Fundamentals of ocean waves and their relation to engineering along the coastline and on the continental shelf. Water wave generation, seismic sea waves, coastal processes, and pollution. Effects of waves on structures. Consideration of hydraulic models, computer simulation, and the design of ocean outfalls, offshore towers, and floating platforms, breakwaters, protection against coastal erosion, etc. Prerequisite: knowledge of fundamental concepts of fluid mechanics and computer programming, or consent of instructor.

3 units, Spr (Hsu) MWF 11


4 units, Aut (Perry) MTThF 10

266. Engineering Hydrology — The hydrologic cycle; runoff relations, unit hydrographs, flood routing, frequency analysis, probabilistic yield determinations. Application to typical water-resources planning problems.

4 units, Aut (Franzini) MWF 9; lab. W 2:15-4:05

269. Water-Resources Engineering Seminar —Discussions on all phases of water-resources engineering including reports on current research at Stanford.

1 unit, Win (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 (Leckie, McCarty) 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 (McCarty, Leckie) MWF 9

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 (Leckie) TTh 8; lab. M 1:15-4:05
274. Water Resources Microbiology—Fundamental aspects of microbiology and biochemistry as related to stream pollution and water quality control; the ecology of streams, lakes, and other water resources; kinetics and energetics of microbial growth; identification and control of microorganisms in water and wastes. Prerequisite: 273.

3 units, Win (McCarty) TTh 10; lab. W 1:15–4:05

275A. Water Quality Control Processes I—Laboratory and pilot plant studies of physical and chemical processes for the treatment of water and wastewaters. Prerequisites: 270 and 273.

3 units, Win (Leckie) M 1:15–5:05 and Th 1:15–4:05

275B. Water Quality Control Processes II—Laboratory and pilot plant studies of biological processes for the treatment of water and wastewaters. Prerequisites: 271 and 274.

3 units, Spr (McCarty) M 1:15–5:05 and Th 1:15–4:05

276. Water Quality in Water Resource Development—Effects of organic, nutrient, and thermal pollution on the ecology and chemical quality of streams, lakes, reservoirs, and estuaries; cause and control of eutrophication; in-place control of natural water quality; quality requirements for various beneficial uses.

3 units, Spr (McCarty) TTh 8 and one hour by arrangement


3 units, Win (P. Kruger) MWF 11

279. Environmental Engineering Seminar—Discussions on all phases of environmental engineering including reports on current research at Stanford.

1 unit, Win, Spr (Staff) W 4:15–6:05

281. Matrix Analysis of Structures—Analysis of statically and kinematically indeterminate structures by the flexibility and stiffness methods; energy and work principles; deflection of structures. Prerequisites: mechanics of materials and elementary matrix algebra.

3 units, Aut (Gere) MWF 11

282. Computer Programming for Structural Analysis and Design—Continuation of 281: Emphasis on the stiffness method of analysis, including programming for a digital computer; analysis of large frameworks by band-matrix and substructures techniques; automated design of framed structures. Prerequisite: 281.

3 units, Win (Weaver) MWF 11


3 units, Spr (Weaver) MWF 11

285. Advanced Structural Design—Design of various types of structures (buildings, auditoriums, bridges, etc.) in steel, concrete, and timber; use of structural models; general aspects of design; lateral load analysis and design; and related design problems. Prerequisite: 182.

4 units, Aut (Staff) TTh 9; lab. W 1:15–4:05


4 units, Win (Visitor) TTh 10; lab. W 2:15–5:05

290. Soil Mechanics—Re-examination of basic principles with emphasis on mechanics; application of theory; stress-strain relations and shear strength; stress distribution; limit theorems of plasticity. Undergraduates may enroll in this course. Prerequisite: 190.

3 units, Win (Höeg) TTh 11 and M 4:15

291. Foundations—Types and characteristics of foundations; design criteria; soil exploration; improvement of soil to support structures; shallow and deep foundations; earth retaining structures; earthquake effects; field instrumentation; case studies. Undergraduates may enroll in this course. Prerequisite: 190.

3 units, Win (Höeg) MWF 10

292. Earth Structures—Earth dams, embankments and natural slopes; site investigation; soil properties and compaction; seepage control; stability; earthquake effects; performance observation. Prerequisite: 190.

3 units, Spr (Höeg) TTh 9 and one hour by arrangement
293. Experimental Soil Mechanics — Laboratory testing and model experiments. Topics selected to suit individual or class interest.

1 to 2 units, Spr (Hoeg) by arrangement

294. Special Problems in Soil Mechanics — Directed individual research with emphasis on theoretical soil mechanics; application of computer techniques like finite element analysis. Open by consent only.

2 units, Aut, Spr (Hoeg) by arrangement

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, Spr (Douglas) TTh 10 and F 1:15-4:05

296A. Structural Dynamics — Vibration and dynamic response of simple structures to periodic and impulsive loadings; techniques for dynamic analysis of linear and nonlinear systems. Prerequisites: 180 or 280, and Engineering 12.

3 units, Win (Weaver) MWF 9

296B. Matrix Theory of Structural Dynamics — Vibration and dynamic response of complex structures using matrix methods for linear and nonlinear analysis, including programming for a digital computer. Prerequisites: 282 and 296A.

3 units, Spr (Weaver) MWF 9

297. Random Processes and Harmonic Analysis — Random functions and their linear transformations; random forces upon linear systems with lumped constants; role of random functions in engineering; linear and non-linear problems in the theory of random processes. Prerequisite: 233.

3 units, Win (Shah) TTh 11:00-12:15

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 in Civil Engineering — Directed study for graduate students on subject of mutual interest to student and faculty member. Student must find faculty sponsor.

1 to 3 units, any quarter (Staff) by arrangement

299A. Predoctoral Seminar — Required of all post-Master's students to serve as orientation to the selection of a research topic.

1 unit, Aut (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


2 units, Aut (Hetényi) TTh 10

397. Random Vibrations — Characterization and transmission of random vibrations; failures due to random vibrations; multi-degree of freedom systems; non-stationary random inputs and response; nonlinear systems; earthquake-type loads. Prerequisite: 296A or equivalent.

3 units, Spr (Shah) TTh 11:00-12:15

398. Seminar in Fluid Mechanics — (Enroll in Engineering 298.) Interdepartmental seminar on problems in all branches of fluid mechanics, with talks by visitors, faculty, and students. Graduate students may register for one unit, without letter grade; a letter grade is given for students presenting talks.

1 unit, Aut, Win, Spr (Staff) T 4:15

399. Advanced Engineering Problems — Individual projects on selected topics. Provides for independent graduate work under the direction of a faculty member on a subject of mutual interest. Student must find faculty sponsor. A written report is usually required.

1 to 5 units, any quarter (Staff) by arrangement
DIVISION OF ARCHITECTURE

Director: Victor Thompson
Associate Director: John Worsley
Professor: Victor Thompson


OFFERINGS AND FACILITIES

Two programs of study are offered by the Division of Architecture: (1) a pre-professional program at the undergraduate level, (2) a graduate program in architecture and environmental design.

The undergraduate program is concerned with providing the student with the opportunity to acquire a broad educational background while receiving basic training in architecture and environmental design. The graduate program provides the opportunity for the student to pursue his interest either in architecture or environmental design to some degree of depth. A unique aspect of the educational program is the internship series of courses. These courses assign the students to the offices of architects and planners for research, investigation, and reporting. This experience is made possible by the Santa Clara Valley Chapter of the American Institute of Architects. A.I.A. members serve as mentors to the students, placing them in offices and conducting a weekly seminar on office assignments. Facilities include individually assigned drafting space, lecture room, seminar room, and offices. A small reference library is maintained in the Division office. The Art library and the Engineering library share a well-supplied collection of books on architecture and environmental design.

PROGRAMS OF STUDY

BACHELOR OF ARTS

The undergraduate study program provides a broad range of courses including art, humanities, sciences, mathematics, and engineering, in addition to basic courses in architecture and environmental design. Each student must satisfy the University's requirement of two courses in writing, three courses in humanities and fine arts, and three courses in social sciences. Each student must also complete 21 units of mathematics, 24 units of science, 30 units of engineering breadth and two courses in technology and society (see listing under School of Engineering).

Required Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tr>
<td>Architecture 71, 72, 73, 171</td>
<td>13</td>
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<tr>
<td>Environmental Design 42, 143</td>
<td>7</td>
</tr>
<tr>
<td>Art 5, 60</td>
<td>6</td>
</tr>
<tr>
<td>Civil Engineering 20, 170, 180</td>
<td>10</td>
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<tr>
<td>Free electives (typically 30-40 units) to bring total to 180 units.</td>
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MASTER OF ARCHITECTURE

A course of study which prepares the student for the practice of architecture. In addition to the required courses, each student will select 15 units for minor specialization from urban 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 equivalent. Candidates will be accepted for this degree for 1970-71 only if they can be admitted with advanced standing into the program and complete it with no more than 45 units of credit.

Required Courses

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<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>Architecture 286 and 30 units of architecture courses</td>
<td>32</td>
</tr>
<tr>
<td>Environmental Design 291, 292, 293, 395, 396A,B,C, 401, 402</td>
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<tr>
<td>Minor Specialization—15 units from Urban Design, Construction Engineering, Structural Engineering, Product Design.</td>
<td>30</td>
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</tbody>
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COURSES IN ARCHITECTURE

71. Introduction to Architecture—Lectures, laboratory work, and projects. Emphasis on
design theories, form determinants and the architect in society.

3 units, Aut (Worsley) MW 9–12

72. Graphics—Laboratory work in drawing. Conventions and symbols for architect and planner.

3 units, Win (Thompson) TTh 9–12

73. Introduction to Technology—Lectures, laboratory work introducing the student to basic technological concepts. Physical properties of materials, statics, and solution of simple trusses, stress analysis, shear and moment diagrams, beam arch and trussed structures. Models built and tested which stress an intuitive approach. Building equipment.

4 units, Spr (Worsley, Hammond, Coddington) MW 8–11, Th 7–9 p.m.

171. Building Design—Case study projects involving the design process, programming, schematics, and presentation drawings.

4 units, Win (Worsley) MW 9–12


2 units, Win (B. Clark) W 11 and F 9–12

**COURSES IN ENVIRONMENTAL DESIGN**

42. Introduction to Environmental Design—History and theories of city and regional planning. Legal background. Case study projects in physical planning.

3 units, Aut (Thompson) TTh 9–12

143. Site and Landscape Design—Grading, drainage, topography, landscape and plant materials.

3 units, Spr (Thompson) TTh 9–12

270. Independent Study.

Aut, Win, Spr (Staff) by arrangement

291. Internship I.

2 units, Aut (A.I.A. Mentor)
W 7–9 p.m. and F 1:15–5:05

292. Internship II.

2 units, Win (A.I.A. Mentor)
W 7–9 p.m. and F 1:15–5:05

293. Internship III.

2 units, Spr (A.I.A. Mentor)
W 7–9 p.m. and F 1:15–5:05

395. Urban Design—Case study projects and field trips.

5 units, Aut (Thompson) TTh 1:15–4:05

396. Environmental Design Research I—Case study project involving actual environmental design problem. A multi-disciplinary course open to a limited number of graduate students in architecture, business administration, engineering, law, and others.

3 units, Aut (Worsley) MW 2:15–4:05

397. Environmental Design Research II—3 units, Win (Thompson) TTh 1:15–4:05

398. Environmental Design Research III—3 units, Spr (Worsley) MW 1:15–4:05

401. Master's Project I—Independent case study project selected by the student. Weekly discussions and individual criticism.

5 units, Win (Worsley) MW 1:15–4:05

402. Master's Project II—Continuation of 401.

5 units, Spr (Thompson) TTh 1:15–4:05

Stanford Environmental Design Research Group—Membership in this research group is available to both laymen and professionals who wish to participate in the multi-disciplinary courses, 396, 397, 398, Environmental Design Research. For further information consult the faculty member in charge.

**ELECTRICAL ENGINEERING**

Emeriti: Leland H. Brown, Joseph S. Carroll, Gerald L. Pearson, Frederick E. Terman (Professors)


Associate Chairmen: Ralph J. Smith, James B. Angell

Assistant Chairman: William R. Kincheloe

Siegman, Hugh H. Skilling, Ralph J. Smith, William E. Spicer, David F. Tuttle, Jr., Oswald G. Villard, Jr., Alan T. Waterman, Jr., Robert L. White, Bernard Widrow


Lecturers: Arnold L. Bloom, Earl D. Crockett, Marcian E. Hoff, Panos A. Ligomenides, Patrick E. Mantey, Robert Nowak, Harold E. Puthoff, Phillip J. Salsbury, Joel E. Schindall, Kensall D. Wise

Instructors: Frederick W. Clegg, Cristy M. Schade, Lawrence E. Sweeney. Acting: Otis L. Frost

PROGRAMS OF STUDY

UNDERGRADUATE

Students desiring to specialize in Electrical Engineering during their undergraduate period may do so by following the depth sequence given earlier in the general discussion of the School of Engineering. Interdisciplinary Majors providing work in electrical engineering with study in another department are available. Attention is also called to the Applied Science, and Technology and Society programs in the same general section. Note that it is possible for a Stanford undergraduate to work simultaneously toward the B.S. and M.S. degrees. Information on this program is available in the Office of the Dean of the School of Engineering.

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 an understanding of the relation between technology and man. 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 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
- Computer Systems
- Electromagnetic Theory and Microwaves
- Electronic Circuits and Devices
- Information Systems
- 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 Chairman, 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 for teaching on the junior college level, 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 should be done as soon as possible and must be 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. Enough additional units of electrical engineering courses so that items 1 through 3 total at least 21 units of graded electrical engineering courses numbered above 200, including at least 9 units of such courses numbered 300 or 400. Some 700 level summer courses may also be considered for inclusion in the M.S. Program.

4. At least three courses in departments other than electrical engineering.

5. At least three quarters of 201, 200 Seminar, unless there is a schedule conflict, with the total amount of plus credits, including 201, 200, not to exceed 6 units in the basic 42 units.

6. Additional courses, such as undergraduate electrical engineering 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 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 described 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. Approval of formal application will normally be dependent on completion of courses at Stanford with a satisfactorily high record.

**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 Departmental 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 satisfying the foreign language requirement. (See 3 below.)

Not later than the first autumn quarter after receiving the Master of Science degree the applicant 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) a written foreign language examination, or an approved foreign language course, or an approved 9-unit sequence of course work in the Humanities or Social Sciences; (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 student 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.
Special Programs

Computer Engineering — The degree of Master of Science in “Electrical Engineering: Computer Engineering” may be conferred upon students who wish to develop a competence in the design of substantial software-hardware computer systems. This degree will be administered by the Committee on Computer Engineering, composed of faculty from the Electrical Engineering and Computer Science Departments. Present members include Thomas H. Bredt, Edward S. Davidson, Jerome A. Feldman, Gene H. Golub, and Edward J. McCluskey, Chairman.

A student should indicate his preference for this degree at the time he applies for admission. His proposed program should show 42 units of work, at least 36 of which must be graded. These will normally come from the following courses: Computer Science 135 Numerical Methods (or both Computer Science 137 and 138 Numerical Analysis), Computer Science 109 Assembly Language Programming, Electrical Engineering 181 Introduction to Computer Organization, Electrical Engineering 182 Digital Computer Organization (or both Electrical Engineering 281 Theory of Switching and 282 Logic Design), Electrical Engineering 286A, B Systems Programming, Computer Science 144A Data Structures, Electrical Engineering 386 Operating Systems, Computer Science 206 Computing with Symbolic Expressions, Computer Science 150 Introduction to Combinatorial Theory (or Computer Science 155 Concrete Mathematics, or some course in discrete mathematics), Operations Research 252 Operations Research, Computer Science 298 Software Engineering Laboratory (or six units of Computer Science 293 Computer Laboratory or six units of Electrical Engineering 390 Special Studies), and Electrical Engineering 380 Seminar on Digital Systems.

This program is open to students with a scientific bachelor’s degree (a B. S. in Engineering, Mathematics, Statistics, or Physics); or with a degree having a mathematical background (courses in calculus, a knowledge of linear algebra, and probability). Some knowledge of programming will be required.

Students requiring remedial help for an inadequate background in programming should enroll in the basic programming course, Computer Science 106, during the summer quarter preceding entrance into this program. Mathematics 113, Linear Algebra and Matrix Theory, and Statistics 116, Probability Theory, or their equivalents, may be taken while the student is a candidate; however, credits for these courses will not count towards the units necessary for this degree.

The Computer Engineering program will begin in autumn quarter each year to enable a full-time student to complete the degree in one academic year. Honors Cooperative students should be able to complete the program in two normal academic years plus one summer quarter.

The degree of Master of Science in “Electrical Engineering: Computer Engineering” is intended as a terminal degree. Students who plan to be candidates for the Ph.D. degree are advised to enroll in the regular Master of Science in Electrical Engineering program.

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 distinction “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.

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.

For further information, the student should read the bulletin entry on “Engineering in Biology and Medicine,” noting especially the data on Information Processing in Biological Systems, Information Processing for Biomedical Systems, and Integrated Circuitry for Medical Electronics.

**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 awards should be addressed to Associate Chairman, 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)
- Tropospheric Propagation: Microwave, Optical, and Acoustic

**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
- Applications to Medical Electronics

**Plasmas**

- Plasma Waves and Instabilities
- Plasma Heating and Turbulence
- Computer Simulation
- Geophysical and Astrophysical Plasmas

**Quantum Electronics**

- Laser Devices and Laser Physics
- Nonlinear Optical Effects: Raman Lasers, Optical Parametric Amplifiers
- Laser Applications
- Holography

**Microwave Physics and Electronics**

- Microwave Acoustics
- Microwave Semiconductor Devices
- Solid State Plasmas
- Nonlinear and Parametric Devices
- Magnetoacoustic and Acoustooptic Phenomena

**Information Systems**

- Statistical Communication Theory
- Pattern Recognition
Control Theory and Optimization
Imaging Systems and Optical Data Processing
Microsystems
Adaptive Systems
Real-Time Computer Applications
Biological Systems Applications
Network Theory

DIGITAL SYSTEMS
Switching Theory
Fault Detection and Diagnosis
Logic Design
Computer Organization

COURSE NUMBERING SYSTEM
Electrical engineering courses are numbered according to the year in which the courses are normally taken:

0–99 first or second year
100–199 third or fourth year
200–299 mezzanine courses for advanced undergraduates or graduates
300–399 first graduate year
400–499 second or third graduate year
700–799 special summer courses

COURSES FOR UNDERGRADUATE STUDENTS
Attention is called to courses listed under "Engineering" starting on Page 82 that may be of special interest to Electrical Engineering undergraduates.

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. The use of 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, Mathematics 44, ability to use digital computation facilities, or consent of instructor.

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. Prerequisites: 101 (or, by consent, Engineering 104 plus supplementary reading).

3 units, Win (——) MWF 10
Spr (——) MWF 8


3 units, Aut (——) MWF 9
Spr (——) MWF 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 MOS and bipolar 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 101 (or consent of 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, 122. Laboratory — Circuit design and measurement techniques for circuits, and electronic devices, supplementing lectures in 101, 102, 103 and 111, 112, 113. Normally taken by Electrical Engineering students in third year. Prerequisite for 121: prior or concurrent registration in 111. Prerequisites for 122: 121 and prior or concurrent registration in 113.

121. 2 units, Win (——) Th 1:15 and
3-hour lab. weekly by arrangement

122. 2 units, Aut, Spr (——) T 1:15 and
3-hour lab. weekly by arrangement
126A. **Electronic and Microwave Measurements** — Laboratory experiments selected from: Measurements of frequency, spectra, distortion, and circuit components at radio and microwave frequencies; power sources, modulation; crystal and bolometer characteristics and their use in standing wave detectors and power meters; resonators and radiation. Normally taken in fourth year. Supplements lectures in 143, 276, and 278. Prerequisites: 113, 122, and 142 (142 may be taken concurrently).

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, computation of fields, magnetostatics, dielectric and magnetic media, time-varying fields, Maxwell's equations, plane waves. Prerequisite: Engineering 41.

3 units, Aut (-----) MWF 8
Win (-----) MWF 9

142. **Electromagnetic Waves** — Continuation of 141. Plane waves in conducting and non-conducting media, reflection and refraction, guided waves and transmission lines, standing waves, radiation. Prerequisites: 141 and 103 (103 may be taken concurrently).

3 units, Win (-----) MWF 8
Spr (-----) MWF 9

143. **Electromagnetic Propagation** — Continuation of 141 and/or 142. Antennas, propagation in non-homogeneous media, troposphere and ionosphere, plasmas, diffraction, holography, acoustic interactions. Prerequisite: 141. Recommended: 142.

3 units, Spr (-----) MWF 8

146. **Electromechanics** — Energy transfer between electrical and mechanical forms.

Electrical and electronic systems are commonly terminated in electromechanical devices in which electrical energy is transformed to mechanical energy; the principles of such energy transfer are presented, with emphasis on dynamic conditions. The theory is illustrated by practical devices such as microphones, speakers, magnets, solenoids, print-outs, motors and generators, including automatic control devices. Elementary Laplace transforms are used. Prerequisite: Engineering 42.

3 units, Aut (-----) MWF 9

179. **Electronic Systems Engineering** — Projects selected 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 (-----)

181. **Introduction to Computer Organization, Machine and Assembly Languages** — (Enroll in Computer Science 111.)


3 units, Aut (McCluskey) MWF 9
Win (Davidson) MWF 9

190. **Special Studies or Projects in Electrical Engineering** — Independent work under the direction of a faculty member for which no letter grade is given. Individual or team activities involving laboratory experimentation, design of devices or systems, or directed reading.

By arrangement

191. **Special Studies and Reports in Electrical Engineering** — Independent work under the direction of a faculty member; a written report or a written examination is required and a letter grade is given. If a letter grade
based on written work is not appropriate, student should enroll in 190.

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 201 A,B,C (see description below) open to students holding assistantships and registering under limited tuition grants.

200A. 0 units, Aut (Kincheloe, Staff)
200B. 0 units, Win (Kincheloe, Staff)
200C. 0 units, Spr (Kincheloe, Staff)

201 A,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 (Kincheloe, Staff)
201B. 1 unit, Win (Kincheloe, Staff)
201C. 1 unit, Spr (Kincheloe, Staff)

202. Medical Electronics—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) W 4:15-6:05

204. Introduction to Brain Theory — A slightly mathematical introduction to the use of information processing devices as metaphors to aid our understanding of brain function. The role of internal models in memory and perception. Survey of Gross neuroanatomy. Computation in neural nets. Parallel computation, interpreters, and hierarchical programs, and their relation to perception, memory, and the control of movement. (Students who continue with 204 are encouraged to undertake a project to be graded at the end of the second quarter.)

3 units, Aut (Arbib) TTh 9:25–10:40

206. Man-Machine Systems—Those systems that require a quantitative analysis of the human component in the system. Emphasis on quantitative modeling of this human component, especially human decision-making. Specific system areas considered include: manual control, monitoring, decision-making, automated instruction, and medical diagnosis. The importance of this area to future systems. Presentation augmented by classroom experiments. Prerequisite: Engineering-Economic Systems 221 or consent of instructor. Recommended: familiarity with transforms.

3 units, Aut (Smallwood) TTh 2:45–4:00

208. Biological Information Processing — 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) TTh 2:45–4:00

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: 113 or equivalent.

3 units, Aut (McWhorter) MWF 10


3 units, Aut (Angell, Staff) MWF 8

216. Principles and Models of Semiconductor Devices—Quantitative description and modeling of the physical processes of trans
port, 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, applicable to both small- and large-signal cases. Prerequisite: 113 or graduate standing in electrical engineering.

3 units, Aut (Angell, Staff) TTh 9:25–10:40 and MWF 1:15
Win (Angell, Staff) MWF 9

218. Amplifier Circuit Theory — Representation of solid state devices over wide frequency ranges. Amplifier design based on steady-state and transient performance. Relationships between steady-state and transient behavior. DC amplifiers. Background in undergraduate electronics and basic complex variable theory required. 216 is useful but not necessary in understanding the models used.

3 units, Win (McWhorter) MWF 10


3 units, Spr (McWhorter) MWF 11

231, 232. Introduction to Lasers and Masers — Introduction to laser and maser devices, their principles of operation, and their practical applications, using semiclassical concepts, simple electronic analogies, and classroom demonstrations (no quantum mechanics background required). Independent laboratory work in connection with the course can be arranged; see 235A,B,C. Prerequisites: 142 (which may be concurrent) and Physics 57. Recommended: 238, Statistics 116 and Engineering 50.

3 units, Win, Spr (Siegman) TTh 9:00–10:30

235A, B, C. Laser and Quantum Electronics Laboratory — Opportunity for individual (or team) special laboratory projects in lasers, laser applications, optics, magnetic resonance, parametric devices. Preferably taken for two consecutive quarters. Prerequisite: 231 and 232 (may be concurrent).

3 or more units, any quarter (Siegman, Staff) by arrangement

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 111 or Engineering 50.

3 units, Aut, Spr (Spicer) MWF 1:15


3 units, Aut (Hellwell, Kino) MWF 10 and TTh 11:00–12:15
Win (Crawford) MWF 9
Sum (Harris) MTWTh 9


3 units, Win (Hellwell) TTh 11:00–12:15
Spr (Crawford) MWF 9

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: 102.

3 units, Aut (Goodman) MWF 2:15
Spr (Bracewell) 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, with and without computer assistance, as appropriate. Prerequisite: 103 and ability to use digital computation facilities.

3 units, Aut (Tuttle) MWF 8


271. 3 units, Win (Tuttle), MWF 9, alternate years, given 1971–72
272. 3 units, Spr (Tuttle), MWF 9, alternate years, given 1971–72

274. The Computer as a Laboratory Instrument—Computer-system architecture and design philosophy described in lectures, and weekly experiments demonstrate basic principles of real-time measurement, control, and computation. Role of small computer as dedicated system component in data acquisition, control, automated testing, real-time transforms, and signal processing is developed in laboratory experiments. Prerequisites: Computer Science 111, or equivalent programming experience.

3 units, Aut, Win (Widrow, Staff) TTh 10 and 3-hour lab. by arrangement

276. Information Transmission and Modulation—Signals and circuits for information transmission in electronic systems; 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: 103 and Statistics 116 or equivalent.

3 units, Win (Staff) 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: 102 and Statistics 116 or equivalent.

3 units, Win (Goodman) MWF 2:15


280A,B. Computer Applications Laboratory—"Hands-on" experience in real-time applications of digital computers as signal processors or portions of control systems. Previous topics include pattern recognition with computer-controlled TV camera, 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, the Medical School, and other research laboratories. Should be taken for two consecutive quarters. Prerequisite: Computer Science 111 or equivalent programming experience. Corequisite: 274.

3 units, Win, Spr (Widrow, Staff) by arrangement

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 (Peterson, Staff) MWF 9 and MWF 1:15
Win (Staff) MWF 11
Sum (Staff) MTWTh 11

282. Logic Design and Digital Systems—Characteristics of switching, memory, and input/output devices. Comparison of digital integrated circuit families. Introduction to large scale integration. Logic design of counters, shift registers, arithmetic circuitry, correlators, etc. Project in detailed design of a system such as a stored program computer, digital differential analyzer, desk calculator, or radar signal processor. Logic laboratory. Prerequisite: 281.

3 units, Win (Peterson, Staff) MWF 11 and MWF 1:15
Spr (Staff) MWF 10

3 units, Spr (Peterson) MWF 1:15


3 units, Aut (Davidson) MWF 3:15
Win (Padulo) MWF 2:15

286A,B. Systems Programming—(Enroll in Computer Science 140A,B.)

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.

Aut (Shockley) by arrangement


3 units, Win (Arbib)

312. Integrated Circuit Technology—Fundamental principles of monolithic integrated circuit technology. Technological limitations on integrated circuit design. Lectures and laboratory instruction including photolithography, oxide masking, diffusion, and thin film deposition. Prerequisite: 113.

3 units, Aut, Spr, Sum (Meindl)

315. Solid State Circuits Laboratory—Experimental projects on design of high-performance circuits or small systems using transistors, integrated circuits, and other modern solid state devices or on device measurement and evaluation, with emphasis on relationships between observed characteristics and underlying physical mechanisms. Students are encouraged to suggest and define their own topics, and normally work on one project for the entire academic quarter. Prerequisite: previous or concurrent registration in any one of the following: 214, 216, 218, 219, 316.

3 units, Aut, Win, Spr, Sum (Angell)

316. Transistor Electronics — Quantitative analysis of the performance of transistors and solid state diodes in tuned, video, low-noise and low-drift amplifiers, in parametric amplifiers, and in nonlinear switching and regenerative circuits; based on the network theory of 214 and the device models developed in 216. Prerequisites: 214 (or 266 may be acceptable after consultation with instructor) and 216.

3 units, Aut, Win, Spr, Sum (Angell)


4 units, Spr (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, Win (Spicer)

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 special attention to ferromagnetic and ferrimagnetic materials. Prerequisite: 238, or Materials Science 188, or elementary quantum mechanics.

3 units, Spr (White) alternate years, given 1970-71
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. Recommended: Mathematics 113.

3 units, Aut (Harris, 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: 322A.

3 units, Win (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: 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: 324A.

3 units, Aut (Pantell)

326A. Wave Phenomena in Active Media I — (Enroll in Applied Physics 250.)

326B. Wave Phenomena in Active Media II — (Enroll in Applied Physics 251.)

327A,B. Descriptive Theory of Semiconductors—Application of energy band theory to the behavior of electrons and holes in semiconductors. Hot carrier effects and recombination through traps. Content and form of second quarter dependent on student interests. Prerequisites: 322A, 322B (may be concurrent), or equivalent.

3 units, Win, Spr (Shockley)

329A,B. 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, Schottky barriers, etc. Registration by consent of instructor. Prerequisite: 327A or Physics 172, or Materials Science 181.

3 units, Win, Spr (—–—)

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: 322A and 322B (may be concurrent); Physics 230 and 231 (may be concurrent); or Materials Science 233 (338A); or consent of instructor.

3 units, Win (Spicer)

335. Seminar in Quantum Electronics and Optics—Discussion by staff and students of topics in lasers, optics, quantum electronics, and optical parametric devices.

1 unit, Aut, Win, Spr (Siegman, Staff)

338A. Introduction to Application of Quantum Theory in Solids—(Enroll in Materials Science 233.)

338B. Electrical Transport Processes in Crystals—(Enroll in Materials Science 234.)

338C. Photoelectric Properties of Solids—(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: 244 or equivalent.

3 units, Spr (Buneman) alternate years, given 1970–71

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 propagation in anisotropic media. Scattering matrices. Prerequisite: 244 or equivalent.

3 units, Spr (Kino) alternate years, given 1970–71

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, and filtering. Prerequisite: 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. Diffraction, lenses, coherent and incoherent imaging, optical data processing, and holography. Prerequisite: familiarity with Fourier analysis.

3 units, Spr (Goodman) alternate years, given 1971–72

348. Ionospheric Processes — The neutral atmosphere; the solar ionizing radiation; the role of production, loss and diffusion processes in establishing the ionosphere; thermal behavior of the ionospheric plasma.

3 units, Spr (Staff) alternate years, given 1971–72


3 units, Spr (Goodman) alternate years, given 1970–71

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: 243 or equivalent.

3 units, Aut (Buneman) alternate years, given 1971–72

355. Plasma Physics Seminar — (Enroll in Engineering 214.)

357A. Applied Physics Measurements I — (Enroll in Applied Physics 350.)

357B. Applied Physics Measurements Laboratory I— (Enroll in Applied Physics 351.)

358A. Applied Physics Measurements II— (Enroll in Applied Physics 352.)

358B. Applied Physics Measurements Laboratory II— (Enroll in Applied Physics 353.)

360. Seminar on the Theory of Systems — Discussion of research problems and current literature in control, communication, and system theory by faculty, students, and outside specialists. Prerequisite: 363A or equivalent.

1 unit, Aut, Win, Spr (Bryson, Franklin)


4 units, Aut, Win, Spr, Sum (Franklin, Staff)

363B. System Theory: Stochastic—Interaction of stochastic processes and linear systems; definitions and general properties. Second-order processes; simple models, linear transformations. Canonical representations and innovation processes; applications to recursive estimation and optimization with quadratic loss. Prerequisites: 363A and either Statistics 116E or equivalent.

3 units, Win (Gray, Kailath)

3 units, Spr (Franklin, Luenberger)


3 units, Win (Franklin)


3 units, Spr (Widrow)

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. Prerequisite: Statistics 116 or Engineering-Economic Systems 221 or equivalent.

3 units, Win (Gray)


3 units, Win (Staff)


3 units, Spr (Cover)

378. Statistical Detection Theory — Signal detection in radar and communications. Ideal receivers and error probabilities for deterministic and random signals in additive noise. Relations to linear and nonlinear least-squares estimation. Prerequisite: 363B or consent of instructor.

3 units, Spr (Kailath)
379. Communication Channels—(Formerly 478.) 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: Statistics 116E or equivalent.

3 units, Aut (Kailath)

380. Seminar on Digital Systems — Discussion of current research in the area of digital systems including logic design, switching theory, and machine organization.

I unit, Aut, Win, Spr (Mccluskey, Peterson) W 4:15

381H. Advanced Computer Organization—
(Enroll in Computer Science 311.)

383. Advanced Topics in Switching Theory and Logic Design — Decomposition theory for combinational and sequential circuits, iterative networks, threshold logic, regular expressions, and related topics. Prerequisites: 282 and 284 or equivalent.

3 units, Spr (Davidson) MWF 2:15

385A. Digital Reliability Seminar — Student-faculty discussions of research problems in areas of reliability, testing, diagnosis, and redundancy in digital systems. Prerequisite: consent of instructor.

I unit, Aut, Win, Spr (Mccluskey)

Th 4:15

385B. Parallel Computing Seminar — Student-faculty discussions of research problems in areas of control of parallel operations, parallel program schemata, parallel computer organizations, higher level languages for parallel operations, etc. Prerequisite: consent of instructor.

I unit, Aut, Win, Spr (Mccluskey, Bredt) M 4:15

386. Operating Systems — (Enroll in Computer Science 246.)

387. Algebraic Coding Theory — Information representation; Huffman and alphabetic encodings. Theory and implementation of codes for detection and correction of independent and burst errors. Recurrent codes. Synchronization; comma-free codes, codes with special correlation properties. Prerequisite: 284 preferred; 376 or 379 acceptable.

3 units, Spr (Gray) MWF 9

390. Special Studies or Projects in Electrical Engineering—Independent work under the direction of a faculty member for which no letter grade is given. Individual or team activities involving laboratory experimentation, design of devices or systems, or directed reading.

By arrangement

391. Special Studies and Reports in Electrical Engineering—Independent work under the direction of a faculty member; a written report or a written examination is required and a letter grade is given. If a letter grade based on written work is not appropriate, student should enroll in 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.

I 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

412. Advanced Integrated Circuit Laboratory — Experimental projects and seminars on integrated circuit fabrication using epitaxial, oxidation, diffusion, evaporation, sputtering, and photolithographic processes with emphasis on techniques for achieving advanced device performance. May be repeated for additional credit. Prerequisite: 312 and consent of instructor.

3 units, Win (Meindl)

430. Band Structure and Photoemission Seminar—Subjects of current research interest 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 (Spicer, Staff)

431. Quantum Electronics — Quantum theory of lasers and related quantum electronic devices. Interaction of radiation and atoms; stimulated transitions; the density matrix; inhomogeneous broadening; quantum noise. Provides the quantum theory underlying the semiclassical approach of 231–232. Prerequisites: quantum theory to the level of 322B or Physics 231. 231–232 is not a prerequisite, but background reading from this course material may be necessary.

3 units, Aut (Siegman) alternate years, given 1970–71

438A. Theory of Solids—(Enroll in Applied Physics 377.)


443. Plasma Wave Theory—Introduction to plasma wave propagation in cold and warm plasmas; equivalent permittivity concept; energy and group velocity; pulse response; dispersion relations for transverse and longitudinal wave propagation; effects of boundaries and inhomogeneities; origins of instabilities and criteria for their classification as absolute or convective; special cases of velocity-space and macroscopic instabilities; wave/wave interaction and parametric amplification. Courses 443 and 444 are complementary, and may be taken in either order. Prerequisite: 244 or consent of instructor. Recommended: 261.

3 units, Spr (Crawford) alternate years, given 1971–72

444. Wave Propagation in the Ionosphere and Magnetosphere — Magnetoionic theory from a modern point of view; applications including ray tracing, dispersion (e.g., whistlers), absorption, boundary effects. Interpretation of experimental observations and use of radio waves as diagnostic tools. Introduction to wave-particle interactions.

3 units, Spr (Helliwell) alternate years, given 1970–71


3 units, Aut (Bracewell) alternate years, given 1970–71

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 laminae, 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: 244 or consent of instructor.

3 units, Aut (Eshleman) alternate years, given 1971–72

451. The Laboratory Plasma—(Enroll in Engineering 211.)

452. Experimental Plasma Physics Laboratory—(Enroll in Engineering 215.)


3 units, Win (Buneman) alternate years, given 1970–71

455. Seminar in Astrophysics—(Enroll in Applied Physics 363.)

456A. Solar-Terrestrial Relations—(Enroll in Applied Physics 360.)


479. Topics in Statistical System Theory—Study of related problems in statistical communication, stochastic control, statistical data processing, network and system realiza-
tion and identification, stability theory. Exact choice of topics will vary from year to year. Prerequisite: 363B or consent of instructor. Recommended: 378.

3 units, Spr (Staff)


3 units, Spr (Arbib) MWF 10

ENGINEERING-ECONOMIC SYSTEMS

Chairman: William K. Linvill
Associate Chairman: Donald A. Dunn
Professors: Willis W. Harman, Ronald A. Howard, William K. Linvill
Associate Professors: Donald A. Dunn, David G. Luenberger, George R. Murray, Jr., Richard D. Smallwood
Assistant Professor: Robert C. Lind
Lecturers: Kan Chen, James E. Matheson

OFFERINGS AND FACILITIES

The Department of Engineering-Economic Systems is dedicated to preparing individuals for careers dealing with the phenomena characteristic of planning, operation, and control of large-scale technological-economic systems through programs of study, internship, and research on the graduate level.

The formal coursework is divided into two main parts: system courses and foundation courses. The system courses provide the basic framework of professional training. They emphasize the system analysis techniques that are sufficiently powerful to have important application in the planning and operation of the complex systems required by modern society. The foundation courses, primarily mathematics, ensure that the education received today will remain relevant and useful in future years.

A unique feature of the doctoral program is the internship, a period of experience in the real world that allows a student to test theory in the face of reality and thereby gain first hand experience in the limitation of existing methodology. The internship experience will often provide the basis for formulating meaningful research problems.

The research programs of faculty and students are designed to abstract from experience and, thus, extend the frontiers of knowledge in the systems area. The research program is the source of new methodology that sustains the course program.

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. Undergraduate course work 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. The Department does not have a thesis requirement for the Master's degree. 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, M.S. programs must involve at least 21 units of courses in Engineering-Economic Systems with letter grades and a total of 45 units of course work including 39 units of courses with letter grades.

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 described in the "Degrees" section of this bulletin.

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.

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 and University 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 Departmental 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.

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 examinations.

Requirements may be summarized as follows: The student is to complete successfully (1) a minimum of three years of residence with graduate standing, (2) Department qualifying examinations, (3) an approved program of courses, (4) an oral examination near the completion of the doctoral program, (5) a dissertation, based on research, which must be a contribution to knowledge. The Department does not have a foreign language requirement.

Ph.D. Minor—Doctoral students throughout the University may complete a minor in Engineering-Economic Systems by taking 15 units of 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.

SYSTEM INTERNSHIPS

Since most large-scale system problems cannot be made available 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 an 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 vari-
ety 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 this 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 Engineer’s degree and Ph.D. programs, but is not a requirement. 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, it is important for a student to receive experience in the application of these concepts to as many specific problem areas as possible. A practitioner, to be responsible and effective, must combine general system knowledge with the important specific factors relevant to the problem at hand. The opportunity for students to receive this important aspect of a systems education exists primarily in the internship program, in various applied research projects that may be in progress within the Department, and in special courses that concentrate on the application of system concepts to specific areas.

While the resources of the Department for providing direct experience with a large number of practical problems is limited, the spectrum of interests and the range of problem areas investigated is not. Thus, at any one time there may be only a limited number of specific problem areas that are being actively pursued by the faculty, although the range of problems encountered over a span of years will be great.

Specific areas that have been studied in the past include industrial systems, public systems, development systems, and human systems. Industrial systems 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 system studies involve problems of man-machine systems, communications, automated instruction, educational system planning, human resource development, motivation, and personal development.

The above list of application areas is not intended to be either exclusive or exhaustive. In particular, only a small subset of these problems is being pursued adequately by the faculty at any time. On the other hand, there is represented in the faculty some level of interest in each of these problem areas. In addition, new system areas will be undertaken whenever technically interesting and practically significant problems arise, 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 three categories of courses: (1) foundation courses from physical sciences, social sciences, economics, and mathematics; (2) courses in en-
gineering-economic systems; and (3) 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
137, 138. Numerical Analysis
205A,B,C. Real Variables
206A,B,C. Complex Variables
220A,B,C. Methods of Mathematical Physics

**ECONOMICS**
210, 211, 212. Theory of Income and Economic Fluctuations
272, 273. Econometrics

**COURSES IN ENGINEERING-ECONOMIC 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) economics and decision analysis—logical balancing of the economic and other factors that affect a decision; and (3) system analysis—development of the models for structuring and procedures for optimizing that formalize the selection among systems alternatives. The courses in this Department are divided into the following categories:

1. System Analysis
   a) Modeling
      1) Introductory System Analysis: 201A*, B*, C*
      2) Probabilistic Models for Problems of Uncertainty: 221*, 251A*, B*
   b) Optimization
      1) Concepts of Optimization: 243*, 263A, B

2. Economics and Decision Analysis: 210, 211, 212A*, B*, 231A*, B

3. Applications and Research
   1) System Analysis Case Study: 220
   2) Man-Machine Systems: 223
   3) Public Policy Analysis: 249, 280
   4) Research, Seminars: 291, 292, 293, 300, 341, 350

* The courses identified by asterisks above are core courses which should be taken by all doctoral candidates. A departmental area examination for the Ph.D. degree is based on a knowledge of the materials in these courses.

**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 15th of January preceding the Autumn 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 Autumn quarter because the course offerings are arranged sequentially with basic courses and prerequisites falling early in the academic year.

**COURSES**

**SYSTEM ANALYSIS: MODELING**


3 units, Aut, Win, Spr (W. Linvill, Staff) TTh 8:00-9:15

**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, Win, Spr (W. Linvill, Staff) TTh 8:00-9:15

**251A,B. Dynamic Probabilistic Systems** — Emphasizes the extension and further application of basic system concepts to modeling of processes exhibiting both dynamic and uncertain behavior. Application of linear system theory to the study of finite- and infinite-state, discrete- and continuous-time, stationary and non-stationary, Markov and semi-Markov processes. Optimization of probabilistic systems over short and long time periods by means of dynamic programming. A concurrent presentation of examples in the areas of system reliability, marketing, automatic control, maintenance and replacement policies, search procedures, inventory control, and other operating problems of systems. Prerequisite: 221 or equivalent.

3 units, Win, Spr (Smallwood) TTh 11:00-12:15

**SYSTEM ANALYSIS: OPTIMIZATION**


3 units, Spr (Franklin, Luenberger)

**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: 201B or Mathematics 113. Recommended: Mathematics 115.

3 units, Aut (Luenberger) TTh 2:00-3:15

**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: 263A.

3 units, Win (Luenberger) TTh 2:00-3:15

**ECONOMICS AND DECISION ANALYSIS**

**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 public policy in relation to government production of services and regulated industries, criteria for public investment, price and non-price rationing of services, financing of services, political and bureaucratic behavior, intergovernmental relations. Prerequisite: 210 or consent of instructor.

3 units, Win (Dunn) 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 2:15–3:30

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. Prerequisite: 221 or equivalent.

3 units, Win, Spr (Howard) TTh 9:30–10:45

APPLICATIONS AND RESEARCH

220. System Analysis Case Study—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 (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, especially human decision-making. Specific system areas considered include: manual control, monitoring, decision-making, automated instruction, and medical diagnosis. The presentation is augmented by classroom experiments. Discussion of the paramount importance of this area to future systems. Prerequisite: 221 or equivalent. Recommended: familiarity with transforms.

3 units, Spr (Smallwood) TuTh 3:15

249. Urban Economic Analysis—(Enroll in Economics 249.) Analysis of structure and functioning of economic activity in urban areas: location and growth of cities, transportation-communication and externalities, intra-metropolitan distribution of firms and residences, operations of land markets, planning, local public services and fiscal problems, slums. Prerequisite: 212 or Economics 204.

5 units (——)

250. Telecommunications Systems and Public Policy—Fundamentals of telecommunications system design and costs. Structure of the U.S. and international communications industry. Regulation of common carriers, TV and radio broadcasters, and other users of the frequency spectrum. Analysis of public policy issues arising out of the rapidly changing technology in this field. Case studies of international satellite communications systems, cable television systems, land-mobile radio systems, and computer-based tele-
processing systems. Prerequisite: graduate standing.

3 units, Spr (Dunn) MW 11:00–12:15

291. System Research Seminar — Group study of an area of current system research. Topics may include areas of system theory, such as optimization theory and decision theory, as well as areas of applications, such as regional development, health systems planning, and transportation planning. Topics will be announced on a quarterly basis.

1 or more units, 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

293. Seminar in Engineering-Economic Systems—Lectures on research problems and recent results in engineering-economic systems by faculty, students, and visiting specialists.

1 unit, Aut, Win, Spr (Staff) M 4:15–5:05

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

340. The Human Potentiality — (Enroll in Graduate Special 340.)

341A,B,C. Seminar in Public Finance — (Enroll in Economics 341A,B,C.)

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. The Industrial Engineering program is designed to introduce the student to measurement and control theory, organization theory and behavior, management, economic analysis and modelling, 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, man-machine systems, and program management. 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. Computer utilization incorporates computation, data processing, and information systems design and operation.

INDUSTRIAL ENGINEERING

Emeritus: Eugene L. Grant (Professor)

Chairman: W. Grant Ireson


Associate Professors: Robert A. Hemmes, Roy E. Lave, Jr., David A. Thompson. Consulting: Paul Gray

Assistant Professors: Hugo A. Di Giulio, Arturo Salazar
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 15 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 or must complete the equivalent of 45 units of mathematics and science. In addition, the student must be sure that he has complied with the prerequisites for the courses listed on his program for the M.S. degree.

**ENGINEER**

The Engineer degree 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 usually 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 Faculty Committee of three appointed by the Department head and having as chairman the faculty member who will direct the thesis work. The final program must be approved by the Department.

**ASSISTANTSHIPS AND SCHOLARSHIPS**

A limited number of fellowships and assistantships with stipends of $750 to $4,200 a year are awarded each year. Application forms and detailed information may be obtained by writing the Department of Industrial 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’s *Information Bulletin* should be consulted for a description of the procedure for making application.

**UNDERGRADUATE COURSES**

50. Human Values in a Technological Society — The ways in which technology is changing our physical lives is obvious: we have better health and longer more comfortable lives, greater mobility, more opportunities and more information about these opportunities, etc. But less obvious and at least as important is the effect of technology on our beliefs and our value system, particularly as it affects ourselves and others. The class will explore some of these effects in an attempt to understand them a bit better and in the conviction that the thrust of technology can be shaped and redirected by society.

2 units, Spr (Thompson) M 2:15-4:05, given 1971-72

100. Industrial Organizations: Theory and Management — A survey of classical and modern organization theory; concepts and functions of management; and the behavior of the individual, the work group, and the organization.

4 units, Aut, Win (——) TTh 8:00-9:50
108. Work Design and Measurement — Concepts and techniques of designing and improving work performance and productivity of men and man-machine systems. Work flow sequences, human physiological information processing capabilities and resultant principles of job design. Measurement and evaluation of work with respect to time and wages. Prerequisite: 120 (or concurrent registration), or a course in statistical methods.

3 units, Spr (——) MWF 11


3 units, Win (——) MWF 11

133. Industrial Accounting — Principles of financial and cost accounting, design of accounting systems, techniques of analysis and cost control, impact of taxes. Interpretation and use of accounting information for decision making is stressed through case discussions. (Students who have taken or are taking another University course in elementary accounting should not enroll.)

4 units, Aut, Win (——) MWF 8 and one hour by arrangement

Sum (——) MTWThF 8

141. Utilization of Computers — Background necessary for effective use of computers in industrial engineering and management problems; machine characteristics; automatic languages. Data processing. Numerical techniques. Systems applications. Prerequisite: Computer Science 105 or 106.

3 units, Aut (——) MWF 9

Win (——) MWF 1:15

Spr (——) MWF 8

141A. Utilization of Computers — Same content as 141 with additional basic material on programming. Intended primarily for graduate students who have had no prior computer programming experience.

4 units, Aut (——) MWF 1:15

and F 2:15

152. Introduction to Operations Research I — (Enroll in Operations Research 152.) 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: Mathematics 43.

3 units, Win (Cottle) MW 4:15-5:30


3 units, Spr (Hillier) TTh 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 260. Prerequisites: 141, 153, Engineering 161, and Statistics 110 or 116.

3 units, Aut (——) MWF 8

162. Scheduling and Control of Production Systems — Continuation of 161: Operational problems of production systems including control of purchased materials inventory; scheduling of job shop, batch, 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 260. Prerequisite: 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 3:15–5:05

COURSES PRIMARILY FOR GRADUATE STUDENTS

208. Biotechnology—Design and analysis of human and man-machine information processing systems. Physiological considerations, such as effort and skill, and intellectual considerations, such as subjective decision making. Design of interactive computer graphic systems. Prerequisite: consent of instructor.

3 units, Aut (———) MWF 10

209. Analytical Methods for Industrial Engineers—Course is designed for first year graduate students who need a detailed course in the recent advances of linear algebra, linear programming, statistics and probability theory, engineering economy, decision analysis, and computer programming.

6 units, special session only, Aug. 24–Sept. 18 (Staff) MTWThF 8–12 and 1:15–5:05

210. Systems Analysis and Synthesis I—A course covering the fundamental concepts of: logic, set algebra, mapping rules and functions, linear functions, linear equations and inequalities, matrices and vectors, linear algebra, linear programming with the simplex method; series and sequences, difference equations with application to economic models, differential equations with application to linear system, Riemann and Stieltjes integration, and Axiomatic probability theory.

3 units, Aut (Di Giulio) MWF 3:15

212. Systems Analysis and Synthesis Techniques III—Course designed to develop practical optimization techniques for design and implementation of deterministic and stochastic systems. Both theory and applications of the techniques will be studied within a computer and interactive graphic environment. Topics include: graphs of systems and their manipulation; discrete, feedback control algorithms; decision analysis with feedback; dynamic programming and branch/bound techniques, and the discrete/continuous maximum principle. Prerequisite: 211, Statistics 116 and 219. Recommended: 241.

3 units, Spr (Di Giulio) MWF 3:15

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 11; lab. Th 1:15–4:05


3 units, Aut (———) MWF 1:15

230. Capital Budgeting—The logic of engineering economy and capital budgeting decisions is developed—first assuming certainty, then assuming uncertainty. Topics treated include discrete and continuous cash flow, income taxes and short and long term borrowing. Prerequisite: 229 or Engineering 161.

3 units, Win (———) MWF 1:15

231. Problems in Engineering Economy—Independent study of selected problems in engineering economy. Prerequisites: 229 or Engineering 161 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, and replacement. Prerequisite: 229 or Engineering 161.

3 units, Win (Ireson) TTh 11
233. Industrial Financial Controls—Following on the basic courses in accounting, cost accounting, and engineering economy, this course develops further sophistication in financial decision making within an industrial environment. The importance of management judgment and effective written and oral expression is stressed. Seminar format is used, with emphasis on case analysis and discussion. Prerequisites: 133 and Engineering 161 or consent of the instructor.

3 units, Spr (Riggs) TTh 8:00–9:15

234. Research and Development Management—The function of research and development in the business enterprise. The practical problems of project selection, integration of R&D with marketing, production, and financial management; selection and retention of scientists and engineers; establishment of research priorities; financial controls of R&D operations; R&D evaluation. An examination of the current state of the art in technological forecasting. Prerequisite: graduate standing or consent of instructor.

3 units, Aut (Blake) MW 4:15–5:30

235A,B. Program Management—A study of the managerial support and integration 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 (Blake) TTh 1:15–3:05 and one hour by arrangement

237A,B,C. Seminar in Planning, Programming, Budgeting Systems—The core seminar in the University’s Educational Program in Systems 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.

5 units, Aut, Win, Spr (Hemmes) by arrangement

241. Advanced Utilization of Computers—Advanced programming techniques; computer systems design; deterministic and random model manipulation; application of computers in an engineering and management environment. Prerequisite: 141 and Statistics 110 or 219. May be taken concurrently.

3 units, Win (——) MWF 2:15 Spr (——) 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


3 units, Win (Cottle) TTh 2:45–4:00


3 units, Win (Hillier) TTh 4:15–5:30


3 units, Spr (Lieberman) 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. See 152 and 153 for course content. Prerequisites: Calculus and Statistics 40 or 110 or 116. (May be taken concurrently.)
4 units, Aut (Eaves) MW 3:15-5:05
Win (Eaves) MW 4:15-6:05

257. Data Processing in Operations Research — (Enroll in Operations Research 257.) Seminar in selected topics in the application of electronic computers to operations research activities. Emphasis on the use of simulation techniques. Prerequisites: Computer Science 105 or 106 or equivalent and at least two courses in Operations Research. (May be taken concurrently.)
3 units, Win ( ) MW 4:15-5:30

260. Design of Production Systems — For graduate students who have not had the equivalent of 161 and 162. See 161 and 162 for course content. Not open to undergraduates. Prerequisites: 141, 153, 211 or 252, 229 or Engineering 161 and Statistics 110.
4 units, Win ( ) MWF 10 and 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 ( ) TTh 9 and Th 1:15-4:05, alternate years, given 1971-72

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 plan, financing and financial planning, design of management organization. Students, including qualified undergraduates, from all appropriate disciplines are encouraged to enroll. Special emphasis on planning small industries in developing nations. Prerequisite: consent of instructor.
3 units, Spr (Ireson) 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, work force, 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 in engineering systems, including man-machine systems in general and interactive computer graphic systems in particular. Prerequisite: 208 or consent of instructor.
2 units, Win (——) Th 2:15-4:05

281. Individual Study in Biotechnology — Directed reading and research in man-machine systems. Prerequisite: consent of instructor.
1 or more units, any quarter (——) by arrangement, given 1971-72

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 (Staff) by arrangement

293A,B,C. Development Planning Seminar, I, II, III—The Development Seminar will undertake in a three quarter sequence the study of planning issues (Fall), preparation of a simulation model of development (Winter), and a case study seminar on implementation (Spring). The class will play the role of the planning division, with teams being responsible for issues (F), sectors (W), and countries (S). The issues will be linked to the simulation model and to the case studies, with the computer being used to test variables in issues. Lectures, discussion, modeling, and team reports. Prerequisites: graduate standing and consent of instructors.
3 units, Aut, Win, Spr (——) TTh 4:15-5:30

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

351. Dynamic Programming and Stochastic Control — (Enroll in Operations Research 351.) Sequential decisions under uncertainty

3 units, Spr (Veinott) TTh 9-11


3 units, Win (——) TTh 11:00-12:15

358. Queueing Theory—(Enroll in Operations Research 358.) Introduction to queueing systems, Markov queues, ballot theorems and applications, random walks and applications, multiple channel queues in heavy traffic. Prerequisite: 359.

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

MATERIALS SCIENCE

Emeriti: Welton J. Crook, O. Cutler Shepard (Professors)
Assistant Professors: David M. Barnett, Craig R. Barrett. Visiting: Richard A. Wallace
Lecturers: Claus G. Goetzke, Bal K. Jindal, Egon E. Loebner

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, George A. Parks, and Paul Kruger.

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 Ad-
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. Students desiring to specialize in this field 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. 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 Materials Science. Deficiencies in previous training should be made up. Eighteen units of the 180 series of courses 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:
      - Materials Science 203. Computer Simulation
      - Materials Science 204. Wave Mechanics
      - Materials Science 222. Statistical Thermodynamics
      - Materials Science 232. Point Defects in Crystals
      - Materials Science 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 Materials Science 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 Materials Science 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. Completion of an acceptable thesis and 20 units of approved advanced course work beyond the requirements of the Master of Science 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:

1. Completion of the substantial equivalent of the requirements for the Master of Science degree in Materials Science.

2. Completion of an acceptable thesis and 20 units of approved advanced course work beyond the requirements of the Master of Science degree.
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 56 course units beyond the B.S. degree requirements must be included in the program. Eighteen units of the 180 series will count toward the 56.

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 (Shyne) MWF 9
Win (Huggins) MWF 11
Spr (Nix) MWF 10

106. Extractive Process Metallurgy — (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.

2 to 3 units, Aut (Parlee) by arrangement

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

2 units, Win (Staff) TTh 1:15-4:05, alternate years, given 1971-72

120. Industrial Report — Report covering at least two consecutive months of industrial experience related to Materials Science.

1 unit, any quarter (Staff) 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 or 3 units, any quarter (Shyne) and by arrangement

180. Atomic Arrangements in Solids — Description and determination of atomic arrangements in perfect and imperfect crystals and in amorphous materials. Among topics to be treated are formal crystallography, crystalline defects, and diffraction phenomena.

5 units, Aut (Barrett) MTWThF 11

181. Thermodynamics and Phase Equilibria — Application of thermodynamics to the properties and behavior of materials. Heterogeneous equilibria with emphasis on solids. Prerequisite: elementary thermodynamics. Recommended: Computer Science 105.

4 units, Aut (Stevenson) MTWF 10

182. Rate Processes in Materials — Diffusion in solids, structural transitions including recrystallization and liquid-solid and solid-solid phase transformations, property control by microstructural control. Prerequisites: 180 and 181.

3 units, Win (Pound) MWF 11


3 units, Win (Sherby) MWF 9

188. 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 units, Win (Geballe) MWF 10

188L. Electrical, Optical, and Magnetic Properties Laboratory—This is a phenomenological treatment of the whole spectrum of electrical, optical, and magnetic properties of materials. The basic laboratory involves six experiments: (1) electrical properties of p-n and n-p-n junctions, (2) optical absorption in solids, (3) Hall effect, (4) temperature dependence of electrical conductivity, (5) temperature dependence of saturation magnetization, and (6) plotting of B-H loop for various magnetic materials.

2 units, Win (Staff) by arrangement

190. Polymer Science — Relationships of structure and composition of organic polymers to their bulk physical properties. Polymerization, copolymerization, degradation, diffusional transport properties, glass transition behavior, and polymer crystallinity are discussed. Illustrative polymer problems and their solutions are presented. Prerequisite: Engineering 50 or equivalent.

3 units, Spr (Wallace) MWF 8

191. Engineering Properties of Polymers—The course studies the mechanical, electrical, and thermal behavior of polymer materials as related to their structural variables. The viscoelastic response of amorphous and crystalline polymers in stress-strain, creep, stress-relaxation, and dynamic tests is discussed. The electrical behavior (conductivity, time-dependent frequency response, and insulation) plus the thermal properties and the degradation behavior of polymeric materials will be treated. The emphasis is on describing and solving relevant problems in polymeric materials. Prerequisite: Engineering 50 or equivalent.

3 units, Aut (Wallace) MWF 10

192. Biomaterials — A study of the properties and functions of biopolymeric materials used to improve the efficiency and performance of biosystems in the body environment. Structure and function of membrane processes, ion transport, diffusion, and electromigration will be treated. Blood surface interactions, medical prosthesis of plastics, and applications of polymers to the artificial kidney and lung will be treated. Prerequisite: consent of instructor.

3 units, Win (Wallace) MWF 9

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 (Staff) MWF 9, alternate years, given 1971–72

203. Computer Simulation in Materials Science—The objective is to provide the graduate student with the techniques and attitudes required for the synthesis of several disciplines of knowledge so that he may be able to effectively resolve the “systems” problems which populate the Materials field. Prerequisite: Mathematics 131.

3 units, Aut, Win, Spr (Abraham) MWF

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: 188.

3 units, Win (Bube) MWF 1:15

205. Strength and Microstructure—(Enroll in Applied Mechanics 216A.) Mechanical properties of solids as viewed by the materials scientist or physical metallurgist. Basic aspects of dislocation theory and the role of dislocations and other defects on mechanical behavior of solids. The elastic, anelastic, and plastic properties of solids, stressing the relation between the internal structure of solids and the corresponding mechanical properties. Methods of hardening materials and mechanisms of hardening. Specific mechanical properties such as fracture, fatigue, and creep. Application of the concepts developed will be made to materials useful in technology. The course is directed toward non-materials science majors.

3 units, Aut (Sherby) TTh 11:00–12:15

206. Imperfections in Crystalline Solids—Relation of lattice defects to the physical properties of crystals. Introduction to point imperfections and their relation to transport properties in metallic, covalent, and ionic crystals. Introduction to the geometric and energetic aspects of dislocation theory. Relation between dislocation mechanics and
207. Metal Refining Processes—(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 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.

3 units, Win (Nix) MWF 8

208. Radioactivation Analysis — (Enroll in Engineering 177.) 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.

3 units, Spr (P. Kruger) TTh 1:15; one lab. by arrangement


3 units, Spr (Barnett) MWF 9

212. Seminar on High Temperature Materials—Applications, product specifications, properties, and fabrication methods for refractory metals, dispersion alloys, reactive metals, graphite, ceramics, cermets, and intermetallic compounds.

3 units, Sum (Goetzel) TTh 10:30-12:00

215. Mechanical Properties Laboratory — Application of the principles of Materials Science through laboratory experience. Integration of the experimental techniques for materials preparation, mechanical property measurement, and structure analysis. Experimental determinations of structure-property relations in elastic properties, yielding, fracture, creep, fatigue, and other selected mechanical properties.

3 units, Aut (Nix, Staff) by arrangement

220. Phase Transformations in Solids — Thermodynamic, kinetic, and crystallographic aspects of phase transformations in metals and alloys, with particular attention to martensitic transformations. Prerequisite: 182.

3 units, Win (Shyne) MWF 10, alternate years, given 1971-72

222. Statistical Thermodynamics — Systematic development of the methods of statistical mechanics. Applications to problems in Materials Science. Prerequisite: 181.

3 units, Spr (Stevenson) MWF 9

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. Prerequisites: 180, 181, and 188 or equivalents.

3 units, Spr (Bienenstock) TTh 10:00-11:30

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. Lectures offered by Professor Eric Hutchinson, Department of Chemistry. No absolute prerequisites, but prior exposure to thermodynamics is recommended.

3 units, Win (Hutchinson, Staff) by arrangement, alternate years, given 1970-71

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, Chemistry 173 or equivalent.

3 units, Spr (Parks) 3 lecs. by arrangement alternate years, given 1970–71

226. Corrosion and Electrometallurgy — Electrochemical principles with applications to corrosion, electrolytic processes, and galvanic cells. Prerequisites: elementary thermodynamics.

3 units, Win (Stevenson) MWF 10

230. Materials Science Colloquium.

1 unit, Aut (Barnett) M 4:15
Win (Barrett) M 4:15
Spr (Shyne) M 4:15
Sum (Staff) 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: 180.

3 units, Aut (Huggins) MWF 9

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: 204 or Electrical Engineering 322A.

3 units, Spr (Bube) MWF 1:15


3 units, Aut (Bube) MWF 1:15, alternate years, given 1971–72

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: 234.

3 units, Aut (Bube) MWF 1:15, alternate years, given 1970–71

236. Advanced X-ray Diffraction — X-ray diffraction from perfect crystals, use of Fourier analysis in diffraction, particle size broadening, strain measurements, effect of stacking faults, diffuse scattering, low angle scattering, diffraction from noncrystalline materials. Prerequisite: 180.

3 units, Aut (Bienenstock) TTh 9


3 units, Aut (Barnett) MWF 1:15


3 units, Win (Barnett) MWF 8

239. Seminar in Advanced Mechanical Metallurgy.

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


3 units, Spr (Pound) MWF 11


3 units, Spr (Huggins) TTh 11:00–12:15


3 units, Spr (Barrett) lec. TTh 10; lab. by arrangement

245. Advanced Mechanical Properties of Solids—A study of dislocation dynamics and the mechanics of yielding in crystalline solids; delayed yielding and dislocation multiplication yield point phenomena; theoretical treatments of dislocation mobilities in imperfect crystals; strain hardening in single
and polycrystals; effects of recovery on plastic flow; special subjects such as the mechanical properties of composite materials and shock phenomena in crystalline solids. Prerequisite: 237.

3 units, Aut (Nix) MWF 8, alternate years, given 1971-72

246. Crystalline Anisotropy — Seminar on the application of tensor notation to the description and analysis of the properties of crystalline materials.

2 units, Spr (Shyne) TTh 9, alternate years, given 1970-71


3 units, Spr (White) alternate years, given 1970-71

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: 185.

3 units, Spr (Sherby) TTh 1:15-2:45

251. Introduction to Heuristics of Invention and Discovery—The objective is to provide the senior undergraduate and the graduate student with a clear understanding of the various methods employed in the inventing and discovering process. A discussion of mathematical induction, rules of inductive inference, psychophysics and patterning of observation, case histories of famous discoveries, strategies for the invention process, conception of invention—its proper disclosure, witnessing and reduction to practice, etc.

3 units, Win (Loebner) TTh 1:15-2:45

258. Optical Properties of Solids—(Enroll in Electrical Engineering 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: 233; Electrical Engineering 322A and 322B (may be concurrent); Physics 230 and 231 (may be concurrent); or consent of instructor.

3 units, Win (Spicer)

259. Basic Quantum Mechanics—(Enroll in Electrical Engineering 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. Prerequisites: Physics 57, 110, 111, and Mathematics 130 and 131, or equivalent. Recommended: Mathematics 113.

3 units, Aut (Harris, White)

260A. Basic Quantum Mechanics—(Enroll in Electrical Engineering 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, electrical double layers, adsorption, equilibrium forms, interface attachment kinetics. Prerequisite: 181 or equivalent.

3 units, Spr (Tiller) TTh 1:15-2:45


3 units, Win (Pound) TTh 3:15-4:35, alternate years, given 1971-72

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, ap-
plied 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 (Jindal) TTh 3:15–4:35, alternate years, given 1970–71

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 (Jindal) TTh 3:15–4:35, alternate years, given 1970–71

300. Research.
Any quarter (Staff) by arrangement

MECHANICAL ENGINEERING

Emeriti: Boynton M. Green, Lydik S. Jacobsen, Stephen P. Timoshenko

Chairman: William M. Kays

Division Directors: James L. Adams (Design), Thomas J. Connolly (Nuclear), Stephen J. Kline (Thermosciences)


Consulting Associate Professor: Richard L. Martin

Assistant Professors: Anthony Leonard, John R. Manning

Lecturers: Frank R. Arnold, Carl G. A. Rosen

Design Division Affiliated Faculty: Matthew S. Kahn (Art), Bruce B. Lusignan (Systems Design), David A. Thompson (Biotechnology and Computer Graphics), Douglas J. Wilde (Optimization)

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 mechanisms 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 interested in concentrating in engineering mechanics should consult the Department of Applied Mechanics section of this bulletin. However, students studying for any of the degrees offered by the Department will ordinarily take courses in Applied 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 Laborato-
ties 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. 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** — Mechanical Engineering is a varied profession, ranging from primarily esthetic aspects of design, to highly technical scientific research. The discipline areas of interest to mechanical engineers include applied mechanics, materials, fluid mechanics, thermodynamics, heat transfer, nuclear reactor physics, magnetohydrodynamics, to name a few of the more important. No mechanical engineer is expected to have a mastery of this entire spectrum. Breadth is particularly important for some, while for others depth in a single specialty may be more relevant.

The Master's degree program, outlined below, is designed to assure some minimum of breadth with an opportunity for modest depth in one or two areas. However, 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 Master's degree program requires 45 units of course work taken as a graduate student. No thesis is required, although many students include some research work in their
course program. At least 36 of these units must be taken at Stanford; any units transferred from other universities (and up to 9 are allowed) must be graduate level courses taken while registered as a graduate student, and may not be applied toward fulfillment of item 2 below.

Students who have already fulfilled the mathematics requirement in full or in part, item 1 below, may place the released units in the approved elective category.

The Departmental requirements which must be met for the degree of Master of Science are:

1. **6 units** of mathematics from Applied Mechanics 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. **18 units** of graduate level courses (200 series) in the Department of Mechanical Engineering (including a maximum of 3 units in Applied Mechanics or Physics), of which not more than 12 units shall be in any one Division. Mechanical Engineering 291 and 292 may not be counted in this requirement.

3. **15 units** of approved electives (approved by adviser); these should ordinarily be in mathematics, physics, chemistry, or engineering. 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; Mechanical Engineering 116B, 116C, 134, 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 Mechanical Engineering 291, 292, and 3 units in credit seminars may be included in this 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 Mechanical Engineering 292 (Experimental Project Work) by arrangement with a member of the faculty, or by completion of any one of the following courses: Mechanical Engineering 175, 219C, 242A, 242B, 247, 273, 274, Engineering 106, Applied Mechanics 205, Aeronautics and Astronautics 131.

   b) In Engineering Synthesis, a minimum of 3 units of Mechanical Engineering 291, 292 (Engineering Synthesis Work) by arrangement with a member of the faculty, or by completion of any one of the following courses: Mechanical Engineering 201, 214, 219A,B, 222, 235A, B, 237A, 282.

   Mechanical Engineering 113 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.

Candidates for the degree of Master of Science will be expected to have approval of the faculty, and 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.) Any courses used to fulfill items 1, 2, and 3 of the Department M.S. requirements should be graded courses (excluding seminars and courses for which a +/- grade is given to all students).

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 primarily for those students who have completed the undergraduate program in this field and who are admissible to the graduate school. For these students, the 49 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>
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<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>3</td>
</tr>
<tr>
<td>M.E. 299A,B,C</td>
<td>Master's Project</td>
<td>12</td>
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<tr>
<td>Art 341D</td>
<td>Master's Project</td>
<td>6</td>
</tr>
<tr>
<td>Art 261</td>
<td>Graphic and Product Design</td>
<td>4</td>
</tr>
<tr>
<td>Indus. Engr. 208</td>
<td>Biotechnology</td>
<td>3</td>
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<tr>
<td>Grad. Sch. Bus. 240</td>
<td>Marketing</td>
<td>3</td>
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<tr>
<td>Free Electives</td>
<td></td>
<td>9</td>
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<tr>
<td>Total</td>
<td></td>
<td>49</td>
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</table>

The grade point average requirements for this program are the same as for the Mechanical Engineering Master's Degree described above.

**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 approval of the faculty and to have a minimum scholastic grade point average of 3.0 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
SCHOOL OF ENGINEERING

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, dynamics, 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 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 (Mechanical Engineering 301) to help fulfill University residence requirements (of 135 units of graduate work), 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, Aut (Adams, Martin) Lec.

MW 1:15; lab. MW 2:15–4:05

102. **Optimization** — (Enroll in Engineering 102.) Mathematical ways of finding the best values of design, decision, or operating variables. Nonlinear and polynomial optimization under constraint. Direct optimum-seeking methods. Dynamic programming and partial optimization of large systems. Prerequisite: elementary differential calculus.

3 units, Win (Wilde) MWF 11

103. **Manufacturing Technology** (formerly 101) — The capabilities and limitations of common manufacturing processes. Selection and specification of metallic and non-metallic engineering materials. Properties of materials as they affect and are affected by manufacturing processes. Engineering shop drawings—the interrelation of part description, dimensioning, tolerances, and process of manufacture. Laboratory experience in machining, casting, and welding. Various aspects of the course will be developed in a project to be designed, described in engineering drawings, and fabricated in shops. Engineering organization.

4 units, Win, Spr (Staff) T 9, Th 9–11; lab. T, W, Th, or F 1:15–4:05 for first four weeks of quarter, and additional hours by arrangement during last six weeks


3 units, Aut (Staff) MWF 11

Win (Staff) MWF 11
105. Control System Analysis and Design—
(Enroll in Engineering 105.) Design of linear feedback control systems for final-value error, stability, and dynamic response specifications. Discussion of the root-locus technique of Evans and the frequency-response techniques of Nyquist, Bode, and Nichols. Introduction to the state-space approach. Examples from a variety of fields. Prerequisite: Engineering 104 or Electrical Engineering 102.

3 units, Aut (J. Manning) MWF 10
and 1:15
Win (Staff) MWF 8
Spr (Staff) MWF 11

106. Control System Analysis and Design—
(Enroll in Engineering 106.) Continuation of 105 with emphasis on experimental methods and non-linear effects. Describing functions. Phase-plane analysis and bang-bang control. Padé approximants and time delay. Analog computer use in simulation and design. Prerequisite: Engineering 105.

3 units, Win, Spr (J. Manning, Staff)
TTh 2:15–5:05

107. Mechanical Systems—An investigation of the techniques used in design and development of complex mechanical systems. The relative role of test, cut-and-try development, intuition and analysis will be investigated. Critical parameters of mechanical system elements and transmission of force and motion through systems will be discussed. Typical mechanical systems and their design and development will be studied. Each student will design and build a simple mechanical system (model flying machine, tree shaker, stair climber, etc.). Prerequisites: Engineering 11 and 12 or equivalent.

3 units, Aut (Roth) Lec. TTh 2:15;
lab. Th 3:15–5:05


3 units, Win (Staff) T 10–12, Th 11

113. Engineering Design—The design process involves the application of information from various sources in the creation of tangible objects and intangible system concepts to improve the quality of human life. In this course, design is both studied as a process and experienced by students as they work on a design project. Final project results are presented to a professional jury. Prerequisites: 101, 103, 104, 107, and 111.

3 units, Win, Spr (J. Manning, Staff)
TTh 2:15–5:05

114. Philosophy of Design—(Enroll in Engineering 114.) An introduction to the philosophy of comprehensive design. A discussion of the attitudes and viewpoints of the designer and an investigation of the techniques of analysis, synthesis, and evaluation that he uses. Emphasis will be placed on understanding the creative process and the factors that influence it. Limited registration. Prerequisite: undergraduate standing.

3 units, Win (Adams) W 2:15–5:05

115A. 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: 101.

3 units, Win (McKim) MW 1:15–4:05

115B. 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: 115A.

3 units, Spr (Staff) MW 1:15–4:05

116A. Advanced Product Design —
Small-scale projects carried to a high degree of refinement. Emphasis upon craftsmanship and aesthetics. Prerequisite: 115B.

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 101, 113, 115A,B and 116A,B. Final presentation to professional jury. Prerequisite: 116B.

3 units, Spr (McKim) TTh 12:00–2:05

131A. Thermosciences—First of a three-quarter sequence that should be taken in consecutive quarters. Lecture and laboratory covering thermodynamics, fluid mechanics and heat transfer. The lecture sessions emphasize basic principles used in the thermosciences and their application in man-made systems. Laboratory sessions devoted to demonstration and experiments in the specific area of the lectures and cover basic experimental procedures, including measurement techniques, experiment design, data collection, processing, and evaluation. Prerequisites: Familiarity with basic principles of thermodynamics, and some elementary knowledge of fluid mechanics, equivalent to Engineering 31 and 21. Mathematical background should include intermediate calculus and ordinary differential equations.

5 units, Aut (Staff) MWF 10; lab. one afternoon by arrangement

131B. Thermosciences — Continuation of 131A.

5 units, Win (Staff) MWF 10; lab. one afternoon by arrangement

131C. Thermosciences — Continuation of 131B.

5 units, Spr (Staff) MWF 10; lab. one afternoon by arrangement

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 Mechanical Engineering 211 series should take 211A rather than this course.) Prerequisite: 131A.

3 units, Win (Staff) MWF 11

137. Air Pollution—Sources and effects of urban air pollution. Photochemical smog. Chemistry and fluid mechanics of pollutants in the atmosphere. Pollution control: devices and legislation. (Open to engineering and science students and a limited number of non-science students.)

3 units, Aut (C. Kruger) MWF 1:15


3 units, Spr (Staff) 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 artifacts and records, by interviews with engineers responsible for phases of the projects, and by class discussion of these data and of their implication. Students will prepare written case histories of these projects. Prerequisite: consent of instructor.

2 or 3 units, Spr (Staff) by arrangement

214. Philosophy of Design—An introduction to the philosophy of comprehensive design. A discussion of the attitudes and viewpoints of the designer and an investigation of the techniques of analysis, synthesis, and evaluation that he uses. Emphasis will be placed on understanding the creative process and the factors that influence it. Limited registration. Prerequisite: graduate standing.

3 units, Spr (McKim) T or Th 2:15–5:05

215A,B,C. Design Seminar — Open to all graduate students. Each quarter seminar develops a theme which bears upon design (e.g., Innovation, Design Frontiers). In typical format, guest speaker or seminar participant gives short prepared talk; remaining time is devoted to discussion between speaker and students. Registration for one unit of credit, with + or − grade, is optional; written papers or required reading may be scheduled by some instructors.
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215A. 1 unit, Aut (Staff) W 4:15
215B. 1 unit, Win (Staff) W 4:15
215C. 1 unit, Spr (Staff) W 4:15

218. Electromechanical Control Systems—
System synthesis, compensation and stabilization using Bode diagrams, root locus, etc.
Linear and nonlinear characterization of mechanical, electromechanical and electronic control components. Prerequisite: Engineering 105.

3 units, Win (J. Manning) T 8–10; Th 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: 113 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 (Staff) TTh 3:15-5:05

219C. Experimental Development Engineering—Testing and improvement of the design produced in 219A or approved alternate. Limited enrollment. Prerequisite: 219A or B, or consent of instructor.

3 units, Spr (Adams, Staff) lab. MW 1:15-4:05

220. Computer Aided Design—The use of machine computation as a design tool. A discussion of techniques and algorithms which increase the rationality of the design process and lead to more nearly-optimum solutions. The emphasis is on extending the designer’s potential, and not on automating his activities. Topics are taken from all phases of the design process. Students, working in teams, will be expected to program algorithms and complete a design project. Prerequisite: FORTRAN (or ALGOL or LISP) programming ability.

3 units, Aut (Roth) MWF 12

221. The Individual and Technology—This course is intended to be an intensive personal experience in which the participants’ career objectives and psychological orientation are contrasted with existing social values and conditions. The emphasis is on helping the individual to assess his role as a person and engineer in modern society. Stereotyped views of engineers and engineering are critically evaluated. The relevance of current political, social, and humanistic thought to technology is considered. Students are asked to do readings, participate in field trips, and complete a term project. Limited registration. Prerequisite: graduate standing or consent of instructor.

3 units, Win (Roth) F 1:15-4:05

222. Kinematic Synthesis of Mechanisms—
The rational design of linkages is the central theme of this course. The problem of determining linkage proportions to fulfill various design requirements is treated analytically. Topics include: three- and two-dimensional displacements and motions, the theory of higher plane curves, higher-order path-curvature analysis, circle and center-point theory. Prerequisite: 107.

3 units, Spr (Roth) MWF 12

223. Advanced Kinematics — Discussion of kinematics from both the mathematical and engineering viewpoints. Introduction to algebraic geometry. Application of matrix, tensor, and dual-quaternion methods to kinematic analysis and synthesis. A survey of current research and unsolved problems in kinematics. Prerequisite: 222.

3 units, Aut, Win, or Spr (Roth) by arrangement


3 units, Spr (J. Manning) T 8–10, Th 11

227. Topics in Unsteady Gasdynamics —

3 units, Spr (J. Manning) by arrangement
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. Prerequisite: Engineering 105 (may be taken concurrently).

3 units, Aut (J. Manning) MWF 1:15

235A,B. Engineering Systems Design—(Enroll in Engineering 235A,B.) Forty to 60 students mostly from engineering and science, but also from business, political science, law, etc., form a team to prepare a preliminary design of a complex system. Systems designed in previous years include: satellites to explore Mars, to monitor the earth’s weather and natural resources, and provide educational TV to developing countries; ocean systems to develop the sea’s resources; and plans for developing urban housing and resources have been designed. Over 20 speakers from government and industry provide the necessary background. At the end of the second quarter the class gives a verbal presentation to a government and industry group and publishes a final report on the system.

235A. 3 units, Win (Lusignan) T 1:15-3:05, Th 1:15 and two hours by arrangement

235B. 3 to 5 units, Spr (Lusignan) TTh 1:15-2:05 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 within 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 (Staff) by arrangement

299B. 4 units, Win (Staff) by arrangement

299C. 4 units, Spr (Staff) by arrangement

THERMOSCIENCES

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 (C. Kruger) MWF 2:15

211B. Physical Gas Dynamics—(Enroll in Aeronautics and Astronautics 211B.) 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 Aeronautics and Astronautics 210B, or equivalent background.

3 units, Spr (Baganoff) MWF 2:15

211C. Physical Gas Dynamics—(Enroll in Aeronautics and Astronautics 211C.) 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: Aeronautics and Astronautics 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. Prerequisite: 211A or consent of instructor.

3 units, Win (Ferziger) MWF 2:15, alternate years, given 1971-72

230. Heat Transmission — A one-quarter course open to all graduate students and to
undergraduates outside of Mechanical Engineering covering conduction, convection, and radiation. This course is intended primarily for students who want an appreciation of the principles of heat transfer to support their major engineering objectives, but who do not wish to devote a full year to the subject. The course should not be taken by students who have had a previous undergraduate heat transfer course or by students who plan to take 231A,B,C. Prerequisite: elementary ordinary differential equations.

3 units, Aut (Staff) MWF 9


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 velocitycompressible boundary layer; design of heat and mass transfer systems. Prerequisites: 231A or consent of instructor.

3 units, Win (Kays) MWF 9

231C. Heat Transmission — Continuation of 231B: Prerequisite: 231B.

3 units, Spr (Kays) MWF 8

232. Advanced Fluids Engineering — A one-quarter course in continuum fluid mechanics, and engineering design and optimization of internal flow systems, e.g. nozzles, diffusers, turbomachines. Brief development of equations of continuity and motion for viscous, compressible, and incompressible substances. Introduction to boundary layer and potential flow methods, dimensional analysis, modeling and analogues, flow visualization. This course should not be taken by students who plan to take 238A,B,C. Prerequisites: elementary vectors, ordinary differential equations, and calculus of functions of several variables; 131A,B,C or equivalent.

3 units, Win (Johnston, Kline) MWF 11

233A. Engineering Thermodynamics — Thermodynamic analysis of engineering systems including thermodynamics of gas mixtures, physical chemistry of combustion and thermodynamic bookkeeping methodology for mass, energy and entropy. Applications to internal combustion engines, power cycles, refrigerator cycles, compressors, turbines, heat exchangers, combustion chambers, cooling towers, etc. for performance predictions and the evaluation of losses (irreversibilities).

3 units, Win (London) TTh 11:00–12:15

233B. Engineering Thermodynamics — A continuation of 233A including a critical review of the fundamental thermodynamic concepts and principles and a study of the classical literature of thermodynamics.

3 units, Spr (London) TTh 11:00–12:15

236. Gasdynamics — Introduction to compressible flow. Sound waves and normal shock waves. Quasi-one-dimensional steady flows in variable area ducts with friction, heating and cooling, etc. Oblique shock waves, Prandtl-Meyer expansions, shock wave structure. Relation of continuum conservation equations to simple kinetic theory. Prerequisite: graduate standing or consent of instructor.

3 units, Aut (Staff) MWF 2:15

237A. Thermodynamics of Propulsion Systems — Analysis of the performance of propulsion prime movers from thermodynamic and dynamic points of view including rocket, ramjet, turbojet, and fanjet systems as well as piston, gas turbine and compound piston-turbine type engines.

4 units, Win (London) MWF 10 and one hour by arrangement

237B. Thermodynamics of Propulsion Systems — A continuation of 237A including the thermodynamics and kinetics of combustion reactions as applied to internal combustion engines of both the piston-cylinder and turbine types.

4 units, Spr (London) MWF 9 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

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. Prerequisite: graduate standing or consent of instructor.

4 units, Spr (Moffat) MWF 10 and 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. Prerequisite: graduate standing or consent of instructor.

3 units, Sum (Moffat) MWF 10 and one 2-hour lab. by arrangement

247. Experimental Plasma Physics Laboratory—(Enroll in Engineering 215.) Comprehensive teaching laboratory facilities are available for students wishing to carry out directed studies in experimental plasma physics. An extensive set of experiments has been developed which introduce the student to selected basic plasma phenomena. These emphasize the characteristics and methods of production of various laboratory plasmas, and involve dc, rf, and optical diagnostic techniques. Alternative experiments may be proposed for consideration. Prerequisite: consent of instructor.

1 or more units, any quarter (Staff) 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 (Buneman) M 4:15

251. Introduction to Partially Ionized Gases — (Enroll in Aeronautics and Astronautics 284.) Fundamental physical principles and equations underlying properties and dynamics of partially ionized gases. Review of electricity and magnetism. Collisional and radiative processes at the atomic level: interaction potentials, cross sections, nonequilibrium relaxation times, Rutherford scatter-
ing, electrical conductivity, recombination rates, classical collision theory. Plasma: collective behavior, the Debye length, plasma frequency, sheaths, weakly and fully ionized limits. Magnetohydrodynamics: motion of single charged particles, Hall effect, ion slip. Equations of motion for conducting fluids and elements of electromagnetic theory; non-dimensional parameters and scaling of flows. Simple illustrative examples. Prerequisites: familiarity with elementary electricity and magnetism and vector analysis.

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.

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 consent of instructor.

3 units, Spr (C. Kruger) MWF 1:15, alternate years, given 1971–72

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, Ramanujan effect. Emphasis will be placed on atomic collision processes of interest in high temperature gas-dynamics. Prerequisite: familiarity with partial differential equations.

3 units, Spr (C. Kruger) MWF 3:15, alternate years, given 1970–71


3 units, Spr (Ferziger) MWF 11

260A. Mathematical Methods in the Thermosciences—Advanced topics in the analytical, asymptotic, and numerical solution of ordinary and partial differential equations with application in a variety of physical problems, including fluid mechanics and heat transfer. Prerequisites: Mathematics 106 and 132, or equivalent. Computer programming capability desirable.

3 units, Aut (Reynolds) MWF 3:15, alternate years, given 1970–71

260B. Mathematical Methods in the Thermosciences—Continuation of 260A. Prerequisite: 260A.

3 units, Win (Leonard) MWF 9

298. Seminar in Fluid Mechanics—(Enroll in Engineering 298.) Interdepartmental seminar on problems in all branches of fluid mechanics, with talks by visitors, faculty, and students. Graduate students may register for one unit, without letter grade; a letter grade is given for students 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

**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.

**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**

171. Nuclear Energy—(Enroll in Engineering 171.) Nuclear reactions. Thermal energy release. Rates of radioactive decay, neutron capture, fission, fusion. Design of nuclear reaction systems: isotope heat sources, fission chain reactors, etc. Measurement techniques in nuclear systems. Radiation effects and shielding. Prerequisites: Physics 57 and concurrent registration in Mathematics 130. 3 units, Aut (Staff) MWF 9

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, radiotracers, radioactivation analysis, and their applications. Prerequisites: Chemistry 3 or 5, Mathematics 23, or Physics 29 or 57. 3 units, Win (P. Kruger) TTh 11

175. Radiation 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
177. Radioactivation Analysis — (Enroll in Engineering 177.) 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.

3 units, Spr (P. Kruger) TTh 1:15 and one lab. by arrangement

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) and 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) and one afternoon by arrangement

276. Neutron Transport Theory — Exact solutions of the one-speed neutron transport equation: escape probabilities, reciprocity theorems, infinite medium Green’s function, 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 (Staff) MWF 8, alternate years, given 1971–72

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 8, alternate years, given 1970–71

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 1971–72


3 units, Win (Staff) MWF 1:15
OPERATIONS RESEARCH

Chairman: Gerald J. Lieberman
Associate Professor: Richard W. Cottle
Assistant Professor: B. Curtis Eaves
Affiliated Faculty:
  Professors: Ronald A. Howard, Samuel Karlin, Douglass J. Wilde
  Associate Professors: Charles P. Bonini, Robert B. Wilson

OFFERINGS AND FACILITIES

Operations Research is a mathematical science concerned with optimal decision making and modeling of deterministic and probabilistic systems. The Department’s principal objectives are to provide a comprehensive program of instruction in the basic mathematical foundations of operations research, to acquaint students with the application of these methods to real problems, and to train research workers in operations research.

The Department offers programs leading to the Master of Science and Doctor of Philosophy. In addition, introductory survey courses are offered for both undergraduate and graduate students from other departments. Under the Graduate Division Special Ph.D. Programs, it is also possible to arrange a well-considered program that is a combination of Operations Research with some other departmental area. Some possibilities are either Computer Science, Statistics, Economics, or Chemical Engineering.

Among the many areas of operations research the Department has special competence in the following: applied probability; control theory, dynamic programming, and mathematical system theory; inventory, queueing, and reliability theory; linear, nonlinear, and integer programming; and networks, graphs, and combinatorial theory.

The Department moved into new quarters in September, 1969. Adequate office facilities are available for visiting scholars and doctoral students. In addition, the Department has its own library and remote-access computer terminal.

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>
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<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. 217</td>
<td>Introduction to Stochastic Processes</td>
<td>3</td>
</tr>
<tr>
<td>Stat. 218</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>
</tbody>
</table>

Electives from the offerings of the Department of Operations Research or from authorized courses in other departments 11

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

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, queuing 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, queuing theory, inventory theory, and game theory.

Candidates for the Ph.D. in Operations Research will normally satisfy the course requirements shown below. An individual student in consultation with his advisor may make adjustments in his program to reflect his special interests.

1. Prerequisites: Mathematics 113, 115, 116; Statistics 116, 119, 120; Computer Science 136; Engineering-Economic Systems 212A.


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 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 have a reading knowledge of at least one foreign language and successfully complete a set of written comprehensive examinations.

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. 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: Mathematics 43. 3 units, Win (Cottle) MW 4:15-5:30

153. *Introduction to Operations Research II* — Introduction to stochastic models in operations research. Stochastic processes and their use in analysis of industrial problems. Game theory, minimax theorem. Emphasis on discrete and continuous time parameter Markov chains. Queueing theory, linear and dynamic programming under uncertainty, including the use of certainty equivalents with quadratic costs. Graduate students en-
roll in 252. Prerequisites: 152 and Statistics 40 or 110 or 116.

3 units, Spr (Hillier) MW 4:15-5:30


3 units, Win (Wilde) MWF 11

240. Linear Programming—This course will survey linear programming, emphasizing standard model formulation, fundamental theorems, variations of the simplex method and parametric programming. Corequisite: Mathematics 113.

3 units, Aut (Hillier) TTh 1:15-2:45

241. Economics of Industry — (Lectures same as Economics 254.) Optimization of investment decisions; plant size, location and time-phasing; equipment replacement; capital budgeting; pricing and investment policies for a multi-product public enterprise; relation between economies-of-scale and oligopoly problems; inter-industry analysis.

3 units, given 1971-72


3 units, Win (Cottle) TTh 2:45-4:00

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 (Hillier) TTh 4:15-5:30

251. Stochastic Models in Operations Research—Formulation, solution, and analysis of stochastic models in operations research, including those of queuing theory, inventory theory, Markov processes, simulation, reliability theory. Prerequisites: 250 and Statistics 116 and 218 (concurrently).

3 units, Spr (Lieberman) 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 40, or 110, or 116. May be taken concurrently.

4 units, Aut (Eaves) MW 3:15-5:05
Win (Eaves) MW 4:15-6:05

257. Data Processing in Operations Research—Seminar in selected topics in the application of electronic computers to operations research activities. Emphasis on the use of simulation techniques. Prerequisites: Computer Science 106 or equivalent and at least two courses in Operations Research. May be taken concurrently.

3 units, Win (———) MW 4:15-5:30

299. Independent Study — Intensive study of literature of special topics.

Any quarter (Staff) by arrangement

340A. Mathematical Programming — Formulation of standard linear programming models. The simplex method and lexicographic resolution of degeneracy. Linear inequality theory, alternative theorems, and duality. Variants of the simplex method including the dual simplex method, the revised simplex method with product form of the inverse, the primal dual method, and parametric linear programming. Matrix games. Theory of polyhedral convex sets. Prerequisite: Mathematics 113 or consent of the instructor.

3 units, Aut (Cottle) TTh 1:15-2:30

340B. Mathematical Programming — Introduction to large-scale linear programming, integer programming, nonlinear programming, and stochastic programming. Topics covered include transportation, transshipment, and distribution problems. The decomposition principle and upper-bounding techniques. The cutting-plane method and the branch and bound method. Theory of convex sets and functions; theorems of John, Kuhn, and Tucker. Duality theorems. Unified constructive treatment of linear programming, quadratic programming, and bi-matrix games via complementary pivot theory. Pivotal methods of nonlinear programming. Recourse models and chance-con-
strained programming. Prerequisites: 340A and Mathematics 115, or consent of the instructor.

3 units, Win (Dantzig) TTh 1:15–2:30

340C. Mathematical Programming — Further study of nonlinear programming including convexity, duality theory, and optimality criteria for constrained optimization problems. Convergent solution methods such as feasible directions, nonlinear decomposition, cutting plane, penalty function, differential gradient. Unconstrained optimization and search techniques. Prerequisites: 340B and Mathematics 116, or consent of the instructor.

3 units, Spr (Eaves) TTh 1:15–2:30

341. Large Scale Systems in Mathematical Programming — 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 non-linear, 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: 340B.

3 units, Aut (Dantzig) TTh 1:15–2:30

345. Finite Graphs and Network Flows—Lectures same as 245, but with more advanced assignments. Prerequisite: 340A.

3 units, Win (Cottle) TTh 2:45–4:00


3 units, Spr (Wilde) MWF 1:15–2:30


347A. 3 units, Aut (----) TTh 11:00–12:15
347B. 3 units, Win (----) TTh 11:00–12:15


3 units, Win (Veinott) TTh 9–11


3 units, Spr (Veinott) TTh 9–11


3 units, Win (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

3 units, Aut (Veinott) TTh 8-10

357A, B. Advanced Probability — (Enroll in Mathematics 230A, B.) 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 (Ornstein) MWF 2:15

357B. 3 units, Spr (Ornstein) MWF 2:15

358. Queueing Theory — Introduction to queueing systems, Markov queues, ballot theorems and applications, random walks and applications, multiple channel queues in heavy traffic. Prerequisite: 359.

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


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


4 units, Aut (Wilson) by arrangement


4 units, Win (Wilson) by arrangement

370. Seminar in Mathematical Programming — Advanced topics. Prerequisite: 340B.

3 units, Spr (Cottle) by arrangement

371. Seminar in Combinatorial Analysis and Integer Programming — Advanced topics. Prerequisite: 341.

3 units, Spr (Dantzig) by arrangement

372. Seminar in Nonlinear Programming — Advanced topics. Prerequisite: 340C.

3 units, Aut (Eaves) by arrangement

375. Seminar in Network Theory — Advanced topics. Prerequisite: 345.

3 units, given 1971-72

381. Seminar in Dynamic Programming — Advanced topics. Prerequisite: 351 and Mathematics 205A.

3 units, given 1971-72

385. Seminar in Reliability Theory — Advanced topics. Prerequisite: 355.

3 units, given 1971-72

386. Seminar in Inventory Theory — Advanced topics.

3 units, given 1971-72

388. Seminar in Queueing Theory — Advanced topics. Prerequisite: 358. The topic for 1970-71 will be optimization of queueing systems.

3 units, Spr (Hillier) by arrangement

389. Seminar in Applied Probability — Advanced topics. Prerequisites: 359, Mathematics 230A.

3 units, Spr (Iglehart) TTh 3:15-4:30

399. Research — Research work in Operations Research. Any quarter (Staff) by arrangement

469A. Management Science Workshop — (Enroll in Business 469A.) Selected topics drawn from the literature.

4 units, Aut, 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: Albert H. Hastorf
Associate Deans: To be announced
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, Interdepartmental Major, 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 Dean of Humanities and Sciences, 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.

INTERDEPARTMENTAL MAJORS

Committee in Charge: Lawrence V. Ryan, Chairman, Philip Dawson, Mason Yearian

The School of Humanities and Sciences sponsors a program for undergraduates...
whose special academic interests lie primarily in subjects taught within the School but do not fit into the major requirements of any department. The program is independent of, though coordinated with, the program of inter-school majors administered by the Committee on Undergraduate Studies. The degree awarded is Bachelor of Arts or Bachelor of Science; a label appropriately identifying the character of his major program is recorded on each student's transcript upon graduation.

Sophomores, juniors, and through registration period of the first quarter of their final year, seniors are eligible to apply. Applicants must be in good academic standing, but since the interdepartmental major is not an honors program, an honors grade point average is not a requisite.

Each applicant is asked to prepare for the Committee in Charge a statement explaining the rationale, including the educational objectives, of his proposed interdepartmental program. The program should be clearly interdisciplinary, educationally sound, and significantly articulated. It should not be a random collection of advanced courses in a variety of fields. It should be a program, furthermore, that clearly lies outside, and cannot be approved simply by petitioning for modification of, existing departmental major requirements.

Along with his statement of purpose, the applicant should submit a proposed list of courses numbered above 100 in this bulletin (approximately 60 credit units) to be offered in satisfaction of the requirements for the interdepartmental major. Each application will be judged on its merits, rather than merely on a first-come, first-served basis or the applicant's previous record of academic performance.

The proposal must have the approval and bear the signatures of at least three members of the Academic Council (faculty members of the rank of assistant professor or above) from at least two different departments of the University. One of these professors, or another person designated by the Dean of Humanities and Sciences, will serve as adviser for the student's program. The Dean of Humanities and Sciences will be responsible at the appropriate time for certifying the eligibility of the candidate for graduation.

Students interested in this program should inquire at the office of the Dean of Humanities and Sciences, Building 1, Inner Quadrangle.

AEROSPACE STUDIES

Chairman: Leon C. Heinle (Lieutenant Colonel, USAF)
Professor: Leon C. Heinle (Lieutenant Colonel, 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. The University and the Air Force are jointly conducting an experimental program in which some courses of the curriculum are taught by the University and some are taught by the Air Force. As a result, exact course requirements are subject to change at any time. Students should contact the department for information about present requirements.

CURRICULUM

FOUR-YEAR PROGRAM

Undergraduates may enroll in a four-year program. The first two years, known as the General Military Course, comprise study in the following areas: the role of U.S. military forces in the contemporary world, with particular attention to the United States Air Force, its organization and mission. The functions of strategic offensive and defensive forces, general purpose and aerospace forces are covered. The roles of these forces are related to national defense policy, with respect to general and limited war, alliances, and strategies and policies of the United States, the Soviet Union, and China. Also discussed are the U.S. defense organization and decision-making processes and their contribution to national objectives.

The second two years, known as the Professional Officer Course, comprise study in the following areas: development of aerospace power from man's early attempts to fly through our current space programs; a detailed study of the military as a profession, with particular emphasis on leadership and management; and development of commu-
nicative skills. Students will attend a four-week Field Training course on an Air Force base during the summer preceding their junior or senior year. Here, the student will experience living on an Air Force base, learn about modern air and space weapons, participate in orientation flying, and gain leadership experience and discipline.

Two-Year Program

Selected undergraduates or graduates who have two years remaining at Stanford University may be admitted to a two-year program leading to commissioning. These students will attend a six-week Field Training course during the summer preceding their enrollment. The Field Training course replaces the General Military Course required in the four-year program and satisfies all Field Training Requirements.

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, which all cadets attend for one hour each week, 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 mission. Orientation flights, often in jet aircraft, are offered to selected students.

Deferral—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.

Pay and Benefits

All necessary military textbooks and uniforms are furnished without cost to the student. Professional Officer Course cadets receive a retainer fee of $50 a month.

Students enrolled in the Two-Year Program receive approximately $150 while attending the six-week Field Training course. Students enrolled in the Four-Year Program receive approximately $190 while attending the four-week Field Training course.

Scholarships

Students enrolled in the Four-Year Program are eligible to apply for competitive scholarships which provide benefits of full tuition, a book allowance, and $50 per month subsistence allowance.

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. The following courses are presently taught by the Air Force; other curriculum requirements are met by prescribed University courses. See the department for details.

100. Military Systems — Doctrine, mission, and organization of the United States Air Force. Strategic offensive and defensive forces; nuclear weapons; civil defense; aerospace defense. Defense organization and decision-making. General purpose and aerospace support forces; tactical air forces.

3 units, Aut (Staff) MWF 1:15

300. Development of Aerospace Power — Development of aerospace power in the United States and of concepts and doctrine for employment of aerospace power.

4 units, Aut, Spr (Staff) MTWTh 8

400. The Professional Officer—Foundations of the military profession; leadership; military discipline and military justice; personnel policies.

4 units, Win (Staff) MTWTh 8

Undergraduate Program in African and Afro-American Studies

Committee in Charge: St. Clair Drake, Chairman, Frederick Bowser, William Chace, Cedric Clark, Elizabeth Cohen, Carl Degler, Sanford Dornbusch, Peter
Duignan, James L. Gibbs, Jr., Edward Greenberg, Joseph Greenberg, O. W. Holmes, Kennell Jackson, Bruce Johnson, G. Wesley Johnson, Martin Lowenkopf, Hans Weiler

STATEMENT OF PURPOSE

This interdepartmental program is designed as a major sequence for students who wish to increase their knowledge and understanding of what is sometimes referred to as “The Black Experience,” combined with training in a traditional academic discipline. The focus is upon sub-Saharan Africa and those societies in the Western Hemisphere where peoples of African descent are a significant element in the population.

ADMISSION TO THE PROGRAM

The Program is open to sophomores, juniors, and seniors with a satisfactory academic record. Those interested in the Program should consult with the Chairman of the Committee in Charge. Freshmen contemplating a possible major in this field are eligible for enrollment in History 47, 48: African Civilizations, and the first term of the core-seminar of the Program. Students wishing to enroll in the Program should write a letter of application to the Committee in Charge. The letter should include a “Statement of Purpose” indicating why the student wishes to enroll in the Program. It should also list any relevant previous experience such as courses in African or Afro-American Studies taken on or off the campus, and work-study or volunteer experience in African or Afro-American communities. It should also list the names of faculty members who may be contacted for references. A transcript should also be included. Students may submit a term paper or other sample of their written work if they wish. Ordinarily students should apply for admission by the last quarter of the sophomore year.

REQUIREMENTS

Students in the program choose an affiliation with one department, but present fifty units of credit for a bachelor's degree in African and Afro-American Studies. Twenty-five of these units will be in “core” courses, including six in the core-seminar. Twenty-five units may be presented from among the “collateral” courses; and, normally, the majority of these units will be earned in the department with which the student is affiliated. Majors in the Program may offer an African language, Hausa, Swahili, or Yoruba for collateral course units. The precise content of each student’s program will be worked out in consultation with an adviser from the department with which he is affiliated who is also a member of the Committee in Charge of the Program. In the senior year each student will write a substantial research paper or carry out a comparable project in consultation with his adviser.

CORE COURSES

(See course descriptions under Departmental listings)

A two-term core-seminar will be offered each year as well as at least one of the following workshops: Black Creative Writing, Black Performing Arts, Community Development. Special courses in Afro-American History and Literature will be announced from time to time. Courses may also be selected from the following regular departmental offerings:

ANTHROPOLOGY
104. Race and Culture Contact in the Caribbean.
109. Peoples of Africa.
110. Urbanization in African Societies.

COMPARATIVE LITERATURE

ECONOMICS
250. Wealth and Poverty in the Urban Economy.

ENGLISH
74. Literature of Black America.
174. The Portrayal of Afro-American Characters in American Literature.
274. Richard Wright, Ralph Ellison, and LeRoi Jones.

FOOD RESEARCH INSTITUTE
160. Trade and Development Problems of Tropical Africa.

HISTORY
47. African Civilizations.
147A. The History of Pre-Colonial Africa.
147B. Modern African History.
148A. The History of West Africa.
149B. Senior Honors: Research in African History.
157A. Black Community and Leadership, 1739–1877.
157B. Black Community and Leadership, 1877–Present.
182. Latin America and the African.
359. Graduate Colloquium: Social and Political Thought in the 20th Century Black Community.

HOOVER INSTITUTION
131. History of Southern Africa.

POLITICAL SCIENCE
113. Latin American Politics.
134. Interstate Relations in Africa.
183. Urban Politics.
186. The Politics of Race

PSYCHOLOGY

SOCIOLOGY
60, 61. Racism and Prejudice.

COLLATERAL COURSES
(To be selected by the student and the adviser from Departmental listings)

ANTHROPOLOGY

Chairman: Benjamin D. Paul


Associate Professors: Harumi Befu, A. Richard Diebold, James L. Gibbs, Arthur P. Wolf

Assistant Professor: George A. Collier

Lecturers: Peggy J. Golde, Louise Spindler

Research Associate: Gene McN. Sterling

OFFERINGS AND FACILITIES

The courses offered by the Department of Anthropology are designed: (1) to provide undergraduate students 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; Sociology 1 or other approved sociology course; Psychology 1 or other approved psychology course; Anthropology 5 or one of the following: Anthropology 170, 175. 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 com-
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.

Anthropology majors are invited to apply for admission to the seminar for undergraduate majors (192) and to graduate-level seminars of interest. 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 182.

**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. 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. demonstrate 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 the following required courses, during the first year, at an acceptable graduate level: 255, 290 (Autumn); 233, 245 (Winter); 283 (Spring).
3. by the end of the second year, pass at a satisfactory graduate level, one acceptable course in each of the following fields: statistics, linguistics, archaeology, physical anthropology. Students who submit satisfactory evidence of having had previous training in any of these fields will be exempted.
4. pass a Special Examination, normally given during the autumn quarter of the third year, covering the candidate’s major topic of specialization and one major ethnological area of the world.
5. pass the University Oral Examination, normally given in defense of the dissertation.
6. present a dissertation based upon independent research.

Normally graduate students will be given directed training in field research (course 288) during the summer after the first academic year, at a foreign or domestic site, depending on the continued availability of funds for this purpose.

Students are expected to serve, and gain experience, as teaching apprentices during one quarter of graduate work, normally during the second year, enrolling in course 308 for this purpose.

**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, Win (Wolf) MTWThF 10
   
   4 units, Sum (——) MTWThF 1:15

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.)

102. Indians of North America—History, cultural background, and contemporary situation of major tribes in North America.
   
   5 units, given 1971–72

103. Peoples of Mesoamerica—Survey of the cultural development culminating in the high preconquest civilizations of Mexico and Guatemala, and tracing postconquest changes in Indian peasant traditions. Emphasis falls on the broader contexts of Mesoamerican society since the time of the Spanish conquest.
   
   5 units, Win (Collier) MWF 9

104. Race and Culture Contact in the Caribbean—Types of social systems and cultural patterns in the West Indies arising from relations between Europeans, West Africans, and Asians, with implications for development and social change.
   
   5 units, Spr (Drake) MWF 11

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. Opportunities for special work on chosen topic. Prerequisite: 1 or consent of instructor.
   
   5 units, Spr (Gibbs) MWF 10

110. Urbanization in African Societies—Ancient centers for urbanism; types of cities arising from contact with Europeans; social problems incident to rapid urbanization; city planning and theoretical issues.
   
   5 units, Aut (Drake) MWF 1:15

112. Religion and the Family in China—Lecture course analyzing family life and religion in traditional and Communist China. The analysis is presented as an example of anthropological interpretation, and attention is given to the theoretical implications of the Chinese case.
   
   5 units (Wolf) given 1971–72

116. Japanese Society and Culture—Racial, cultural, social characteristics, and background. Relationships between Japanese and other peoples of East Asia. Opportunities to read on special areas. Prerequisite: 1 or consent of instructor.
   
   5 units, Aut (Befu) MWF 9

117. Traditional Chinese Society—Course of lectures which analyzes the society, polity, and economy of late traditional China as a total system. Secondary attention is given to the nature of premodern social change. Pre-
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) MWF10

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: 1 or consent of the instructor.
5 units (Skinner) given 1971-72

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 the instructor.
5 units (Befu) given 1971-72

124. Art and Culture—The focus of this course is on the linkage between society and expressive behavior manifested in plastic and graphic art. Reading, slides, and artifacts will provide ethnographic context and orientation to the art of Australia, Africa, Mexico, New Guinea, and North America. Prerequisite: 1 or consent of instructor.
5 units, Spr (Golde, Siegel) MWF 2:15

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.
5 units, given 1971-72

127. Applied Anthropology—A course focusing on the interplay between anthropological theory, methods and findings; and the instigation, study, ethics and findings of planned culture change and action programs. Consideration of case materials (U.S. and overseas) on programs of technological change, community and national development, and urban migration and relocation. Students will be encouraged to study or participate in action programs. Prerequisite: 1 or consent of instructor.
5 units, Spr (Barnett) MWF 9

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.
5 units, Aut (Siegel) MWF 11

136. Comparative Urbanism—Course of lectures designed to place problems and pathologies of contemporary urbanism in comparative perspective. African and Asian cases are utilized as well as those from the Western world. Emphasis is given to stratification and to the integration of ethnic minorities.
5 units (Drake), given 1971-72
187. 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.
5 units, Aut (Frake) MWF 2:15

5 units, Aut (Diebold) MWF 1:15

189. Introduction to Special Linguistic Topics (Same as Linguistics 269.)—Topically, 169 is a continuation of 168. Speech surrogates and the history of writing. Introduction to historical linguistics. Selected topics in psycholinguistics, sociolinguistics, and “language-and-culture.” Prerequisite: 168 or consent of instructor.
5 units, Win (Diebold) MWF 1:15

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

192. Seminar on Selected Topics in Anthropology—Normally open to anthropology majors. Registration limited. Prerequisite: consent of instructor.
5 units, Aut (Staff) by arrangement
5 units, Win (Wolf) by arrangement
5 units, Spr (Paul) by arrangement

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

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, given 1971–72

220. Seminar on Ethnoscience—Intracultural analysis of folk classification; investigation of relevant specific analyses, with special
attention to methodological procedures directed towards discovering organizing principles underlying cultural behavior; demonstration of problems involved in confronting the actual data. Prerequisite: graduate standing or consent of instructor.

5 units, given 1971–72

222. Seminar in Cultural Process — Typology of social movements. Consideration of such social problems as origins, recruitment to membership, organization, and group-environment interaction. Attention paid to competing theories (e.g., collective behavior, revitalization, relative deprivation, cognitive dissonance, stress-strain relations). Relation to peasant and national movements. Examples drawn principally from North America, Latin America, Africa, and Europe. Prerequisite: consent of the instructor.

5 units, Win (Siegel) Th 2:15–5:05

226. Advanced Culture Change — Seminar on selected topics and problems, especially at the community level. Prerequisite: graduate standing in the department or consent of instructor.

5 units, Aut (Paul) Th 2:15–5:05

233. Social Organization — Examination of theories and findings in the area of culturally defined interpersonal relations, focusing on kinship and local group organization. Prerequisites: graduate standing and consent of the instructor.

5 units, Win (Befu) TTh 10:30–12:00

235. Kinship and Social Behavior — Analysis of kinship terminologies; relations among terminological systems, social behavior, and social structure; kinship as a principle of social grouping, marriage regulation, and role behavior; examination of the technical vocabulary of kinship studies; training in data elicitation, analysis, and interpretation. Prerequisite: graduate standing or consent of instructor.

5 units, Aut (Frake) T 2:15–5:05

237. Premodern Urbanism — Comparative analysis of the nature and role of cities in traditional complex societies. The attempt is made to utilize systematically the ecological, locational, interactionist, and normative approaches to the study of urbanism/urbanization, and to incorporate findings from archaeology, historical sociology, and urban geography as well as urban anthropology.

5 units (Skinner) given 1971–72

245. Advanced Political Anthropology — 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. Prerequisite: graduate standing.

5 units, Win (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 — Analysis of selected psychocultural processes, including attention to group and individual adaptations to rapid cultural change and urbanization. Prerequisite: graduate standing and consent of the instructor.

5 units, Aut (Spindler) TTh 10:30–11:50

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.

5 units, Aut (Spindler) M 7–10 p.m.
4 units, Sum (——) TTh 3:15–5:05

260. Languages of the Pacific — Comparative Austronesian linguistics, structural characteristics of Oceanic languages, sociolinguistics in the Pacific and Insular Southeast Asia.

5 units (Frake) given 1971–72

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 (Greenberg) given 1970–71

266. Seminar: Linguistic Ways to Prehistory — The application of historical-comparative linguistic techniques to problems of cul-
ture history. Genetic and areal classifications of languages. Diachronic lexicostatistics (glottochronology). Dialect geography and "migration theory." Inferences from etymology. Prerequisite: an introductory course in general or historical linguistics satisfactory to the instructor.

5 units (Diebold) given 1971–72

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 1971–72

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, 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, Win (Barnett) W 7–10 p.m.

281. Research Methods in Anthropology—Consideration of methodological problems in anthropology such as models, typology, theory, etc. Prerequisite: graduate standing or consent of instructor.

5 units (——) given 1971–72

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 (Diebold) T 9:00–11:50

284. Seminar on Ethnographic Methods—Study of ethnographic theories, methods, and techniques, toward the goal of achieving adequate description of a culture; how to obtain testable evidence about the operation of a particular cultural subsystem and the interrelations of such subsystems; problems involved in making effective statements of comparative relevance. Prerequisite: graduate standing or consent of instructor.

5 units, given 1971–72

287. Data Analysis—Training in computer applications and other formal methods of data analysis. Prerequisite: Statistics 60 or equivalent.

5 units, Spr (Collier) TTh 2:15–4:05

288. Field Training in Cultural Anthropology — Instructions and practices in data gathering methods and analyses in native or ethnic settings. Prerequisite: graduate standing in department and consent of instructor.

3 to 12 units, Sum (Staff)

290. History of Anthropological Theory—A historical treatment of the chief theoretical trends in anthropology. Prerequisite: graduate standing and consent of instructor.

5 units, Aut (Siegel) TTh 9:00–10:20

292. Metatheory—Using historical and contemporary materials, the seminar will explore a problem in the conceptual systems used by anthropologists. Prerequisite: graduate standing or consent of instructor.

5 units (Cancian) given 1971–72

294. Seminar in Social Exchange—Review of social exchange theories in anthropology, sociology, and social psychology; their application to anthropological data. Prerequisite: graduate standing or consent of instructor.

5 units, Spr (Befu) Th 9:00–11:50

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 3:15–4:30

302. Directed Individual Study—Provides opportunities for advanced students to explore special areas of interest. Any quarter (Staff) by arrangement
5 units, by arrangement

308. Teaching Apprenticeship—Supervised experience as assistant in one undergraduate course.
5 units, any quarter (Staff) by arrangement

309. Directed Graduate Research — Research "apprenticeship" undertaken as alternative to Master's thesis.
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.

APPLIED PHYSICS

Chairman: Calvin F. Quate
Professors: Marvin Chodorow, Sebastian Doniach, Theodore H. Geballe, Walter A. Harrison, Hubert Heffner, Calvin F. Quate, Peter A. Sturrock (Space Science and Astrophysics)
Associate Professors: Arthur I. Bienenstock, Mitchel Weissbluth
Assistant Professors: Robert L. Byer, Vahe Petrosian (Astrophysics)

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 biological 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 Laboratories of Physics, the Stanford Electronics Laboratories, the Institute for Plasma Research, and the McCullough Laboratory.

The number of graduate students admitted to Applied Physics is limited. Applications should be received by January 15, 1971. Graduate students may normally enter the Department only at the beginning of autumn quarter.

PROGRAMS OF STUDY

Requirements for admission to candidacy for the M.S. and Ph.D. degrees in Applied Physics include a Bachelor's Degree in Physics or an equivalent Engineering degree. Students entering from an engineering curriculum should expect to spend at least an additional quarter of study acquiring the background to meet the requirements for advanced degrees in Applied Physics. All graduate students majoring in Applied Physics will be required to take a written comprehensive examination on undergraduate-level physics. This examination will be given annually in the winter quarter.

The University's basic requirements for the Master's degree are discussed in the section "Degrees" in this bulletin. Forty-five units of applied physics, physics, engineering, and mathematics are the minimum requirements for the degree. Up to 6 units of transfer credit for post-B.S. work taken elsewhere may be granted by validation in individual cases. Minimum subject matter requirements for the Master's degree include Physics 170, 171, 220 (or Electrical Engineering 342), Physics 230, 231, 232 (recommended but not required), Applied Physics 213, 214 (or Physics 210, 211), one quarter of advanced laboratory (chosen from Physics 200, 201, 202, 203, Applied Physics 351, 353, Electrical Engineering 329A,B, or Engineering 215), plus sufficient additional approved courses in applied physics, physics, engineering, or mathematics, to total 45 units. A reading knowledge of French, German, or Russian can be substituted for 9 of these required units. A minimum grade average of B is required in the courses taken toward the Master's degree.

Doctor of Philosophy

The University's basic requirements for the doctorate (residence, dissertation, exam-
Applications for fellowships, scholarships, and assistantships are made to the Office of
Financial Aid and must be completed by January 15, 1971.

COURSES

213, 214. Methods of Theoretical Physics—
A course designed to illustrate mathematical methods in physics and engineering. Topics
covered will include: series and integral transforms; eigenfunction expansions and
operators in function space; contour integration; special functions; Green's functions
for operators with discrete and continuous spectra; numerical methods with computer
exercises; approximation methods (scattering theory, WK, surface waves); mode mixing
and instabilities in non-linear systems. Prerequisites: Mathematics 130 and 131.

213. 3 units, Aut (Doniach) TTh 11:00-12:15
214. 3 units, Win (Doniach) TTh 11:00-12:15

232, 233, 234. Atomic and Molecular Physics
—A systematic development of the structure
and interactions of atoms and molecules
based on quantum mechanical methods and
concepts. Topics will include Dirac, Pauli
and Schrodinger formulations, multiplet
structure by Racah methods, Hartree-Fock
calculations, hyperfine couplings, vibra-
tional-rotational structure, molecular orbi-
tals, ligand-field theory as well as the physi-
cal content of various experimental methods. Prerequisite: Physics 132 or Electrical En-
gineering 322B.

232. 3 units, Aut (Weissbluth) MWF 11
233. 3 units, Win (Weissbluth) MWF 11
234. 3 units, Spr (Weissbluth) MWF 11

237. Quantum Mechanics of Atomic Sys-
tems—Directed toward application to solid
state, magnetics, quantum electronics, etc.
Includes the density matrix; quantization of
the EM field; second quantization; interac-
tion of EM radiation and matter; multiple-
quantum effects. Prerequisite: Electrical En-
gineering 322B or Physics 231.

3 units, Spr (Hefner), given 1971-72

250. Wave Phenomena in Active Media I—
Theory of wave interactions in various active
media. Space charge waves in electron
beams, plasmas and semiconductors. Insta-
Bility criteria for growing waves. Applica-
tions to various types of devices such as the
klystron, the Gunn amplifier and the small signal theory of the avalanche diode. Domain theory of the Gunn oscillator, and the LSA mode. The Read diode, and other types of IMPATT oscillators. Carrier waves dependent on electron-hole interactions in semiconductors. Prerequisites: Physics 111 and 122, or Electrical Engineering 244 or the equivalent.

3 units, Aut (Chodorow) TTh 9:00-10:15

251. Wave Phenomena in Active Media II — Interactions of coupled systems. The traveling wave tube, the backward wave tube, and the acoustoelectric amplifier. Normal mode theory and coupled mode theory. Parametric interactions. The Manley-Rowe relations. The principles of various types of oscillators, amplifiers and frequency conversion devices. Applications using various types of nonlinear media such as varactor diode, harmonic generators and amplifiers, the scattering of light by sound waves in dielectric materials, interactions between sound waves, between light waves, and nonlinear interactions in plasmas. Prerequisite: 250.

3 units, Win (Chodorow) TTh 9:00-10:15

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: consent of instructor.

3 units, Spr (Auld) alternate years, given 1971-72

261. Introduction to Astrophysics — Introduction to nonthermal phenomena of astrophysics: radio and X-ray radiation and the production of high-energy particles by the sun, neutron stars (pulsars), galaxies, and quasars. Discussion of cosmic rays, microwave background and cosmology. Prerequisites: Physics 122 and 131, or equivalents; Aeronautics and Astronautics 226 desirable.

2 units, Win (Byer) MW 9

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
361. The Sun and Solar Activity — Photosphere, chromosphere, and corona. Fraunhofer spectrum. The solar cycle. Active phenomena: sunspots, prominences, flares, radio bursts. Prerequisites: Physics 221, Electrical Engineering 244, or equivalent. (Physics 131 desirable.)

3 units, Spr (Sturrock) MWF 11, alternate years, given 1970–71

362. Stellar Structure and Evolution — Astronomical data on stars and star clusters; classification; Hertzsprung-Russell diagram. Equations of hydrostatic equilibrium and energy transport; equation of state for normal and degenerate matter; opacity; nuclear and neutrino processes. Stellar evolution from main sequence to white dwarfs, neutron stars and black holes. Prerequisites: Physics 220 or Electrical Engineering 243, or consent of instructor. (Physics 132 desirable.)

3 units, Aut (Petrosian) MWF 11, alternate years, given 1970–71

363. Seminar in Astrophysics — Limited enrollment. Study of the principles and techniques of scientific research with application to current problems of astrophysics. Students are required to take an active role, preparing and presenting reviews; working out specific research problems; acting as referee and as session chairman. Topics to be selected but may include: astrophysical plasmas; solar activity; pulsars and neutron stars; quasars and activity in galactic nuclei; experimental tests of general relativity and gravitational waves.

3 units, Aut, Win, Spr (Petrosian, Sturrock) by arrangement

364. Radiation from Plasmas.

3 units (——) given 1971–72

365. Introduction to General Relativity and Cosmology.

3 units (——) given 1971–72

366. High-Energy Astrophysics.

3 units (——) given 1971–72


3 units, Win (——) MWF 11, alternate years, given 1970–71

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) alternate years, given 1970–71

377, 378, 379. Theory of Solids — Basic methods and concepts of solid-state physics, including metals, semiconductors and insulators, crystal symmetry, band theory, the pseudopotential method, classical and quantum theories of the electron gas, optical properties, tunnelling in solids, properties of crystal defects and liquids, lattice vibrations, magnetism, and the theory of superconductivity. Prerequisite: Physics 231 or Electrical Engineering 322B.

377. 3 units, Aut (Staff) MWF 10

378. 3 units, Win (Staff) MWF 10

379. 3 units, Spr (Harrison) MWF 10

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; 379 may be taken concurrently.

2 units, Spr (Geballe) F 12:00–1:45

388. Many Body Problems in Solid-State Physics — Topics will include—the normal state: Green’s function theory of linear response, impurity scattering and electrical resistivity; instabilities of the interacting Fermi gas: ferro and antiferromagnetism, superconductivity and the insulator-metal transition; localized states in a fermion system: the X-ray problem and the Kondo effect. Prerequisites: Applied Physics 379 and Physics 232, or equivalents.

3 units, Spr (Doniach) TTh 11:00–12:15

390A. Solid-State Physics Seminar — Discussion of research problems and current litera-
ture in solid-state physics is offered by faculty, students and outside specialists.

1 unit, Aut, Win, Spr (Geballe, Staff)

Th 4:15

390B. Physics of Biological Systems — A seminar devoted to the discussion of biological systems from the standpoint of physics. Research problems and current literature on topics including molecular properties, energy transfer and transport phenomena.

1 unit, Aut, Win, Spr (Weissbluth)

T 4:15

ART

Emeriti: Daniel M. Mendelowitz (Professor); Victor M. Arnautoff (Assistant Professor)
Chairman: Lorenz Eitner
Professors: Elliot W. Eisner, Lorenz Eitner, Albert Elsen, Ray N. Faulkner, Matthew S. Kahn, Michael Sullivan
Associate Professors: Keith Boyle, 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
Principal Adviser to Undergraduate Studio Majors: Keith Boyle
Principal Adviser to Undergraduate Art History Majors: Albert Elsen

OFFERINGS AND FACILITIES

The Department offers courses of study in three areas: (1) in the history of art, (2) in the practice of drawing, painting, sculpture, design and printmaking, and (3) 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 or the Practice of Art (Studio). 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 Product Design), 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 Chairman 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
33 units in courses in art history
Art 40 and Art 50—Recommended, but not required
Total units—36

Each undergraduate major in the history of art shall take at least one year of beginning German, French, or Italian, or present proof of reading ability in one of these languages. (Students are encouraged to become proficient in two 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 en-
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 Graduate Studies 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 36 units of graduate work in the history of art in courses at the 200 level. Students will also be required to take a non-credit seminar in art historical bibliography in the first quarter.

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. Submission of two from among the term papers written during the year, for consideration by the faculty in conjunction with the written examination.

5. Completion of a comprehensive written examination covering three main areas in the history of art (the student may choose from the following: Ancient, Medieval, Renaissance, Baroque, Modern, and two areas in Oriental 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 Graduate Studies. Immediately upon acceptance of a student into the Doctoral program, a committee of at least three art historians shall be formed which shall take responsibility for advising and evaluating that student through the obtaining of the degree. It shall be left to the discretion of the committee whether or not the student will take examinations to test competence in the major field. (The committee shall also decide on the type of examination if one is required.) The committee shall also pass on the candidate's satisfying of the language requirements.

The principal thesis adviser shall be the committee chairman. It is the responsibility of the incoming student to contact his advisers before registration in order to be interviewed and counseled on a program of course work.

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.

Collateral Studies—At least 15 units must be taken in one or, at most, two supporting fields of study (such as history, literature, classics, anthropology, or philosophy), determined in consultation with the Departmental Advisers.

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:

Studio requirements:
Art 40, 50, 60

The student is required to formulate his program in careful consultation with his adviser. A flexible program expressing the concerns of the student should evolve. Such a program might place stress on one or more of four areas: drawing/painting, sculpture, printmaking, or design. The validity of a major in the studio area should reflect the artistic individuality of the student.

Art History requirements for studio major:
Art 1 (to be taken only in the freshman or sophomore year).
Art 5, 10

Students are urged to take a sequential series in art history (e.g., Art 120A, B, C.)

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 product design, undertaken on a collaborative basis with the Department of Mechanical Engineering as described in the section, "Product 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.

PRODUCT DESIGN
A Master of Arts in Art with emphasis in Product Design is offered jointly by the Department of Art and the School of Engineering (Department of Mechanical Engineering, Design Division). 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 in art education 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.

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, Eitner, 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, Ackerman, Staff)
10. Survey II—Main currents in the history of art from the Renaissance to the present.
    3 units, Win, Spr (Lewis, Ackerman, Staff)

INTERMEDIATE COURSES
100A. Ancient Art I—The Pre-Hellenic Cultures: Egypt, Mesopotamia, Crete.
      3 units, Aut (Raubitschek)
100B. Ancient Art II—Greece.
      3 units, Win (Raubitschek)
100C. Ancient Art III—Roman.
      3 units, Spr (Raubitschek) given 1970-71
103B. Greek Architecture—Origin to Hellenistic Age, with emphasis on Classical Period.
      3 units, Spr (Raubitschek)
105A. Medieval Art I—Early Christian 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)
105D. Byzantine Art—Art of the Byzantine Empire, 330-1452 A.D.
      3 units, Aut (Lewis) given 1970-71
110A. Renaissance Art I—Italian architecture, sculpture and painting of the fourteenth and fifteenth centuries.
      3 units, Aut (Forster)
110B. Renaissance Art II—Italian architecture, sculpture and painting of the sixteenth century.
      3 units, Win (Forster, Ackerman)
111A. Northern Renaissance Art I—Art in German-speaking countries during the Ref-
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)

Note: Courses numbered 110 and 111 examine a selected group of major works in their historical context and do not merely survey the period. Each quarter may be taken separately.

112. The Renaissance City—A study of the institutions, the planning and building of Italian Renaissance cities; theory, architecture and representations of urban renewal in key examples: Rome, Pienza, Florence, Verona, Mantua, Ferrara, and Sabbioneta.
3 units (Staff)

115A. Baroque Painting in Italy — Important developments in painting 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; Gericault; Delacroix; and Ingres.
3 units (———)

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.
3 units (———)

3 units (———)

121A. Modern Twentieth Century Painting I, 1900-1920 — Fauvism, Matisse, German and Austrian Expressionism, Cubism, Orphism and Futurism.
3 units (Elsen)

3 units (Elsen)

122. Contemporary Art—Aspects of recent art and architecture. An inquiry into the meaning and the historical roots of art from the 1960's.
3 units, Spr (Forster)

3 units, Aut (Elsen)

123B. Modern Sculpture II — Sculpture between World War I and World War II. Tatlin, Malevich, Gabo, Pevsner, Duchamp, Arp, Giacometti, Ernst, Moore, Lipchitz, Picasso, Gonzalez.
3 units, Win (Elsen)

123C. Modern Sculpture III — Sculpture since World War II.
3 units, Spr (Elsen)

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, given 1969-70

126D. The Art of Southeast Asia.  
3 units, Spr (Sullivan) alternate years, given 1969-70

130A. American Art I—Architecture, sculpture, painting and the household arts from pre-Columbian times to the Civil War (1860).  
3 units, Aut (Staff)

130B. American Art II—American art and architecture during the nineteenth century.  
3 units, Win (Staff)

130C. American Art III—Architecture, sculpture, painting and the household arts from 1914 to today.  
3 units, Spr (Staff)

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

3 units, any quarter (Raubitschek)

201. Seminar in Ancient Art.  
3 units, any quarter (Raubitschek)

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)

211A. Seminar: Renaissance Studies I—Grünewald.  
3 units, Win (Forster)

211B. Seminar: Renaissance Studies II—Renaissance urban planning in Italy.  
3 units, Spr (Forster)

211C. Seminar: Renaissance Studies III.  
3 units (Forster) given 1971-72

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)

221A. Studies in Modern Painting from 1900-1920.  
3 units, any quarter (Elsen)

221B. Studies in Modern Painting from 1920-1960.  
3 units, any quarter (Elsen)

3 units, any quarter (Ackerman, Elsen, Forster)

223. Seminar in Twentieth Century Art.  
3 units, any quarter (Ackerman, Elsen, Forster)

3 units, any quarter (Elsen)

224A. Seminar: Modern Art, Der Blaue Reiter—Developments of German Expressionism until 1914. Works of Kandinsky, Marc, Macke and Klee in their international context. Prerequisite: Reading knowledge of German.  
3 units, Win (Forster-Hahn)

224B. Seminar: Modern Art, Der Blaue Reiter—Continuation of Art 224A: Expressionism in its international context.  
3 units, Spr (Forster-Hahn)

3 units, Aut, Win, Spr (LaPlante)

3 units, Aut, Win, Spr (Sullivan)

3 units, Aut, Win, Spr (Sullivan)

228A. Seminar: Japanese Ceramics.  
3 units, Aut (LaPlante)

228B. Seminar: Architecture of India and Farther India.  
3 units, Win (LaPlante)
SCHOOL OF HUMANITIES AND SCIENCES

228C. Seminar: Indian Painting.  
3 units, Spr (LaPlante)

3 units, Aut, Win, Spr (Staff)

235. Methods of Art Historical Research.  
3 units, any quarter (Staff)

236. Readings in the Literature of Art.  
3 units, any quarter (Ackerman)

237. Methods of Museology.  
3 units, any quarter (Staff)

3 units, Aut (Forster-Hahn)

238. Seminar in Art for the Theater.  
3 units, Spr (Russell)

Any quarter (Staff) by arrangement

Any quarter (Staff) by arrangement

301. Master’s Thesis: Art History.  
Any quarter (Staff) by arrangement

Any quarter (Staff) by arrangement

RELATED COURSES

Philosophy of Art—See Philosophy 8.

Classical Greek Painting and Sculpture—See Classics 101.

Hellenistic Painting and Sculpture—See Classics 102.

Greek Mythology in Greek Art—See Classics 103.

Early Greek Art—See Classics 104.

Athenian Everyday Life—See Classics 105.

Art and Monuments of the Romans—See Classics 106.

Attic Red-Figure Vases—See Classics (Greek) 214.

INTERDEPARTMENTAL SEMINAR

The Nature of the Humanities—See Humanities 192. The Arts as Humanities.

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.  
3 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- and three-dimensional design.  
3 units, Aut, Win, Spr (Staff)

INTERMEDIATE COURSES

140. Drawing I—Life drawing and composition. 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)

142. Drawing III—Advanced drawing. Prerequisite: 140. May be repeated for credit.  
3 units, any quarter (Boyle)

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 (Oliveira)

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)

147. Painting III—Advanced painting. Prerequisite: 145. May be repeated for credit.  
3 units, any quarter (Lobdell)

148. Lithography—Introduction to lithography. Prerequisite: 140. May be repeated for credit.  
3 units, Aut, Win, Spr (Oliveira)

150. Sculpture I — Introduction to woodcarving and wood construction. Prerequisite: 50.  
3 units, Aut, Win, Spr (Staff)
151. Sculpture II—Introduction to sculpture in metal. Gas and arc welding are principal techniques used. Prerequisite: 150.
   3 units, Aut, Win, Spr (Staff)

160A. Design I A—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, Bowman)

160B. Design I B—Continuation of 160A on advanced level. Prerequisite: 160A.
   3 or more units, Aut, Win, Spr (Kahn, Bowman)

161. Design II—Studio seminar in design and color. Individual projects with emphasis on the relation of theory to practice.
   4 units, 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.
   (Boyle) by arrangement, given 1970–71

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

248. Advanced Lithography.
   Aut, Win, Spr (Oliveira) by arrangement

250. Individual Work—Sculpture.
   Any quarter (Staff) by arrangement

251. Metal Sculpture—Plastic construction, plastic forming. Prerequisite: 151.
   3 units, Aut, Win, Spr (Staff)

252. Advanced Metal Sculpture—Welding aluminum and stainless steel. Prerequisite: 251.
   3 units, Aut, Win, Spr (Staff)

   3 units, Aut, Spr (Staff)

   Any quarter (Kahn, Staff) by arrangement

261. Graphic Design I—Informal problems in visualizing ideas and information with emphasis on graphic thinking.
   3 or more units, Aut (Bowman)

262. Graphic Design II—Problems in the design of functional images and symbols with emphasis on graphic communication.
   3 to 6 units, Win (Bowman)

263. Graphic Design III—Projects in design and execution for photoreproduction with emphasis on graphic technology.
   3 to 6 units, Spr (Bowman)

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 1970–71

267. Three-Dimensional Design II: Media and Processes—Work with surface design in textiles, papers, plastics, and tile. Concentration on silk screen process.
   6 units, Aut (Kahn)

   6 units (Kahn) alternate years, given 1969–70

   Any quarter (Staff) by arrangement

341. Master's Project (Studio).
   Any quarter (Staff) by arrangement

341D. Master's Project: Product Design (Seminar).
   Any quarter (Kahn) by arrangement

342. Advanced Creative Studies Seminar—Intensive emphasis in areas of personal specialization, with comparative analysis.
   Aut, Win, Spr (Kahn) by arrangement

RELATED COURSE

Philosophy of Design—See Mechanical Engineering 214.

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)
Chairman: James J. Y. Liu
Professors: S. Wing Chan, Albert E. Dien, James J. Y. Liu, David S. Nivison
Assistant Professors: John C. Y. Wang, Dana B. Young. Acting: Kung-yi Kao
Lecturers: Yin Chuang, Hiroyasu Kubota, Kimie Nebrig, Hiroshi Sakamoto

Chinese-Japanese Language and Area Center

Director: Albert E. Dien
Associate Professors: Harumi Befu, Harold L. Kahn, Lyman P. Van Slyke, Arthur P. Wolf
Assistant Professors: Kung-yi Kao, John D. LaPlante, Lawrence J. Lau, Alan L. Miller, Michel Oksenberg, Stephen M. Olsen, John C. Y. Wang, Lee H. Yearley, Dana B. Young
Lecturers: Yin Chuang, Hiroyasu Kubota, Kimie Nebrig, 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, 131, 132, and one of the following: 191, 199 (Individual Reading in Chinese), or Philosophy 120 (Ancient Chinese Philosophy).

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, provided that 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 suitable literary or historical worth. 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.

**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, 213, 223, 299; four courses in Chinese numbered between 251 and 291; and two courses on the upper division or graduate level in fields such as Chinese anthropology, art, history, philosophy, and politics, as approved by the Graduate Adviser. Students may be exempted from 211, 212, 213 and 221, 222, 223, by passing examinations to demonstrate that they have attained equivalent language competence.

**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, 213, 243, 299; four courses in Japanese numbered between 246 and 262; and two courses in such fields as Japanese anthropology, history, politics, and religion, as approved by the Graduate Adviser. Students may be exempted from 211, 212, 213 and 241, 242, 243 by passing examinations to demonstrate that they have attained equivalent language competence.

**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 literature, 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 equivalent work at another university.

2. He must demonstrate a reading knowledge of French or German by the end of his first year after completing the A.M. degree.

3. He must complete two seminars numbered above 310. These seminars must be in different subjects.

4. He must pass an examination in the supporting Asian language. If the candidate's field is Chinese, he will be examined on his ability to read modern Japanese works relevant to his field of study. This requirement may be met by completing Japanese 103. If the candidate's field is Japanese, he will be examined on his ability to read Classical Chinese works relevant to his field of study. This requirement may be met by completing Chinese 103.

5. He must pass comprehensive written examinations in four fields. One of these will emphasize comparative or methodological approach to a discipline. The remaining three fields are to be chosen, with the approval of the Graduate Adviser, from the following: Chinese literature, Chinese history, Chinese philosophy, Chinese linguistics, Japanese literature, Japanese history, Japanese religion.

**University oral examination**—General regulations governing the oral examination will be found in the section “Degrees” in this bulletin. The candidate will be examined on questions related to his dissertation, after acceptable parts thereof have been completed in draft form.

**Dissertation**—The candidate will write a dissertation demonstrating his ability to un-
 undertake original research based on primary materials in Chinese or Japanese.

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

131 (231). Chinese Poetry and Drama — Graduate students may register under 231, in which case they will be expected to do additional work.
   4 units, Aut (Liu) MWF 10

132 (232). Chinese Fiction—Graduate students may register under 232, in which case they will be expected to do additional work.
   4 units, Win (Wang) MWF 10

134 (234). Japanese Prose Literature — Graduate students may register under 234, in which case they will be expected to do additional work.
   4 units, Aut (Young) MWF 11

135 (235). Japanese Poetry and Drama — Graduate students may register under 235, in which case they will be expected to do additional work.
   4 units, Win (Staff) MWF 11

   3 to 5 units, Aut (Dien) by arrangement

   3 to 5 units, Spr (Staff) MWF 11

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 and Staff) MTWThF 9
   2. 5 units, Win (Kao and Staff) MTWThF 9
   3. 5 units, Spr (Kao and Staff) MTWThF 9

5. Intensive First-Year Modern Chinese — Equivalent to 1, 2, and 3 combined.
   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. Prerequisite: 3 or equivalent.
   15 units, Sum (——) MTWThF 8–12

41, 42, 43. Intensive Modern Chinese — Intensive study in grammar, reading, conversation, and composition, the equivalent of first-year and second-year Modern Chinese
Asian Languages

The successful completion of this course will qualify the student to take 101.

41. 10 units, Aut (Staff, Chuang) MTWThF 1:15 and 2:15
42. 10 units, Win (Staff, Chuang) MTWThF 1:15 and 2:15
43. 10 units, Spr (Staff, Chuang) MTWThF 1:15 and 2:15

Advanced

101, 102, 103. Introduction to Classical Chinese—Reading, syntax, composition. Prerequisite: 23 or equivalent.

101. 5 units, Aut (Kao) MTWThF 11
102. 5 units, Win (Kao) MTWThF 11
103. 5 units, Spr (Kao) MTWThF 11

105. Intensive Introduction to Classical Chinese—Equivalent to 101, 102, 103 combined. Prerequisite: 23 or equivalent.

15 units, Sum (Staff) by arrangement

121, 122, 123. Advanced Conversation—Prerequisite: 23 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 Languages majors only). Prerequisite: 101 or equivalent.

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

Graduate

200. Directed Reading in Chinese—Prerequisite: 103 or equivalent.

Number of units to be arranged, Aut, Win, Spr (Staff) by arrangement

201, 202. Proseminar—Research methods in Chinese studies. Prerequisite: 103 or equivalent.

201. 3 units, Aut (Dien) M 2:15-4:05
202. 3 units, Win (Dien) 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 consent of the instructor, the courses may be repeated for credit in a consecutive year. Prerequisite: 103 or consent of instructor.

211. 5 units, Aut (Chan) MW 11:00-12:15
212. 5 units, Win (Chan) MW 11:00-12:15
213. 5 units, Spr (Chan) MW 11:00-12:15

215. Modern Expository Chinese—Journalistic, legal, scholarly and other types of writings in modern Chinese prose, excluding belles lettres. The materials read cover half of those of the two-year sequence of 211, 212, and 213. Prerequisite: 103 or consent of instructor.

15 units, Sum (Staff) MTWThF 9-12

221, 222, 223. Advanced Classical Chinese—Prerequisite: 103 or equivalent.

221. 4 units, Aut (Wang) MWF 11
222. 4 units, Win (Wang) MWF 11
223. 4 units, Spr (Wang) MWF 11

251, 252. Chinese Philosophical Texts—Prerequisite: 223 or consent of instructor.

251. 4 units, Aut (Nivison) WF 2:15-4:05
252. 4 units, Win (Nivison) WF 2:15-4:05

253. Local Histories—Prerequisite: 223 or consent of instructor.

4 units, Spr (Nivison) WF 2:15-4:05

254. Chinese Historical Texts—Prerequisite: 223 or consent of instructor.

4 units, Win (Dien) by arrangement

261, 262. Chinese Poetry—Prerequisite: 223 or consent of instructor.

261. 4 units, Aut (Liu) by arrangement
262. 4 units, Win (Liu) by arrangement

271, 272. Vernacular Chinese Fiction—Prerequisite: 103 or consent of instructor.

271. 4 units, Aut (Wang) by arrangement
272. 4 units, Win (Wang) by arrangement

281, 282. Modern Chinese Literature—Prerequisite: 213 or equivalent.

281. 4 units, Aut (Chan) MW 2:15-4:05
282. 4 units, Win (Chan) MW 2:15-4:05


4 units, Spr (Kao) 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 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 (Dien) M 2:15-4:05

361. Seminar in Chinese Literary Criticism—May be repeated for credit. Students intending to enroll in the seminar are required to consult the instructor at the beginning of the preceding winter quarter.

5 units, Spr (Liu) by arrangement

399. Dissertation.

(Staff) by arrangement

II. COURSES IN JAPANESE

1, 2, 3. First-Year Modern Japanese — Conversation, grammar, reading, elementary composition.

1. 5 units, Aut (Sakamoto and Nebrig) MTWThF 9
2. 5 units, Win (Sakamoto and Nebrig) MTWThF 9
3. 5 units, Spr (Sakamoto and Nebrig) MTWThF 9

5. Intensive First-Year Modern Japanese—Equivalent to 1, 2, and 3 combined.

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, and 23 combined. Prerequisite: 3 or equivalent.

15 units, Sum (-----) MTWThF 8-12

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 (Sakamoto, Kubota) MTWThF 1:15 and 2:15
42. 10 units, Win (Sakamoto, Kubota) MTWThF 1:15 and 2:15
43. 10 units, Spr (Sakamoto, Kubota) MTWThF 1:15 and 2:15

ADVANCED

101, 102, 103. Modern Written Japanese—Reading texts representative of various modern written styles. Prerequisite: 23 or equivalent.

101. 5 units, Aut (Staff) MTWThF 9
102. 5 units, Win (Staff) MTWThF 9
103. 5 units, Spr (Staff) MTWThF 9

105. Intensive Modern Written Japanese—Equivalent to 101, 102, and 103 combined. Prerequisite: 23 or equivalent.

15 units, Sum (-----) MTWThF 9-12

121, 122, 123. Advanced Conversation —Prerequisite: 23 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, Aut, Win, Spr (Staff) by arrangement

GRADUATE

200. Directed Reading in Japanese — Prerequisite: 103 or equivalent.

Number of units to be arranged, Aut, Win, Spr (Staff) by arrangement


201. 3 units, Aut (Staff) M 2:15-4:05
202. 3 units, Win (Staff) M 2:15-4:05

211, 212, 213. Modern Expository Japanese—Scholarly and journalistic writings in Japanese. Prerequisite: 103 or equivalent.

211. 5 units, Aut (Staff) by arrangement
212. 5 units, Win (Staff) by arrangement
213. 5 units, Spr (Staff) by arrangement
209. Modern Expository Japanese—Scholarly and journalistic writings in Japanese. Prerequisite: 103 or equivalent.
   15 units, Sum (——) MTWThF 9-12
215. Introduction to Classical Japanese—The basic principles of the classical literary language; the first quarter is devoted to a study of Heian grammar, while the subsequent quarters deal with later developments in style. Prerequisite: 103 or equivalent.
   241. 4 units, Aut (Young) 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, 247. Japanese Historical Texts — Prerequisite: 243 or equivalent.
   246. 4 units, Aut (Staff) by arrangement
   247. 4 units, Win (Staff) by arrangement
248, 249. Classical Japanese Prose Literature—Prerequisite: 243 or equivalent.
   248. 4 units, Win (Young) by arrangement
   249. 4 units, Spr (Young) by arrangement
251. Modern Japanese Literature—Poetry, prose, and drama after 1868. Prerequisite: 103 or equivalent. May be repeated for credit.
   4 units, Aut, Spr (Staff) WF 2:15-4:05
261, 262. Classical Japanese Poetry — Prerequisite: 243 or equivalent.
   261. 4 units, Win (Staff) by arrangement
   262. 4 units, Spr (Staff) 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. Students intending to enroll in the seminar are required to consult the instructor at the beginning of the preceding winter quarter.
   5 units, Spr (Staff) by arrangement
361. Seminar in Japanese Literary Criticism—May be repeated for credit.
   5 units, Win (Staff) M 2:15-4:05
399. Dissertation.
   (Staff) by arrangement

ADDITIONAL INFORMATION
For information concerning other opportunities for study in the Asian field, see listings under the following departmental headings: Anthropology, Art and Architecture, Economics, Graduate Division Special Programs, History, Humanities Special Programs, Philosophy, Political Science, Social Sciences (Special Program), Sociology. For additional offerings in literature, see Comparative Literature.

BIOLOGICAL SCIENCES
Chairman: Donald Kennedy
Director of Undergraduate Studies: Allan M. Campbell
Director of Graduate Studies: Philip C. Hanawalt
By Courtesy: Charles S. French, William M. Hiesey
Associate Professors: Philip C. Hanawalt, Harold A. Mooney, Peter H. Raven, John H. Thomas, Norman K. Wessells, Dow O. Woodward
Assistant Professors: David Epel, Welton L. Lee, Ward B. Watt
Instructors: Marcia K. Allen, Elizabeth M. Center, Patricia A. Sokolove

ORGANIZATION AND FACILITIES
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 designed 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 degree of Doctor of Philosophy. The Department also administers a graduate program leading to the Ph.D. in Biophysics. Applications are not accepted for the Master’s degree.

The Jasper Ridge Biological Experimental Area near the Stanford Campus provides a 735-acre reserve for ecological and population biology. Research vessels and special laboratory facilities for biological oceanography and marine research are described in the Hopkins Marine Station Bulletin.

The Falconer Biology Library in Herrin Hall contains 880 current subscriptions and back sets of journals, and an extensive collection of monographs and reference works. Smaller specialized libraries serve the needs of the Hopkins Marine Station and the botanical and zoological collections of the Division of Systematic Biology.

**PROGRAMS OF STUDY**

**BACHELOR OF ARTS**

Candidates for the degree of Bachelor of Arts must complete:

(1) **Core Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology 1</td>
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</tr>
<tr>
<td>Biology 21</td>
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<td>Biology 22</td>
<td>3</td>
</tr>
<tr>
<td>Biology 23</td>
<td>3</td>
</tr>
<tr>
<td>Biology 24</td>
<td>6</td>
</tr>
</tbody>
</table>

Total: 19

(2) **Elective Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electives</td>
<td>21</td>
</tr>
</tbody>
</table>

Total Core and Electives: 40

Elective courses may be selected from the offerings in the Department of Biological Sciences or from a list of courses in other departments. Those from other departments which are accepted as electives are: Anatomy 201, 203, 209, 212; Biochemistry 200, 201, 202, 211; Electrical Engineering 204; Genetics 201, 210, 211, 216; Geology 112, 115, 199; Medical Microbiology 101; Pathology 210; Psychology 148, 175.

Not more than 10 units from 198 and/or 199 and/or any “in-depth” course, such as 175H, 176H, 178, 222H, may be applied toward the total number (40) of required biology units.

(3) **Cognate Courses**

Required courses in cognate fields include:

- A year (three quarters) of General Chemistry
- A half year (two quarters) of Organic Chemistry
- A half year (two 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, 3 or 4, 5
- Organic Chemistry 121 and 123, or 119
- Mathematics 10, 11, 21 or 41, 42 or 31, 32, 33
- Physics 21, 23 or 51, 53, 55

It is strongly recommended that students intending to do graduate work in Biological Sciences acquire reading ability in an appropriate modern European language.

**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>Biology 1</td>
<td>Introductory Biology</td>
<td>—</td>
<td>—</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>Writing &amp; Distribution Requirements or Electives</td>
<td>—</td>
<td>8</td>
<td>8</td>
<td>4</td>
</tr>
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</table>

Totals: 15 15 15

**Second Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology 21</td>
<td>Principles of Biology</td>
<td>3</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Biology 22</td>
<td>Principles of Biology</td>
<td>—</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Biology 23</td>
<td>Principles of Biology</td>
<td>—</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>Biology 24</td>
<td>Experimental Biology</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Chem. 121, 123</td>
<td>Organic Chemistry</td>
<td>3</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Writing &amp; Distribution Requirements or Electives</td>
<td>—</td>
<td>7</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

Totals: 15 15 15

**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 21, 23</td>
<td>Introductory Physics</td>
<td>4</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>Writing &amp; Distribution Requirements or Electives</td>
<td>11</td>
<td>11</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Totals: 15 15 15
**BIOLOGY HONORS PROGRAM**

(See Biology 198 under “Courses.”) This program is open to juniors or seniors. The aim of the program is to aid students to gain independence of thought and a more professional approach to biological problems. Emphasis will be placed on the importance of original ideas in research rather than on the mastery of established facts. Satisfactory completion of the program by March 31 preceding June Commencement leads to graduation “with Departmental Honors.” This designation appears on the student’s transcript and in the Commencement Program. An Honors Certificate is awarded.

**PREMEDICAL STUDENTS**

It is recommended that premedical students who are not biology majors take at least the following courses in biology: 1, 21, 22, 23, 24, and 116, or such substitutes as may be recommended by Stanford’s Premedical Advising Office, Anatomy A44. Consult that office also for specific requirements of various medical schools.

**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 Biology 1, 21, 22, 23, 24, and 116, or such substitutes as may be recommended by Stanford’s Premedical Advising Office, Anatomy A44. Consult that office also for specific requirements of various dental schools.

**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). This describes the areas of specialization represented in the Department, facilities for study and research, and the opportunities for financial aid available to graduate students. A separate publication, the *Hopkins Marine Station Bulletin*, describes the activities and facilities of the Marine Station.

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 Mi-
crobiology, Pharmacology, Anatomy, Biochemistry, Neurology. 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 on the aptitude tests of the Graduate Record Examination as part of his application. The advanced biology test is recommended but not required. 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 ordinarily encouraged to undertake graduate study elsewhere to ensure breadth of experience. Printed information regarding choice of a graduate school can be obtained from the Student Affairs Office of the Department.

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.

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. (See Biology 350.)

Teaching Experience—Full opportunity is provided for all graduate students to gain experience in teaching at the university level by assisting in courses. A minimum of three half-time quarters of assisting is required of all graduate students in the Department. An assistantship is considered a professional appointment with all its privileges and responsibilities. Considerable flexibility exists in timing, choice of courses and amount of teaching to the extent consistent with the needs of the individual and the Department.

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 qualify-
ing 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.

Dissertation Reading Committee — Immediately upon successful completion of the qualifying examination the dissertation reading committee shall be appointed. The committee will consist of at least (1) the principal dissertation adviser, (2) a second member from within the major department, and (3) a third member chosen from the major or another department. When this third member is from another institution a fourth member must be chosen from the major department. The principal adviser and at least one of the other committee members must be Academic Council members.

Language Examinations — Proficiency in reading scientific literature in one foreign language, normally German, is required by the Department. Where appropriate, additional foreign languages may be required by the major professor. If, in the opinion of the major professor, a foreign language is not appropriate to a student's training, the student may petition the Department for a waiver of the requirement.


The Oral Examination — This consists of a forty minute formal seminar open to the public, followed by a twenty minute public discussion. After the seminar the candidate and examiners go into a closed session which will not exceed one hour. The seminar should place the candidate's work into the broader context of his field of specialization. Examiners may question in the area of specialization beyond the specific dissertation topic. This examination is taken after the dissertation is completed and submitted to the University.

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.

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 or classroom instruction for the equivalent of a half-time academic year.

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 January 15, though the Department of Biological Sciences will accept applications to March 1.

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 December. 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 most Monday afternoons at 4:15. Topics of current bio-
logical interest are presented by speakers from Stanford and from other institutions, and are announced in the weekly Campus Report. Graduate students are expected to attend.

COURSES

Additional courses not listed here are frequently offered in the areas of their special research competence by selected postdoctoral or terminal Ph.D. personnel. These are listed in the quarterly time schedules, and course descriptions are circulated in advance.

1. Introductory Biology—A survey of major topics of interest in biology, with particular emphasis on the mechanisms of Mendelian heredity. Serves as introduction to the Biological Sciences major; also open to students interested in a survey course in biology.


3 units, Win (Ehrlich) MWF 11

21, 22, 23. Principles of Biology—A comprehensive study of the principles of modern biology from the molecular to the population level of organization, including cellular and organismal biology. These courses must be taken in sequence, although not necessarily in the same year. Prerequisites: 1 or 10, and Chemistry 1, 2, 3.

21. 3 units, Aut (Staff) MWF 9
22. 3 units, Win (Staff) MWF 9
23. 3 units, Spr (Staff) MWF 9

24. Experimental Biology—Introduction to experimental methods and experimental analysis of problems in the major areas of biology. A year course designed to be taken concurrently with Biology 21, 22, and 23. Prerequisites: Chemistry 1, 2, 3.

2 units, Aut; 2 units, Win; 2 units, Spr (Staff) labs. and discussion (I) TTh 9–12, (II) TTh 2:15–5:05, (III) WF 2:15–5:05

97. Biology of Subtidal Communities — Lectures and field trips treating shallow water communities accessible to SCUBA divers. For selected communities it will introduce: (1) physical characteristics of the environment, (2) organismal composition, (3) selected aspects of their life histories and adaptation, (4) interactions between species. Enrollment is limited and by permission of instructor. Prerequisites: SCUBA certification, SCUBA equipment, and ocean experience.

3 units, Aut (Baxter, ———) TTh 7:30–10:00 p.m. plus 5 Sunday field trips

100H. Marine Algae—See Hopkins Marine Station.

102. Invertebrate Biology—The phylogeny, classification, morphology, physiology, and ecology of invertebrates. Lectures, laboratory, and field trips. Prerequisites: an elementary biology course and permission of instructor.

5 units, Aut (Baxter) MWF 9; lab. TTh 1:15–4:05

103. Comparative Histology — Microscopic structure of animal tissues; special reference to vertebrates. Prerequisite: consent of instructor.

3 units, Aut (Oliphant) TTh 10; lab. Th 1:15–4:05

104. Comparative Animal Physiology — A consideration of physiological systems in their present diversity which will emphasize generalities based on phylogeny and environmental relationships. Lectures and laboratory. Prerequisites: 12, or 22 and 24, and permission of instructor.

5 units, Spr (Baxter) MWF 10; lab. TTh 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—See Hopkins Marine Station.

112H. Marine Invertebrates—See Hopkins Marine Station.


3 or 5 units, Aut (Wessells) MWF 9; lab. (I) TTh 8–11, (II) TTh 1:15–4:05
117H. Zooplankton — See Hopkins Marine Station.

118H. Phytoplankton—See Hopkins Marine Station.

119H. Marine Ecology—See Hopkins Marine Station.

120H. Marine Ecology—See Hopkins Marine Station.

124. Comparative Parasitology: Protozoa, Helminths — Principal attention to forms parasitic in man, animals, plants of importance in human economy. Prerequisite: consent of instructor.

4 units, Win (Oliphant) TTh 10; lab. TTh 1:15-4:05


4 or 5 units, Spr (Thomas) WF 1:15; lab. WF 2:15-5:05; field trips by arrangement

132. Anatomy and Morphology of Vascular Plants—Structure, development, evolutionary relationships of vascular plants. Lectures, laboratory, field trips. Prerequisite: 11 or 22.

5 units, Aut (Thomas) MWF 1:15; lab. WF 2:15-5:05

145. Laboratory Techniques in Development—Application of microsurgical, chemical, tissue culture procedures to developmental problems. Prerequisites: 116 and consent of instructor.

3 units, Win (Wessells) TTh 1:15-5:05

147H. Comparative and Experimental Embryology—See Hopkins Marine Station.

148H. Comparative and Experimental Embryology—See Hopkins Marine Station.

151. Evolutionary Genetics—Application of genetics to study of evolution.

2 units, Win (Regnery) TTh 10, alternate years, given 1971-72

153. The Physiological Basis of Behavior—Properties of neurons, synapses, sensory receptors, and muscles; organization of neural networks and reflexes; the analysis of more complex behavior. Prerequisites: 21, 22, 23; or 1 or 10 and consent of instructor.

3 units, Win (Kennedy and Wilson) MWF 1:15

156. Plant Physiology—Principal functions of green plants, including respiratory metabolism, photosynthesis, gas exchange, water and nutrient transport, mineral metabolism, growth, and environmental responses. Prerequisites: 114 or 21 and consent of instructor.

3 units, Aut (Ray) MWF 11

157. Laboratory in Plant Physiology — Selected projects to provide experience with major experimental approaches to the functions of green plants. Prerequisites: 156 and 24, or equivalent, and permission of instructor.

2 units, Win (Ray) by arrangement

160. Topics in Population Biology—Interactions of individuals and populations. Prerequisite: 23 or 115A.

3 units, Aut (Ehrlich, Mooney, Raven) MWF 9

173H. Problems in Marine Pollution—See Hopkins Marine Station.

175H. Problems in Marine Biology — See Hopkins Marine Station.

176H. Problems in Biological Oceanography—See Hopkins Marine Station.

178. Biology of Natural Populations—An introduction to the study of natural populations: lectures, laboratory, and field studies with emphasis on individual projects. Designed primarily for undergraduates. See unit limitation under 198 and 199. Prerequisites: 11, 12 and 115A, or 22 and 23, and consent of the instructors.

10 to 15 units, Spr (Mooney, Ehrlich, Raven, Thomas, Watt) by arrangement

184. Problems in Entomology — Independent study of the morphology, physiology, ecology, behavior, taxonomy of insects. Prerequisite: 116 and consent of instructor.

4 units (Ehrlich) by arrangement

197. Student Seminars—Intensive study of specific areas of the biological literature by means of oral presentation by the students, discussion, and term papers. Topics covered will vary from year to year. Prerequisites: 113A and 115A or 21, 23, and 24.

3 units, Win (Campbell) W 2:15-4:05

198. Senior Honors Program—Research in some phase of biology of special interest to the individual. Successful completion of a minimum of ten units of 198 is required for graduation with Departmental Honors.
Units taken in another numbered research course in biology may be counted toward this minimum by arrangement between the student and the course instructor and with approval of the Committee on Undergraduate Studies upon written recommendation by the instructor to the Committee on a form provided. Biology 198 may be taken with an out-of-department faculty member only with the prior approval of the Committee on Undergraduate Studies by petition. An essay based on the research in each course taken for Honors must be presented to, and accepted by, both the research director and the Department. The essay, to be submitted in duplicate, will be deposited in the Department Library and in the University Archives. Not more than 10 units of work taken in 198 and/or 199 and/or “in-depth” courses may be counted toward the units of electives required for graduation in Biology.

(Staff) by arrangement

199. Special Problems—Not more than 10 units of work taken in 198 and/or 199 and/or “in-depth” courses (such as 175H, 176H, 178, 222H) may be counted toward the units of electives required for graduation in Biology.

(Staff) by arrangement

199H. Special Problems—See Hopkins Marine Station.

212. Evolution of the Flowering Plants — Phylogenetic relationships of angiosperms. Prerequisite: 11 or 22.

3 units, Win (Raven) MWF 10, alternate years, given 1970-71

213. Viruses — Principles of virus growth, genetics, architecture and assembly. Relation of temperate viruses and other epimemes to the host cell. Prerequisite: 21 or 113A.

3 units, Aut (Campbell) MWF 9

215. Biosystematics — Current methods of approach to systematic problems in higher plants. Prerequisites: 11 or 22 and consent of instructor.

4 units, Win (Raven) by arrangement alternate years, given 1971-72

219. Introduction to Behavior Genetics (Same as Psychiatry 219) — Designed to provide upper undergraduates and graduates in the fields of biology, psychology and anthropology with background in the principles and methods of behavior genetics. Prerequisites: Genetics 201 or equivalent course in genetics; at least one course in biology or psychology treating animal behavior.

2 units, Win (Kessler) TTh 1:15-2:05

220. Advanced Plant Ecology—Lectures and field problems in plant ecology with emphasis on the experimental approach. Prerequisites: 11 and 12, or 22 and 23, or consent of instructor.

3 units, Win (Mooney) WF 11; lab. F 1:15-4:05

221. Advanced Topics in Plant Physiology and Development—Will consider in depth currently important aspects of plant physiology such as growth and its hormonal regulation, transport phenomena, photosynthesis, and environmental responses. Topic will vary from year to year and the course may be repeated for credit with permission of instructor. Prerequisites: 156, Biochemistry 200, or equivalents, and permission of instructor.

3 units, Win (Ray) MW 2:15-3:30

222H. Biological Oceanography—See Hopkins Marine Station.

248. Genetic Recombination—Emphasis on meiotic recombination and chromosome organization in eukaryotes. Prerequisite: a knowledge of general genetics.

2 units, Aut (Perkins) M 2:15-4:05

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, or 1 and 22, a knowledge of genetics, and consent of instructor.

3 units, Aut (Ganesan) MWF 10

250. Molecular Biophysics — Physical biochemistry and physical approaches to biological problems at the molecular level. Lectures include discussion of macromolecular structure and intermolecular interactions, physical methods for characterizing proteins and nucleic acids, the interaction of electromagnetic radiation with biological molecules, isotopic tracer techniques, and classical physics of cellular processes. Open to qualified advanced students upon consent of instructor.

4 units, Win (Hanawalt) TTh 10 and T 7:15-9:00 p.m.
251. Biophysical Measurements — Selected laboratory exercises to provide experience with modern biophysical instruments and experimental techniques, including: spectrophotometry, nuclear and electron magnetic resonance, chromatography and electrophoresis, radioactive tracers, sedimentation, etc. Open to limited number of advanced students, by permission of instructor.

2 or more units, Win, Spr (Hanawalt and Staff) by arrangement

252. Gene Action—Lectures and discussion of various aspects of gene action and the regulation of enzyme formation. Prerequisite: 113A or 21 or Biochemistry 200.

3 units, Spr (Yanofsky) TTh 9, given 1971–72

253. Laboratory in Neurophysiology—Experimental approaches to the electrical properties of neurons, muscle cells, and receptors, and to the organization of central nervous systems. Enrollment limited to students intending to pursue careers in neurobiology.

4–15 units, Spr (Kennedy and Wilson) by arrangement

254. Advanced Topics in Neurobiology — By consent.

2 units, Aut (Wilson, —) by arrangement

255. Chemical Evolution — The astronomical, chemical, and geological processes leading to the appearance of life on earth. Experimental and theoretical considerations related to prebiological syntheses and models of precellular life. Prerequisites: 113A or 21, Chemistry 121 or consent of instructor.

3 units, Spr (Ponnampuruma) MWF 9

256. Drug Interactions with Biological Systems — A lecture and discussion course for graduate and advanced undergraduate students in the sciences describing selected examples of experimental approaches to the study of interactions of drugs with their biological receptors. Prerequisites: 113 or 114, or 21 and 24, organic chemistry, or consent of instructor.

2 units, Spr (Schimke) MW 4:15

257. Molecular Photobiology — Fundamentals of photochemistry, photon effects on biological macromolecules, photoinactivation of biological systems, cellular recovery from radiation damage, photodynamic action, and comparisons with ionizing radiations.

2 units, Spr (Hanawalt, K. Smith) TTh 11

258. Physiological Basis of Adaptation — Lectures and discussion on recent research, encompassing subjects from molecular to ecological aspects of adaptation. Topics may vary from year to year; thus the course may be repeated for credit with permission of instructor.

2 units, Aut (Mooney, Watt) TTh 1:15–2:05

259. Biological Clocks—Innate oscillations in physiological systems that measure environmental time. The phenomena considered will range from biochemical to behavioral, and the time periods from daily to annual. Lectures and discussion. Prerequisites: 114 or 21 and consent of instructor.

2 units, Spr (Pittendrigh) by arrangement

261H. Comparative Biochemistry of Marine Organisms—See Hopkins Marine Station.

269H. Ecological Physiology—See Hopkins Marine Station.


(Ehrlich, Mooney) by arrangement

300. Research.

(Staff) by arrangement

300H. Research—See Hopkins Marine Station.

350. Graduate Seminars—Seminars are regularly offered by research groups in the areas of population biology, molecular biology, neurophysiology, etc. Interested students should consult the Director of Graduate Studies for further information.

(Staff) by arrangement

BIOPHYSICS PROGRAM

Committee on Biophysics:

Philip C. Hanawalt, Associate Professor of Biology, Chairman; Earl E. Jacobs, Lecturer and Research Biophysicist; Harden M. McConnell, Professor of Chemistry; Howard H. Pattee, Lecturer and Research Biophysicist; Eric M. Shooter, Professor of Genetics and Biochemistry; Donald M. Wilson, Professor of Biology; two student members elected annually by the students from the group.
The Biophysics Program offers instruction and research opportunities leading to the Ph.D. in biophysics. Students admitted to the Program may perform their graduate research in the Department of Biological Sciences or, through special arrangements, in other University departments.

Represented research interests of the Committee on Biophysics include the following:

Physical-chemical characterization of nucleic acids and their modes of replication; spin-labeled biological systems; electronic structure and hyper-fine interactions in radicals; triplet excitons in molecular crystals; high pressure effects on organic solids; mechanisms of electron transport and oxidative phosphorylation in respiratory and photosynthetic enzyme systems; information theory applied to chemical reactions and chemical evolution; origin of life; theories of primitive ecosystems and evolution; molecular neurobiology; biochemical and biophysical studies in the nervous system; comparative neurophysiology and behavior; nerve network models.

PROGRAM OF STUDY

A small number of highly qualified applicants will be admitted to the Program each year. Applicants should present strong undergraduate backgrounds in the physical sciences and mathematics. The graduate course program, beyond the stated requirements, will be worked out for each student individually with the help of appropriate advisers from the Committee on Biophysics.

The requirements for the Ph.D. degree include the following:

1. Training in physics equivalent to that of an undergraduate physics major at Stanford.
2. A graduate minor in physics, chemistry, or biology (or in a related field). Consult appropriate Departmental announcements for minor requirements.
3. Completion of the following courses (or their equivalents) with a grade point average of 3.0 or better:
   a) Biology 250; and 252 or 153, depending upon interest.
   b) Biochemistry 200, 201 and 202.
   c) Chemistry 121, 171, 173 and 175.
   d) Additional courses as required for the individually tailored program.
4. Proficiency in one or more foreign languages and/or a computer language may be required at the discretion of the major professor.
5. Successful passing of a comprehensive examination as a requirement for admission to Ph.D. candidacy.
6. The presentation of a Ph.D. thesis as the result of independent investigation and expressing a contribution to knowledge in the area of biophysics.
7. The successful passing of the University oral examination which is to be taken only after the student has substantially completed his research. The examination will be preceded by a public seminar in which the research will be presented by the candidate.

COURSES

Biophysics 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: consent of instructor.

   220. 3 units, Win (Jacobs) by arrangement
   221. 3 units, Spr (Jacobs) by arrangement


   2 units, Win (Pattee) by arrangement

Other courses of interest to biophysics students:

Biochem. 200 and 201. Biochemistry Lectures.
Biochem. 213. The Arrangement of Information in Chromosomes.
Chem. 121. Organic Chemistry.
Chem. 171, 173, and 175. Physical Chemistry.
Chem. 221. Advanced Organic Chemistry.
Chem. 271, 273, and 275. Advanced Physical Chemistry.
Computation Center 1. Introduction to a Programming Language.
Elec. Engr. 204. Brains, Machines and Mathematics.
Engr. 177. Radio-activation Analysis.
Genetics 249. Cytogenetics.
Genetics 309. Selected Topics in Neurobiology.
Radiology 201. Biological and Clinical Effects of Radiation (see Medical School Bulletin.)

DIVISION OF MARINE BIOLOGY AND OCEANOGRAPHY, HOPKINS MARINE STATION

Emeriti: Lawrence R. Blinks, Rolf L. Bolin, Arthur C. Giese, Cornelis B. vanNiel (Professors)
Director: John H. Phillips, Jr.
Associate Director: Donald P. Abbott
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, and including a sheltered landing place and storage for small boats. Buildings include the “Marinostat,” the Alexander Agassiz Laboratory and the Jacques Leob Laboratory. The library subscribes to approximately 450 journals, and 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). 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 — 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 or 22 and 24; and Chemistry 1, 2, and 3; and consent of instructors.
15 units, Spr (D. Abbott, Epel, Gilmartin, Lee, Phillips, Wheeler) 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 the organisms and environment of the open sea—to the concepts, problems, and methods of biological oceanography; involves extensive work at sea aboard an oceanographic research vessel. Students will spend the entire fall quarter in residence at Pacific Grove. Open to matriculated graduate students in biology. By consent.
15 units, Aut (Gilmartin, Wheeler)
300H. Research—Problems involving original work may be undertaken with members of the staff in the following fields:

**Marine Zoology** — Problems on the functional anatomy, taxonomy, development, and ecology of marine animals.

(Abbott)

**Physiology** — Problems on physiology of invertebrate animals; photobiology, especially effects of ultraviolet light.

(Giese)

**Biological Oceanography.**

(Gilmartin, Wheeler)

**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 15 units in the full quarter is not ordinarily advisable, owing to the intensive schedule.

#### First Term

**100H. Marine Algae**—Lectures, laboratory, field work on various classes of algae. Pre-requisite: one year of biological science at college level.

5 units (I. Abbott) TThS

**111H. Marine Invertebrates** — Structure, classification, biology, phylogeny of lower marine invertebrates, echinoderms, protochordates. Prerequisite: an elementary zoology course.

5 units (D. Abbott) TThS

**117H. Zooplankton** — Lectures and laboratory work designed to provide a working knowledge of zooplankton at the organism and population level, stressing the role of zooplankton in oceanic environments from surface waters to the deep sea. Prerequisite: Invertebrate Zoology.

5 units (Wheeler) MWF, alternate years, given Sum 1971

**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 (Lee)

**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 (Epel) MWF

**176H. Problems in Biological Oceanography**—Lectures, laboratory work, field studies and individual problems. The course is designed primarily to give undergraduate majors in biology (preferably seniors) an opportunity to engage in research at sea aboard an oceanographic research vessel. Prerequisites: Biology 4 and 5, or 10, 11, and 12 or 22 and 24; and Chemistry 1, 2, and 3.

10 units (Gilmartin)

**269H. Ecological Physiology** — Physiological responses of animals to variations in environmental factors and to organisms. Most of the work will deal with marine invertebrates. Prerequisites: general zoology and elementary chemistry.

5 units (Giese) MTW

#### Second Term

**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 (D. Abbott) TThS

**118H. Phytoplankton** — Lectures, laboratory, and field work on inshore and some open sea phytoplankton, morphology and systematics, ecology and sampling tech-
niques. Prerequisite: one year of biological science at the college level.

5 units (Gilmartin) MWF, alternate years, given Sum 1972

120H. Marine Ecology — Continuation of 119H: The class will meet daily during periods of low tides. Further meetings will be announced, to make a total of 15 meetings. Prerequisite: 119H.

5 units (Lee)

148H. Comparative and Experimental Embryology—Continuation of 147H: Prerequisite: 147H.

5 units (Epel) MWF

173H. Problems in Marine Pollution—Lectures and readings dealing with selected aspects of chlorinated hydrocarbon, heavy metal, oil, and sewage pollutions. 2 units (Staff) TTh 7:30-9:30 p.m.

261H. Comparative Biochemistry of Marine Organisms—Prerequisites: elementary biology and organic chemistry.

5 units (Phillips) MWF

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

Associate Professor: Peter H. Raven


Curators: Paul R. Ehrlich (Entomological Collections), John H. Thomas (Dudley Herbarium)

Associate Curator: Warren C. Freihofer (Zoological Collections)

Research Associates: S. Stillman Berry (Malacology), Walter C. Brown (Herpetology)

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, including taxonomy, morphology, ecology, and distribution); and (c) population biology.

DUDLEY HERBARIUM

The Dudley Herbarium, named in honor of Professor William Russel Dudley, a distinguished member of the original faculty of Stanford University, is especially rich in material of vascular plants from western North America from Alaska to Central America. Representative collections from other parts of the world, especially the Mediterranean region, furnish authentic comparative material. Important private collections now incorporated into the Dudley Herbarium include a portion of the herbarium of William Harvey of Trinity College, Dublin, the herbarium of Dr. Herman Knoche, a student of the Balearic Islands, and that of Gaston Gautier, a well known 19th century French botanist. The collections in the Dudley Herbarium now number about 750,000 sheets and constitute one of the most important resources in existence for critical systematic and distributional studies of the vascular plants of North America.

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.

CHEMISTRY

Emeriti: Frederick O. Koenig, Philip A. Leighton, J. Murray Luck, J. Pearce Mitchell, Carl R. Noller (Professors)
Chairman: Paul J. Flory
Vice Chairman: Douglas A. Skoog
Associate Professors: John I. Brauman, Robert Pecora
Assistant Professors: Lawrence J. Altman, Hans C. Andersen, Leonard M. Stephenson, Frank A. Weinhold
Lecturer: Carole L. Hamilton
Affiliated Faculty: Paul Kruger (Civil Engineering)

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 by the American Chemical Society or to the B.S. degree with Honors. A year or more of secondary school preparation in German is desirable.

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

University writing and distribution requirement; 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, 153, 171, 173, 175, 176. In addition, a reading knowledge of scientific German is strongly recommended. Premedical students majoring in chemistry may substitute Physics 21, 23, 29 for Physics 51-58 provided they also complete Biology 1, 21, 22, 23. 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, at least three units from Chemistry 145, or 190; and at least three units from one of the following: Chemistry 143, 145; 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. A reading knowledge of scientific German or Russian is required. This requirement may be fulfilled by completing one year of college level courses or by passing the graduate language examination.

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; and nine additional units from Chemistry 221, 223, 225, 241, 251, 253, 255, 271, 273, 275, 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 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>Writing Requirement</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>5</td>
<td></td>
</tr>
<tr>
<td>Math. 10, 11, 21. Analytic Geometry and Calculus</td>
<td>3</td>
<td>3</td>
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</tbody>
</table>

Totals: 14 14 16

**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>3</td>
<td></td>
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<tr>
<td>Math. 22, 23. Analytic Geometry and Calculus</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Physics 51, 53, 54. Mechanics, Sound, Electricity</td>
<td>4</td>
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<tr>
<td>Electives (see Note 1)</td>
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Totals: 15 16 15

**Third Year**

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<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 113, 114. Quantitative Analysis</td>
<td>4</td>
<td>—</td>
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<tr>
<td>Chem. 116. Instrumental Analysis</td>
<td>4</td>
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<tr>
<td>Chem. 171, 173, 175. Physical Chemistry</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
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<tr>
<td>Chem. 176. Physical Chemistry Laboratory</td>
<td>3</td>
<td>—</td>
<td>3</td>
<td></td>
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<tr>
<td>Physics 55, 56, 57, 58. Light and Heat, Atomic Physics</td>
<td>5</td>
<td>4</td>
<td>—</td>
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</tr>
<tr>
<td>Electives (see Note 1)</td>
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Totals: 15 15 15

**Fourth Year**

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<th>Subject</th>
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<tbody>
<tr>
<td>Chem. 153. Inorganic Chemistry</td>
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<td>Electives (see Note 1)</td>
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<td>12</td>
<td>15</td>
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</table>

Totals: 15 15 15

*Note 1.* — Elective courses must be used to complete the University Writing and Distribution Requirement. They may also be used to broaden the student's background in science and non-science areas and to provide an opportunity for advanced study in chemistry. Courses offered by other departments that may be of interest to chemistry majors include: Chem.Engr. 128, 130A, 130B, 150, 204; Economics 1; English 102; Mathematics 44, 106, 113, 130, 131, 132; Physics 61, 110, 111, 132; Statistics 27, 110, 116; Geology 1, 25; Engr. 50; Min.Engr. 105; Mat. Sci. 107; Microbiology 101; Biology 1, 21, 22, 23, 116; Biochem. 101, 102; Comp.Sci. 106, 127; Civil Engr. 171, 175, 278.

**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.

Candidates for advanced degrees must have a minimum grade point average of 3.0 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.

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 25, 26, 1970, 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 25, 1970. 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, 255, 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 organic chemistry ordinarily will be met in German and in French or Russian. The foreign language requirement in physical or inorganic chemistry ordinarily will be met in either German 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 271, 273, and 275 (or be exempted therefrom by passing special examinations administered by the professors in charge of these courses); (2) two courses from Chemistry 251, 253, or 255; (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) demonstrate laboratory proficiency 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 3.0 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 3.0 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 203, 211, 212, 213, 214, 215 or 217 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 221, 223, 225, 251, 253, 255, 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 3.0 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, 255, 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, Edward Curtis Franklin Fellowship, James W. McBain Memorial Fellowship, Staufer 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 Gard 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—Primarily for freshmen. Preparation for medicine, biochemistry, chemistry, and related fields. Stoichiometry and the properties of gases, liquids, solids and solution. Prerequisite: high school algebra.


2. General Chemistry — Continuation of 1: Solutions of electrolytes, chemical equilibrium, electro-chemistry and elementary thermodynamics. Prerequisite: 1 or consent of instructor.

4 units, Win (Staff) lec. and lab. sections same as under Chemistry 1.

3. General Chemistry — Continuation of 2: Atomic and molecular structure in relation to the properties of matter. Prerequisites: 2, or consent of instructor; trigonometry.

5 units, Spr (Staff) lec. (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) lec. TTh 8; lab. sections same as under Chemistry 1.

5. General Chemistry—Continuation of 4.

4 units, Win (Staff) lec. TTh 9; lab. sections same as under Chemistry 1.

111. Quantitative Analysis — Primarily for premedical students. Not for Chemistry or Chemical Engineering majors. Chemical principles underlying quantitative analyses for common inorganic ions by gravimetric, volumetric, potentiometric and colorimetric procedures. Concurrent enrollment in 112 required. Prerequisite: 3 or 5. It is recommended that 121 and 123 be completed previous to enrollment in 111.

2 units, Spr (Loring) TTh 11

Sum (Staff) MWF 11

112. Quantitative Analysis Laboratory — Concurrent enrollment in 111 required. Quantitative analyses are required of a series of unknowns involving the chemical principles covered in 111.

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 (Skoog) TTh 11

114. Quantitative Analysis Laboratory — Concurrent registration in 113 required.

2 units, Aut (Skoog) MW 1:15–4:05 or TTh 1:15–4:05

116. Instrumental Analysis—Fundamentals of modern analytical techniques, especially spectrometric methods, electrochemical methods and those of separation. Theory and techniques of absorption spectrometry, polarimetry, refractometry, flame photometry, conductometric, amperometric, potentiometric and coulometric titrations, chromatography and electrophoresis. Prerequisites: 113, 114, 171 and previous or concurrent enrollment in both 173 and Physics 29 or 57.

4 units, Win (Skoog) 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. Given summer only.

5 units, Sum (Staff) MTWThFS 9

120. Organic Chemistry Laboratory—Prerequisite: concurrent enrollment in 119 Given summer only.

1 unit, Sum (Staff) M or W 1:15–5:05

121. Organic Chemistry—A systematic introduction to the chemistry of carbon compounds. Aliphatic and aromatic hydrocarbons, alcohols, halides, ethers, aldehydes and ketones, reaction mechanisms, and stereochemistry. Prerequisite: 3 or 5.

4 units, Aut (Brauman) lec. (I) MWF 11, (Mosher) lec. (II) TThS 10, and one recitation by arrangement

122. Organic Preparations — Laboratory course. About twenty organic compounds will be synthesized. Experiments will be designed to introduce the techniques and...
Manipulations common to many research labs. Some emphasis will be placed on methods of analytical separations. Prerequisite: 119, or previous or concurrent enrollment in 123.

3 units, Win (Altman, Stephenson) MW 1:15-5:05 or TTh 1:15-5:05
Sum (Staff) MW 1:15-5:05

123. Organic Chemistry — Continuation of 121: Organic acids, esters and other acid derivatives, amines and other nitrogen compounds, optical isomerism, amino acids, carbohydrates and other natural products.

3 units, Win (Brauman) lec. (I) MWF 11; (Mosher) lec. (II) TTh 10

124. Qualitative Organic Analysis Laboratory — Techniques and theory, including both spectroscopic and “wet chemical,” in the identification of organic compounds and mixtures in the 0.1 to 1 gram range. Assigned reading and problems. Prerequisite: 122.

3 units, Spr (Altman) MWF 1:15-4:05

125. Organic Chemistry — Continuation of 123: Natural products, physical methods in organic chemistry, selected advanced topics.

3 units, Spr (Bonner) MWF 11

143. Nuclear Chemistry—(See Civil Engineering 172.) Properties of nuclei 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 29 or 57, or equivalent.

3 units, Win (Kruger) TTh 11

145. Radioactivation Analysis — (See Civil Engineering 177.) 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.

3 units, Spr (Kruger) TTh 1:15 and one lab. by arrangement

153. Inorganic Chemistry — Intended for undergraduates. Survey of the chemistry of transition metal compounds. Bonding, stereochemistry, and structural patterns among transition metal complexes. Emphasis will be given to the synthesis and reactions of organometallic compounds. Prerequisite: 171.

3 units, Win (Collman) MWF 10

171. Physical Chemistry—Chemical thermodynamics: 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”).

3 units, Aut (Pecora) MWF 11

173. Physical Chemistry—Quantum Chemistry, molecular structure and spectroscopy including atomic spectroscopy, molecular rotation and microwave spectroscopy, molecular vibration and infrared spectroscopy, electronic states of molecules and magnetic resonance spectroscopy. Prerequisite: 171.

3 units, Win (Baldeschwieler) MWF 11


3 units, Spr (Weinhold) MWF 11

176. Physical Chemistry Laboratory—Vacuum, temperature control, electronic and optical techniques used in the measurement of electrolyte dissociation, reaction rates, viscosity, vapor pressure, molecular rotation-vibration spectra, electronic spectra, electrochemical potential, surface tension and molecular dipole moments. Prerequisites: 116 and previous or concurrent enrollment in 175.

3 units, Spr (——) lec. T 10; lab. TTh 1:15-4:05 or WF 1:15-4:05

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—Introduction to physical organic chemistry.
Basic M. O. theory and application. Methods of determining organic reaction mechanisms from a theoretical and experimental point of view. Prerequisites: 125 and 175.

3 units, Aut (Stephenson) MWF 9

223. Advanced Organic Chemistry — Continuation of 221: Applications of physical methods, notably mass spectrometry and optical rotatory dispersion, to organic chemical problems; synthetic reactions in the steroid field, and degradative organic chemistry with illustrations from the field of natural products. Prerequisite: 221 or consent of instructor.

3 units, Win (Djerassi) M 8–10 and W 8

225. Advanced Organic Chemistry — Continuation of 223: Organic reactions, new synthetic methods, conformational analysis, and exercises in the syntheses of complex molecules. Prerequisite: 223 or consent of instructor.

3 units, Spr (Johnson) MWF 9

227. Selected Topics in Organic Chemistry — May be repeated for credit. Possible topics include synthetic organic chemistry, photochemistry, inorganic-organic chemistry, bioorganic chemistry, reaction mechanisms, physical-organic chemistry. Prerequisite: 225 or consent of instructor.

3 units, Aut, Win, Spr (Staff) MWF 10

229. Organic Chemistry Seminar — Attendance is required of all graduate students majoring in organic chemistry.

1 unit, Aut, Win, Spr (Staff) F 4


2 units, Spr (Altman, Brauman) by arrangement


2 units, Aut (Loring) TTh 9

251. Advanced Inorganic Chemistry—The chemistry of complex ions. Prerequisite: one year of physical chemistry.

3 units, Aut (——) TTh 11

253. Advanced Inorganic Chemistry — Solution of ions; substitution and electron transfer reactions, emphasizing the principles of kinetics and other approaches to defining reaction mechanisms. Prerequisite: one year of physical chemistry.

3 units, Win (Taube) TTh 11


3 units, Spr (Collman) TTh 11 and one hour by arrangement

271. Advanced Physical Chemistry—Quantum mechanics. Prerequisite: 175.

3 units, Aut (——) MWF 11

273. Advanced Physical Chemistry—Molecular spectroscopy and molecular structure. Examination of the experimental and theoretical basis for various models of molecular structure: review of quantum theory of atomic and molecular structure, Born-Oppenheimer approximation, molecular energy levels, interaction of radiation with matter, microwave, infrared, and ultraviolet spectroscopy of molecules. Also, special topics to be chosen according to the interests of the students and instructor; for example, scattering of light by fluids, correlation function methods, spectra of molecules in solution, Mössbauer spectroscopy, magnetic resonance, Raman spectroscopy. Prerequisite: 271.

3 units, Win (Andersen) MWF 11

275. Advanced Physical Chemistry—Basic principles and methods of statistical mechanics from the ensemble point of view, statistical thermodynamics, heat capacities of solids and polyatomic gases, chemical equilibria, equations of state of fluids, phase transitions. Prerequisite: 271.

3 units, Spr (Pecora) 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 consent of instructor.

3 units, Aut, Win, Spr (Staff) MWF 10
281. Chemical Physics—Lectures. Prerequisite: 175 or permission of instructor.
3 units, Aut (McConnell) MWF 9, alternate years, given 1971–72

283. Chemical Physics — Continuation of 281: Prerequisite: 281 or consent of instructor.
3 units, Win (McConnell) MWF 9, alternate years, given 1971–72

285. Chemical Physics — Continuation of 283: Prerequisite: 283 or consent of instructor.
3 units, Spr (McConnell) MWF 9, alternate years, given 1971–72

300. Department Seminar — Attendance is required of all graduate students, and all undergraduates registered for 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 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 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 200 (or 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 124.
(Staff) by arrangement

See also Senior Colloquia.

CLASSICS

Emeriti: Hermann F. Fränkel, Raymond D. Harriman (Professors)
Chairman: Mark Edwards
Professors: Mark Edwards, Edwin M. Good (Religion and Hebrew), C. John Herings-
ton, Lionel Pearson, Antony E. Raubitschek, T. B. L. Webster (Emeritus)
Associate Professor: Michael Wigodsky
Assistant Professors: William Berg, N. Gregson Davis, Andrew Devine, Ronald Mellor, John Moore

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 is a very important part of a liberal education and should be undertaken with that thought in mind. The department hopes that some students who make it their major subject will devote themselves to teaching Latin and Greek in high schools or colleges.

ADMISSION TO THE DEPARTMENT

Prospective majors in Classics should enroll in the Department as early as possible, since at least three years of work in Latin or Greek will generally be required of them, and those with no previous knowledge of Latin (or Greek) should begin the study of the language in their freshman year, or as early as possible in their sophomore 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. A student interested in obtaining certification for teaching Latin in the State of California should consult the Chairman of the Department or his adviser.

1. Latin and Greek. 50 units in Latin and
Greek courses at the 100 level or higher. If recommended by the student’s adviser, some work in Latin or Greek composition and in the other 170 courses should be included. (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: 30 units in Latin courses, all at the 100 level or higher (including, if recommended by the student’s adviser, some work in Latin Composition and in the 170 courses); two courses in ancient history; some work in Greek, or two related courses, acceptable to the department, in ancient art and archaeology, classical civilization, or the Humanities program.
   b) Greek: 30 units in Greek courses, all at the 100 level or higher (including, if recommended by the student’s adviser, some work in Greek Composition and in the 170 courses); two courses in ancient history; some work in Latin, or two related courses, acceptable to the department, in ancient art and archaeology, classical civilization, or the Humanities program.

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 any field acceptable to the department.

Combined Majors

Students may with the consent of the Chairman 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 Chairman 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 16 shall be on the 100 level or above, and 4 units in related courses (Greek or Roman history, ancient art and archaeology).

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:

- CL O 2nd Year Greek 3-4 units
- CL L Latin Readings 4 units
- CL G Greek Readings 4 units
- CL A Art and Archaeology 3 units
- CL H Ancient History 4 units

All students interested in this program should consult the Chairman 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 15
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 Departmental secretary).
   c) Final written examinations 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 examinations 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 the reading and writing of Greek and Latin unless they receive a satisfactory grade in Greek 205 and Latin 205.

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 examinations in the spring term of the same year and the autumn term of the following 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 Chairman 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 Chairman 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.

Comparative Literature

The Classics Department cooperates closely with the Graduate Program in Comparative Literature. Interested students should consult the Chairman of the Department.

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 with no previous experience may begin the study of Greek with either Greek 1 or Greek 51. The series 1, 2, 3 begins in Autumn quarter (4 units a quarter), the series 51–52 in Winter quarter (5 units a quarter), and is intended to cover the same ground at a more rapid pace, so that the series 101, 102, 103 forms a sequel equally to Greek 3 and Greek 52. During the first year some Xenophon or Plato will be read, so as to prepare the student in the following year for further reading of Plato, Homer, and Euripides. These courses all form part of a series, but qualified students may be admitted to the class in winter or spring by consent of the instructor.

Students who have done previous work in Greek elsewhere should consult a member of the department to determine for what course they are qualified.

Students whose major work is in another department and who wish to fulfill a departmental language requirement by taking Greek should consult their departmental advisers to determine what courses will be required, but most departments will be satisfied if part of the series 101, 102, 103 is completed.

1. First-Year Greek—For beginners.
   4 units, Aut (Mellor) MTWF 10
2. First-Year Greek—Continuation of 1.
   4 units, Win (Mellor) MTWF 10
3. First-Year Greek—Continuation of 2.
   4 units, Spr (Mellor) MTWF 10
51. First-Year Greek—Accelerated course.
   5 units, Win (Moore) MTWThF 1:15
52. First-Year Greek—Continuation of 51.
   5 units, Spr (Moore) MTWThF 1:15
101. Second-Year Greek—Reading of Plato, Apology, and other selections.
   3 units, Aut (Raubitschek) TTh 10 and one hour by arrangement
102. Second-Year Greek—Continuation of 101. Homer, Odyssey.
   3 units, Win (Raubitschek) TTh 10 and one hour by arrangement
103. Second-year Greek—Continuation of 102. Euripides, Alcestis.
   3 units, Spr (Raubitschek) TTh 10 and one hour by arrangement
   2 units, Spr (——) by arrangement
Students who wish to do extra work and earn additional units in Second-Year Greek should consult the instructor.

Third- and Fourth-Year Courses

The series 111–113 is offered every year. 151–153 and 161–163 are offered in alternate years and may be taken in succession.

111. Tragedy—Sophocles, one or more plays.
   3 to 4 units, Aut (Webster) MWF 10
112. Euripides.
   3 to 4 units, Win (Berg) MWF 10
### COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

#### COURSES FOR UNDERGRADUATE STUDENTS

<table>
<thead>
<tr>
<th>Course Description</th>
<th>Units</th>
<th>Quarter/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>113. Attic Prose.</td>
<td>3-4</td>
<td>Spr (-----) MWF 10</td>
</tr>
<tr>
<td>151. Aristophanes.</td>
<td>3-4</td>
<td>Aut, given 1971-72</td>
</tr>
<tr>
<td>152. Herodotus.</td>
<td>3-4</td>
<td>Win (-----) given 1971-72</td>
</tr>
<tr>
<td>153. Homer. Iliad.</td>
<td>3</td>
<td>Win (-----) given 1971-72</td>
</tr>
<tr>
<td>160. Individual Work.</td>
<td>3-4</td>
<td>Spr (-----) MWF 10</td>
</tr>
<tr>
<td>161. Hesiod and Aeschylus.</td>
<td>3-4</td>
<td>Aut (Moore) MWF 10</td>
</tr>
<tr>
<td>162. Plato and Aristotle.</td>
<td>3-4</td>
<td>Win (Moore) MWF 10</td>
</tr>
<tr>
<td>163. Plato and Aristotle — Continuation of 162.</td>
<td>3-4</td>
<td>Spr (Berg) MWF 10</td>
</tr>
</tbody>
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The sequence of authors in undergraduate courses is intended to provide an initial acquaintance with the best of classical literature and to meet each student's level of competence in the language. Modifications may be made to suit the needs and interest of each class.

#### COURSES FOR GRADUATE STUDENTS

<table>
<thead>
<tr>
<th>Course Description</th>
<th>Units</th>
<th>Quarter/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>205. The Reading and Writing of Greek.</td>
<td>2</td>
<td>Aut, Win (to be followed by Latin 171) (-----) MWF 10</td>
</tr>
<tr>
<td>206. Classical Political Theory.</td>
<td>4</td>
<td>Aut (Raubitschek) by arrangement</td>
</tr>
<tr>
<td>207. Hellenistic Poetry.</td>
<td>4</td>
<td>Aut (Webster) W 2:15</td>
</tr>
<tr>
<td>208. Hesiod.</td>
<td>4</td>
<td>Aut (Berg) by arrangement</td>
</tr>
<tr>
<td>209. Odyssey.</td>
<td>4</td>
<td>Win (Edwards) by arrangement</td>
</tr>
<tr>
<td>210. Aristotle (Poetics).</td>
<td>4</td>
<td>Win (Webster) by arrangement</td>
</tr>
<tr>
<td>211. Pindar.</td>
<td>4</td>
<td>Win (Pearson) by arrangement</td>
</tr>
</tbody>
</table>

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### II. COURSES IN LATIN

#### FIRST-YEAR COURSES

Students with no previous experience may begin the study of Latin with either Latin 1 or Latin 51. The series 1, 2, 3 begins in autumn quarter (4 units a quarter), the series 51, 52 in winter quarter (5 units a quarter) and is intended to cover the same ground at a more rapid pace, so that the series 101, 102, 103 forms a sequel equally to Latin 3 and Latin 52. During the first year some Caesar or other simple Latin prose will be read so as to prepare the students in the following year for Cicero, Virgil, and Ovid. These courses all form part of a series, but qualified students may be admitted to the class in winter or spring by consent of the instructor.

The responsibility for teaching first-year Latin courses will be shared between a regular member of the department and a teaching assistant.

Students whose major work is in another department and who wish to fulfill a departmental foreign language requirement by taking Latin should consult their depart-
mental advisers to determine what courses will be required, but most departments will be satisfied if part of the series 101, 102, 103 is completed.

1. First-Year Latin—For beginners.
   4 units, Aut (——) MTWF 1:15
2. First-Year Latin—Continuation of 1.
   4 units, Win (——) MTWF 1:15
3. First-Year Latin—Continuation of 2.
   4 units, Spr (——) MTWF 1:15

51. Accelerated Beginners’ Course.
   5 units, Win (Davis) MTWThF 9
52. Accelerated Beginners’ Course—Continuation of 51.
   5 units, Spr (Davis) MTWThF 9

The intensive Latin course (Latin 10) offered in summer quarter should prepare students to enter Latin 101 in the autumn quarter.

INTERMEDIATE COURSES

Students will be admitted to these courses by completing Latin 3 or Latin 52 or on the basis of previous work done in high school or elsewhere. Usually two years of high school Latin qualifies a student for 101, three or four years for 111. New students should determine for which course they are best fitted by writing the Latin placement examination, which is set every autumn in orientation week, or by consultation with a member of the Department. These courses form two consecutive series, but students may be admitted to the class in winter or spring quarter by consent of the instructor.

101. Second-Year Latin (Sequel to Latin 3 or 52.)—Reading in Latin prose. Cicero, Sallust, Caesar.
   4 units, Aut (Pearson) MWF 10
   4 units, Win (Pearson) MWF 10
103. Second-Year Latin (Continuation of 102.)—Latin Poetry. Virgil, Aeneid. One or more books will be studied.
   4 units, Spr (Pearson) MWF 10
104. Christian or Medieval Latin Authors.
   Spr, by arrangement
111. Third-Year Latin (Sequel to Latin 103.)—Literature of the Augustan Age. Horace, Odes, a selection.
   4 units, Aut (Berg) MWF 9
112. Third-Year Latin (Continuation of 111.)—The Augustan Age. Virgil, Eclogues and Georgics.
   4 units, Win (Berg) MWF 9
113. Third-Year Latin (Continuation of 112.)—The Augustan Age. Livy and the elegiac poets, a selection.
   4 units, Spr (Edwards) MWF 9

MORE ADVANCED COURSES

The series 151–153 and 161–163 will be offered in alternate years and may be taken in successive years.

151. The Letters of Cicero and Pliny.
   3 to 4 units, Aut (——) given 1971–72
152. Cicero, Oratory.
   3 to 4 units, Win (——) given 1971–72
153. Roman Comedy or Satire.
   3 to 4 units, Spr (——) given 1971–72
160. Individual Work.
   By arrangement
161. Lucretius.
   3 to 4 units, Aut (Davis)
   3 to 4 units, Win (——)
163. Tacitus.
   3 to 4 units, Spr (Mellor)

The sequence of authors in undergraduate courses is intended to provide an initial acquaintance with the best of classical literature, and to meet each student’s level of competence in the language. Modification may be made to suit the needs and interest of each class.

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

171. History of Latin Literature.
   2 plus 4 units, Win, Spr (follows Greek 171) (Wigodsky) MWF 10
175. Latin Composition.
   2 units, Aut, Win (Davis)

GRADUATE COURSES

205. The Reading and Writing of Latin.
   2 units, Aut, Win, Spr (Devine)
   by arrangement
206. Seneca’s Tragedies.
   4 units, Aut (Herington) by arrangement

207. Cicero, De Finibus.
   4 units, Aut (Wigodsky) W 2:15

208. The Latin Epic after Virgil.
   4 units, Win (———) by arrangement

209. Tacitus.
   4 units, Win (Mellor) by arrangement

   4 units, Spr (Berg) by arrangement

211. Apuleius.
   4 units, Spr (Berg) by arrangement

260. Directed Reading.
   By arrangement

Note: Any student can continue courses 206, 207, 208, and 209 in the following quarter by arrangement with the instructor. This will usually require the writing of a research paper based on work directly related to the course.

Courses alternate or vary from year to year. In 1969–70 there were courses in the following authors or topics: Virgil, Cicero, Horace Satires, Latin Elegiac Poetry, Petronius.

See also Classics 201, 207, 208, and 213.

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 (Wakeman) MTWThF 9

2. First-Year Hebrew—Continuation of 1.
   5 units, Spr (Wakeman) MTWThF 9

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 (See Humanities 61)—A study of the epic in respect to structure, character, theme, and imagery.
   3 units, Aut (Edwards) 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

163. Comparative Mythology: Topics from Greek and Roman, Near-Eastern and African Culture.
   3 to 4 units, Win (Davis) MWF 1:15

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

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, given 1971–72

173. Classical Political Theory — Ancient political ideas (Plato, Aristotle, Polybius, Cicero) and their impact on modern theory.
   3 units, Win (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) TTh 1:15, given 1971–72

V. COURSES IN ANCIENT HISTORY

These courses are accepted by the History Department for credit towards a major in History.

INTRODUCTORY COURSES

Open to all students.

102. History of Greece.
   4–5 units, Aut (Raubitschek) MTWTh 2:15

103. History of Rome.
   4–5 units, Win (Mellor) MTWTh 2:15

For courses concerned with the history of Ancient Near East, see Humanities Special Programs.
MORE SPECIALIZED COURSES

112. Alexander and the Hellenistic World—Open to all students, designed as a sequel to 102.
   4 units, Spr (Pearson)

113. The Roman Empire in the Second Century—Open to all students, designed as a sequel to 103.
   4 units, Aut (Mellor)

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. Classical Greek Painting and Sculpture.
   2 units, Aut (Webster) T 3:15

102. Hellenistic Painting and Sculpture.
   2 units, Win (Webster) T 3:15

103. Greek Mythology in Greek Art.
   2 units, Spr (Webster) T 3:15

Additional work in the Museum can be arranged. Students should consult Professor Webster.

104. Early Greek Art.
   2 units, Aut (Webster) T 3:15, given 1971–72

105. Athenian Everyday Life.
   2 units, Win (Webster) T 3:15, given 1971–72

106. Art and Monuments of the Romans.
   3 units, Spr (Wigodsky), given 1971–72

See Greek 214.
See also Art 100A,B,C, 103B, and 201.

VII. GENERAL COURSES

201. Introduction to Classical Scholarship.
   1 unit, Aut (Wigodsky, Staff) T 10

207, 208. Comparative Grammar of Greek and Latin.
   207. 4 units, Win (Devine) by arrangement

208. 4 units, Spr (Devine) by arrangement

209. Classical Rhetorical Practice — (See Classics 209 under Comparative Literature.)
   4 units, Spr (Davis) by arrangement

213. Introduction to German Classical Scholarship.
   4 units (Berg) by arrangement

Introduction to Comparative Linguistics (Indo-European)—See Linguistics 201.
   3 units, Aut (Devine) W 4:15–6:05

Sanskrit 211A,B,C. First Year Sanskrit—Introduction to the phonology and grammar of Classical Sanskrit.
   5 units, Aut, Win, Spr (Devine)
   MWF 2:15–3:45, alternate years, given 1971–72

Sanskrit 212A,B. Sanskrit Grammar and Reading of Texts.
   5 units, Aut, Win (Devine) MWF 2:15–3:45, alternate years, given 1970–71

COMMUNICATION

Emeritus: Chilton R. Bush (Professor)
Chairman: Wilbur Schramm
Director, Institute for Communication Research: Wilbur Schramm
Director, Professional Journalism Fellowship Program: Lyle M. Nelson. Associate Director: Harry N. Press
Associate Professors: Henry S. Breitrose, William J. Paisley, Edwin B. Parker
Assistant Professors: Cedric C. Clark, David L. Grey. Acting: Don H. Coombs, G. Ray Funkhouser, Aimee D. Leifer, Donald F. Roberts
Lecturers: Jules Dundes, Templeton Peck

The Department of Communication engages in research in communication and offers curricula leading to the A.B., A.M. and Ph.D. degrees in communication. The Master of Arts degree prepares students for careers in journalism or documentary film. The Ph.D. degree is for careers in teaching and research or other research specialties.
The Institute for Communication Research is the research arm of the Department and offers research experience to advanced students.

The Professional Journalism Fellowship Program brings promising young journalists to study at the University in a non-degree program.

**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. Sophomore students must have completed one course in the Department prior to declaring a major.

The exceptionally well-qualified undergraduate major student wishing to pursue a professional program leading to the A.M. degree after one graduate year may apply for admission during winter quarter of his junior year.

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 University's Office of Admissions.

Prospective graduate students should write to: Chairman, 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 in exceptional circumstances where the applicant is prevented from taking the tests.

**PROGRAMS OF STUDY**

**Bachelor of Arts**

A student planning a major in Communication is strongly urged in consultation with his adviser to select courses in literature, social sciences, and sciences. Most commonly, majors take elective courses in psychology, sociology or anthropology, political science, history, economics, speech and drama, and in such interdepartmental studies as urban affairs, human ecology, and black studies.

One degree program is offered with the opportunity to concentrate in the general study of communication and the mass media or in pre-professional study in journalism or broadcasting and film. The undergraduate major is designed to provide flexibility of offerings within the Department combined with a flexible program of breadth and depth in courses outside the Department. Burden of program development rests with the student in close consultation with his adviser.

Requirements for the degree are as follows:

1. Two survey courses, Communication 1 and 142 or 220.
2. Two courses, either Communication 100–102, and 150 or 175; or 200 and 223A.
3. Plus Communication electives for a total of at least 25 and not over 35 units.
4. A unified program totaling not less than 20 units of advanced courses in another department or interdepartmental major, or an interdisciplinary honors program, or a second major.
5. Undergraduates must have a grade-point average of 2.50 or higher in Communication Department courses in order to receive the departmental recommendation for graduation.

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 other recommended courses.

**MASTER OF ARTS**

The Master of Arts degree is awarded by the Department in the fields of Journalism and Broadcasting and Film. Requirements are as follows:

1. The candidate must earn at least 45 units in graduate residence at Stanford; he must be enrolled as a major in the Depart-
ment for at least two quarters; he must earn an average grade of B on his entire program of study. At least 20 of the 45 units must be in courses numbered 200 or higher, and the other units in courses numbered 100 to 199. An independent project (on occasion a thesis) 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. Completion of the entire program (45 units, including independent project, plus an internship experience) normally takes four or five quarters. Tuition usually is charged only for the three or four quarters of regular class attendance.

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.) While an attempt will be made to tailor each student's program to fit his individual needs, normally all Broadcasting and Film students will take 215, 208A,B,C, 200, and 223A. The rest of his curriculum will be worked out in consultation with his adviser and will probably include 205A, 206A,B, 101, 141, 142, and 220.

4. Students in the Journalism A.M. program with neither undergraduate journalism instruction nor professional experience are required to take: Communication 100, 102, 107, 150 or 175, 207, 220, two quarters of 225, 230 or 240, 249 or Law 104, 309, and an internship with a media organization. Students without adequate prior course work in the behavioral sciences are required to take Communication 215. Remainder of the program is to be a cohesive group of at least two or three courses outside the Department. Students with undergraduate journalism training or media experience should check with their advisers to determine which of the above departmental courses will be required and which can be replaced with electives.

5. No particular specialization in undergraduate work is expected of a candidate. A few special programs of study may be arranged for individual candidates, which will take account of the nature of their previous preparation. No special sequence in broadcast journalism is offered at this time, but students interested in this field can take several broadcast courses.

**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 written examination in the subjects required of all candidates and in the area of specialization of the particular candidate.

3. Demonstrate proficiency in tools required in area of specialization. Chosen with the advice of the faculty, tools may include foreign languages, statistics, computer programming, etc.

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 activity relevant to the area of specialization, 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. 211A. Theory of Communication I
   Comm. 211B. Theory of Communication II
   Comm. 211C. Theory of Communication III

2. Methodology
   Comm. 218. Communication Research Methods I
   Comm. 219. Communication Research Methods II
   C.S. 105. Introduction to Computing
   Comm. 309. First-Year Research Project
   Comm. 319. Pre-Dissertation Research Project
   Two advanced seminars on Communication Research Methods

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. 146. Language and Thought
   Psych. 211. Advanced Developmental Psychology
   Psych. 246. Methods in Developmental Research
   Psych. 266. Seminar in Developmental Psychology

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
C.S. 224. Models of Thought Processes
C.S. 225. Artificial Intelligence Research
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. 211A, B, C. Sequence in Communication Theory

2. Structure and Function of the Mass Media
Comm. 220. Mass Communications in Society
Comm. 225A, B, C. Problems of the Mass Media (at least three 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. 249. Mass Media Law (or Law 104. Courts and the Legal Processes, or both.)
Comm. 255. International Communication
Comm. 256. Communication in Economic and Social Development

3. Methodology and Statistics
Comm. 218, 219. Sequence in Research Methods
Comm. 227. Analysis of Documentary Evidence
Comm. 309. First-Year Research Project
Comm. 319. Pre-dissertation Research Project

Psych. 60. Statistical Methods, or Stat. 50. Elementary Statistics
At least one other course in statistics or advanced research methods.

4. Political Science, Law, History, Economics — a unified program of six courses in one or two of these fields. 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. 132. Modern Political Thought
Pol. Sci. 153. Theoretical Foundations of Political Sociology

Public Law:
Law 104. Courts and the Legal Process
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.)

5. At least two courses from the above or other departments (including Communication) chosen in consultation with an adviser, in preparation for the degree examinations, the dissertation, and a teaching and research career. This requirement is designed especially for students who have not concentrated in the behavioral 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 20 units of graduate courses in the Communication Department, including a total of three theory or research methods courses. The balance between communication theory, methods, and applications courses will be determined by the candidate and his senior adviser. Communication 211A,B,C, together with Communication 218 and 219 are most often chosen to satisfy the minor requirement.

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 1971–72

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

100. 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 102. Open to non-majors.

3 units, Aut (Rivers) MWF 11
Spr (Grey) MWF 9

102. Editorial Techniques I Laboratory — Practice in news writing. Weekly conferences, laboratory, outside assignments. To be taken concurrently with 100. Open to non-majors. Prerequisite: typing skill of 35 words per minute. (Graduate sections taught separately.)

1 unit, Aut (Rivers) by arrangement
Spr (Grey) by arrangement

107. Editorial Techniques II — Copy editing, headline writing, news display, illustration, typography, printing processes. With laboratory that includes editing daily teleprinter reports of Associated Press, news evaluation and page make-up. Prerequisites: 100 and 102.

4 units, Win ( ) MWF 9, and labs by arrangement

140. History of Anglo-American Journalism — Open to non-majors.

3 units, Aut ( ) TTh 9

150. Forms of Journalistic Writing — Practice in writing magazine articles, with emphasis on marketing manuscripts. Conferences. Prerequisites: 100 and 102.

3 or 4 units, Win (Rivers) TTh 11

152. Magazine Editorial Techniques — Planning, writing, production studied with local magazine editors, correspondents; industrial editing. Prerequisite: 150.

3 units, Spr (Rivers) W 4:15-5:30

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.

3 or 4 units, Win (Grey) MWF 10

183. Internship Experience — San Francisco area media experience coordinated with Department faculty.

0-4 units, Aut, Win, Spr, Sum (Staff) by arrangement

III. BROADCASTING AND FILM

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.

3 units, Aut (Breitrose) MWF 9

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, Aut (Dundes) TTh 11

180. Broadcasting and Film Criticism — The techniques and role of criticism based upon the objectives and potential of these media. For advanced students. Prerequisites: 141 or 142 and consent of instructor.

3 units, Spr (Breitrose) MWF 9

189. Uses of Ethnographic Film — (Same as Anthropology 189) Critical examination of the problems of validity and reliability involved in reporting and interpreting aspects of a culture using essentially non-verbal forms. Evaluation of the uses of ethnographic films as research reports, as research instruments and as instructional materials. Students will prepare a series of written exercises and a term paper. Prerequisite: Anthropology 1 and consent of the instructors.

4-5 units, Spr (Breitrose, Gibbs) MW10, lab. Th 7:30-10:00 p.m.

200. Visual and Aural Communication Techniques — An investigation of the techniques of cinematography and sound from the standpoint of the communication of ideas. Students will produce short film and sound assignments. No previous knowledge of the media is required. This course is a prerequisite for all further production work in film. (Open only to graduate students in Autumn Quarter.)

5 units, Aut, Win, Spr (Breitrose, ——) MW 2:15-4:05

205A. Television Production I — Production and direction of news and documentary tele-
vision programs. Prerequisites: 200, 223B or 100.

- 4 units, Win (graduate students only) Spr (open to undergraduates) by arrangement

205B. Film Production I—An intermediate course in which students produce their own short films. Prerequisites: 200 and consent of instructor.
- 5 units, Win (——) TTh 10-12

206A. Television Production II—Prerequisite: 205A.
- 3 units, Spr (——) by arrangement

206B. Film Production II—Primarily for graduate students producing film projects for a degree. Admission by recommendation of instructor only. Prerequisite: 205B.
- 5 units, Spr (——) Th 1:15-4:05

221. Film and Television Directing — Theory and technique of directing actors and non-actors for film and television. Prerequisites: 200, 205A,B, 223A.
- 3 units, Spr (——) by arrangement

223A. Writing for Broadcasting and Film I —Techniques of research and writing for the visual media.
- 4 units, Aut (——) TTh 10-12

223B. Writing for Broadcasting and Film II —Structure and style in the construction of factual film and television scripts. Prerequisite: 223A.
- 3 units, Win (——) MW 1:15-3:05

223C. 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 (——) TTh 10-12

Summer Broadcasting and Film Institute
(See Summer Session Bulletin for 1971.)

COURSES FOR GRADUATES

- 3 units, Aut (——) W 2:15-4:05

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

208A. Seminar in Broadcasting and Film I — Limited to Broadcasting and Film A.M. students.
- 2 units, Aut (Breitrose) by arrangement

208B. Seminar in Broadcasting and Film II — Limited to Broadcasting and Film A.M. students.
- 2 units, Spr (Breitrose) by arrangement

208C. Seminar in Broadcasting and Film III—Limited to Broadcasting and Film A.M. students.
- 2 units, Spr (Breitrose) by arrangement

211A. Theory of Communication I — Seminar and tutorial meetings, extensive readings and papers. For doctoral candidates planning to continue with the sequence on theory.
- 4-6 units, Aut, Win, Spr (——) TTh 2:15-4:05

211B. Theory of Communication II — Continuation of 211A.
- 4-6 units, Win (——) TTh 2:15-4:05

211C. Theory of Communication III—Continuation of 211B.
- 4-6 units, Spr (——) TTh 2:15-4:05

- 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, Spr (Dundes) T 7:30-10:00 p.m.

218. Communication Research Methods I —Methods of research in mass and interpersonal communication. Application of scientific method to communication research. Sample surveys, laboratory and field experiments, historical analyses. Conceptualization of variables, sampling, data collection, data processing and analysis. Prerequisite: elementary statistics.
- 4 units, Win (Staff) MW 3:15-5:05

- 4 units, Spr (Staff) MW 3:15-5:05
220. Mass Communications in Society —
The nature and social responsibilities of the
media, the structure of the industry, prob-
lems of regulation, management, educa-
tional and commercial interests.
4 units, Spr (Rivers) TTh 2:15–4:05
Sum (Staff) by arrangement

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

225A. Problems of the Mass Media—Visit-
ing lecturer series.
1 unit, Aut (Rivers, Nelson)
by arrangement

225B. Problems of the Mass Media—Con-
tinuation of 225A.
1 unit, Win (Rivers, Nelson)
by arrangement

225C. Problems of the Mass Media—Con-
tinuation of 225B.
1 unit, Spr (Rivers, Nelson)
by arrangement

227. Analysis of Documentary Evidence—
Research methods — especially historiogra-
phy and “qualitative” content analysis—pri-
marily for doctoral students in Public Affairs
Communication.
4 units, Aut (Grey) by arrangement

230. Mass Media and Government—Study
of the interaction between the government
and the press. Role of the press in the gov-
ernmental process as a disseminator, opin-
ionmaker and adversary.
4 units, Win (Rivers, Grey) 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 influ-
enced by the media.
4 units, Aut (Leifer) by arrangement

232. Developmental Communication II —
Continuation of 231.
4 units, Win (Leifer) by arrangement

233. Developmental Communication III—
Continuation of 232.
4 units, Spr (Leifer) by arrangement

240. Mass Media History—Review of the
literature and research in the historical de-
velopment of newspapers, magazines, broad-
casting and film.
4 units, Spr (——) by arrangement

245. Economics of the Mass Media—Analy-
sis of the literature in mass media economics
and intensive research projects. Primarily for
doctoral students in Public Affairs Commu-
nication.
4 units, Spr (Grey) by arrangement

249. Mass Media Law — Review of the lit-
erature and research in legal issues involv-
ing the press and mass media.
4 units, Aut (Grey) T 2:15–4:05

255. International Communication — Chief
patterns of mass communications through-
out the world; philosophies behind them;
economic, social, political reasons why a
given kind of pattern develops where it does;
channels by which nations, cultures com-
 municate with each other; kinds of barrier
which intervene in those channels; manipu-
 lative communication between nations
which is characteristic of the “cold war.”
4 units, Spr (——) M 2:15–4:05

256. Communication in Economic and So-
cial Development — Seminar on the com-
munication problems of economic and so-
cial 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 (——) 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: 211C 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: 211C 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: 211C and 219.
3 units, Spr (Staff) by arrangement

275. Advanced Data Analysis—Continu-
tion of analysis topics covered in 219: Stu-
dents may choose individual analysis projects.

4 units, Aut (Paisley) M 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

COMPARATIVE LITERATURE

Committee in Charge: Herbert Lindenberger, Chairman, Robert G. Cohn, N. Gregson Davis, Albert J. Guerard, David G. Halliburton, Kurt Mueller-Vollmer

Professor: Herbert Lindenberger (Comparative Literature and English)

Assistant Professors: N. Gregson Davis (Classics and Comparative Literature)

David G. Halliburton (English and Comparative Literature)

The interdepartmental program in Comparative Literature admits students for the Ph.D. It also supervises a minor program for students working toward the Ph.D. in the individual departments of literature and, in conjunction with the Humanities Honors Program, offers a concentration in Comparative Literature for undergraduates.

UNDERGRADUATE PROGRAM

Students planning to concentrate in Comparative Literature must apply for admission to the Humanities Honors Program and for graduation with Honors in Humanities.

Freshmen and sophomores interested in the program must first consult with the Director or the Associate Director of the Humanities Honors Program. Because of the strong language requirements, the consultation should take place at the earliest oppor-
tunity, preferably during the freshman year. No student may declare his major later than two weeks after the start of his junior year. After admission to the program, the student will be assigned an adviser drawn from the Committee on Comparative Literature.

Students in the program do not need to complete a formal major in another field but, in order to satisfy the final requirement listed below, students will normally have a major, or the equivalent of a major, in a single national literature. Requirements are as follows:

1. World literature—Humanities 61-62-63—15 units, to be taken as early as possible.

2. One seminar drawn from the series Humanities 191-193—5 units, as approved by the adviser, junior year.

3. Humanities 194—Critical Theory and Practice—5 units, junior year.

4. Two courses of a primarily genre nature such as the English 75-77 series.

5. At least three literature courses in a foreign language and at least one advanced course—preferably a literature course—in a second foreign language.

6. Two additional literature courses which need not be in the original languages, but which must be of widely divergent cultural traditions or be distributed between an ancient and a modern culture.

7. Honors essay—an essay in literary criticism (2 units, spring, junior year; 5 units, autumn, 5 units, winter, senior year). A grade of at least B is required on the essay for graduation with Honors in Humanities.

8. Course distribution should be designed in such a way that students develop an extensive background in a single national literature, either English or a foreign literature.

GRADUATE PROGRAM

The Ph.D. program is designed for a small group of students whose linguistic background, breadth of interest in literature, and curiosity about the problems of literary scholarship make this program more appropriate to their needs than the Ph.D. in one of the individual literatures. Students will take courses in at least three literatures (one of which may be English), to be studied in the original languages.

A considerable part of a student's work
will consist of individual study toward the Ph.D. examination, for which each student will draw up his own reading list. The examination is centered not on national lines, but on the study of particular periods, genres, and problems of criticism. Students will normally complete the program in four or five years, the exact period to depend on their language competence at entrance.

REQUIREMENTS:

Residence—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 of Arts 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 course work must be taken at Stanford.

Languages—Students must know three foreign languages, two of them sufficiently to qualify for graduate courses in these languages and the third sufficiently to demonstrate ability to read a major author in this language. One of the three languages must be French or German, and one of the other two must be Latin (for which Greek may be substituted when appropriate), if the period in which he concentrates is earlier than the Romantic period. Of the three literatures in which a student takes courses, no more than two may be in the same department at Stanford. Literatures written in the same language (such as Spanish and Latin-American) are counted as one in the planning of a student’s program. One of the student’s three literatures will be designated his primary field; the other two his secondary fields. Minimum course requirements are as follows:

1. English 304A and B, and at least two additional graduate courses of a primarily comparative nature

2. At least three graduate courses in each of the student's two secondary fields

3. A sufficient number of courses in the student’s primary field to assure his knowledge of the basic works in one national literature from its beginnings until the present day

Foreign Study—Students are urged, whenever it can be conveniently arranged, to spend two quarters at one of the Stanford programs in foreign countries.

Examination—The examination will consist of four written sections in addition to the University Oral Examination. Each student’s reading list for the examination must be approved by his advising committee. The written sections will be as follows:

1. A literary genre, to consist of (1) a knowledge of a substantial number of literary works in a single genre, the list to include works from a number of centuries and from at least three national literatures, and (2) a grasp of the theoretical problems involved in dealing with this genre and with the question of genre in general. This examination must be taken no later than the first quarter of the student’s second year of graduate work. On successful completion of this section of the examination students may apply for candidacy to the Ph.D.

2. Literary criticism, to consist of (1) a knowledge of the basic texts of either 20th-century criticism or the history of criticism up to 1900, and (2) the exploration of a specialized problem in criticism. Students electing modern criticism must take a course in the history of criticism before 1900.

3 and 4. A literary period, to consist of a knowledge of a literary period of at least a century in three or more literatures. The reading list for these two sections will cover not only the major literary texts of this period but also studies of intellectual backgrounds, trends in the other arts, and modern critical discussions of the period. Students must demonstrate a grasp of how to discuss and define this period as well as the concept of periods in general. Students whose course work combines an ancient with a modern literature, or an Eastern with a Western literature, have the option of dividing the period sections into two wholly separate periods.

The last three sections of the written examination will normally be taken by the end of the student’s third year of graduate work. The University Oral Examination, which will be scheduled as soon as possible after the completion of the written examination, will be based on the material of the last three sections of the written examination and the student’s plans for a dissertation.

Dissertation—With the help of his advising committee, the student will propose a dissertation topic for approval by the Committee on Comparative Literature, which in turn will appoint a dissertation committee to be drawn from at least two departments.
Minor — Students interested in the minor should apply for admission to the individual departments of literature. They may apply to the Committee on Comparative Literature for entrance to the minor after they have completed their first quarter of graduate work at Stanford.

1. A knowledge of at least two foreign languages, one of them sufficient for the student to qualify for graduate-level courses in that language, the second sufficient for the student to read a major author in the original.

2. A minimum of 24 units of graduate courses, of which 12 units must be in the department of the second literature and 12 in Comparative Literature, the latter to include either English 304A or 304B. Except for students in the Asian Languages, students must choose a second literature outside the department of their major literature.

Students working toward the Ph.D. in English are directed to the program in English and Comparative Literature described among the English offerings.

COURSES

Courses primarily of a comparative nature are listed below:

Humanities 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.

See Humanities section for detailed description.

English 75, 76, 77. Introduction to the Chief Types of Literature—Open to all undergraduate students.

See English section for detailed description.

Comparative Literature 145. Neo-African Literature of the Caribbean—With focus on the literature of the former French and British islands.

4 units, Win (Davis) MWF 2:15

English 171. Contemporary Drama—Post-World War II theater, with emphasis on Brecht, Jonesco, Genet, Beckett, and Pinter.

5 units, Spr (Friedlander) TTh 2:15–4:05


5 units, Win (Guerard) MTWTh II

Humanities 194. Comparative Literature: Critical Theory and Practice—A study of the major schools of modern criticism. Students will write papers on individual literary texts. Required of Humanities majors concentrating in Comparative Literature. For others, prerequisite: consent of instructor.

5 units, Win (Lindenberger) by arrangement

Classics 209. Classical Rhetorical Practice—Comparative study of the rhetorical practice of representative Greek and Roman as well as non-western lyric poets. A reading knowledge of Greek or Latin desirable. Enrollment limited to 7.

4 units, Spr (Davis) by arrangement

English 259. Comparative Literature: Yeats, Eliot, Neruda—Questions of person, politics, myth-making in modern poetry. Introduction by way of Yeats, followed by intensive reading of Four Quartets and Alturas de Macchu Picchu. Prerequisites: a course in modern poetry, knowledge of Spanish. Limited to 15. (Please see instructor beforehand.)

5 units, Aut (Felstiner) MW 2:15–4:05

English 280. Comparative Literature: Towards an Understanding of Modernism—Study of such major strains in modern literature as the Symbolist aesthetic, psychoanalysis, and existentialism, with emphasis on their origins in the 19th century. Prerequisite: one course in modern literature, either English or European. Reading knowledge of French or German desirable.

5 units, given 1971–72

English 290. Workshop in Verse Translation—In collaboration with foreign language departments. Graduate students and qualified undergraduates. Prerequisite: consent of instructor.

5 units, Win (Davie) MW 2:15–4:05

Comparative Literature 300. Existential and Visionary Literature—Major modern writers (Austrian, English, French, and American) whose work presents or helps to form a modern existentialist perspective. Normally includes such authors as Beckett,
Poe, Sartre, Hofmannsthal, Kafka, Artaud, Woolf. Some prior advanced work in one of the literatures is recommended, and a reading knowledge of French or German is required.

5 units, Spr (Halliburton) given 1971–72

Slavic Languages and Literatures 300. Graduate Seminar: Problems in Literary Translation.

Spr (Brown) by arrangement

Comparative Literature 303. Methods of Interpretation: Old and New Approaches.

Win and Spr (Lohner) given 1971–72

English 304. Comparative Literature Seminar: Major Modern Critics—Although planned as a sequence, 304A and 304B may be taken independently.

304A. Modern Anglo-American Criticism.
4 units, Aut (Lindenberger)
TTh 2:15–4:05

304B. Modern Continental Criticism.
4 units, Win (Halliburton)
given 1971–72

English 305. Seminar in the History of Literary Theory.

305A. Classical Backgrounds.
4 units, given alternate years

305B. The Middle Ages and the Renaissance.
4 units, given alternate years

English 307E. The Modern Novel—Problems of structure and style. Students must be free to attend a number of the lectures in English 172.

4 units, Win (Guerard) TTh 2:15–4:05

Comparative Literature 310. The Don Juan Legend — Reading and discussion of key works by Tirso de Molina, Molière, Da Ponte, Hoffmann, Pushkin, Grabbe, Musset, Zorrilla, Shaw, Frisch, Anouilh, Montherlant, and others. Two foreign languages desirable. Prerequisite: consent of instructor.

3 units, Win (Weinstein) W 4:15–6:05

English 327. Comparative Literature Seminar: Historical Drama — Uses of history, from Shakespeare and Corneille to Büchner and Brecht, to define relation of the individual to political forces. Prerequisites: considerable previous study of Shakespeare and/or European drama; reading knowledge of French or German.

4 units, given alternate years

German 335. Drama des Barock.
4 units, Aut (Lohner) M 4:15–6:05 and W 4:15

English 361. The Modern Tradition—Same as Modern Thought and Literature 361. Introduction to the interdisciplinary study of modern thought and literature. Limited to 15.

4 units, Aut (Guerard) TTh 4:15–6:05

German 375. Seminar: Humboldt’s Sprachphilosophie und der Strukturalismus — A close study of Humboldt’s writings on linguistics and the nature of language and their relation to modern structuralism. It is the aim of the seminar to examine critically the notion of structure and the limits of its applicability in literary studies. Taught in German.

4 units, Spr (Mueller-Vollmer) W 4:15–6:05

German 378. Lessing, Wieland und die Aufklärung—Enlightenment ideas of man, history, and society and the rise of a new aesthetics. Theoretical works and works of creative literature will be studied. Taught in German.

4 units, Aut (Mueller-Vollmer) MTTh 1:15

English 382. Utopian and Anti-Utopian Literature and Society—Representative works of utopian and anti-utopian fiction studied in relation to revolutionary theory and practice. Authors to be read include Plato, Thomas More, Engels, E. A. Abbott, Edward Bellamy, Lenin, Eugene Zamiatin, Mayakovsky, Jorge Luis Borges, Ivan Yefremov, and Mao Tse-tung. Prospective students are urged to read Engels’ Socialism: Utopian and Scientific before registering for the seminar. Enrollment limited to 12.

4 units, Aut (Franklin) TTh 2:15–4:05

English 383. The Existential Hero in Modern Literature.

4 units, Win (Ruotolo) TTh 4:15–6:05

English 386. Comparative Literature Seminar: The Enlightenment and Its Literary Traditions—Eighteenth-century social and philosophical backgrounds in relation to various forms of fictional, historical, and confessional writing. A seminar designed for students in Comparative Literature and Modern Thought and Literature programs as well as in English. Readings to include works by Boswell, Anne Radcliffe, Hume,
Godwin, Diderot, Rousseau, De Sade, Lessing, Goethe, Kant. Reading knowledge of French or German required.

4 units, Spr (Watt) TTh 4:15–6:05

German 400. Heideggers Existenzphilosophie und die Literatur — Die Relevanz grundlegender existenzphilosophischer Kategorien in Sein und Zeit und kleineren Schriften Heideggers für das Verständnis der modernen Literatur. Heideggers Interpretationsmethode von Dichtungen (Hölderlins, Rilkes, Trakls, etc.) und der Einfluss seiner Methode auf die modern Literaturwissenschaft. Dieses Seminar kann auch als Kolloquium genommen werden. Taught in German.

4 units, Win (Sokel) Th 4:15–6:05

**ADDITIONAL COURSES**

Courses primarily within individual national literatures, but of special interest to students in Comparative Literature, are listed below:

**ASIAN LANGUAGES**


**ENGLISH**

81. Literature and Revolution.
138. Literature and the Performing Arts.
262. Melville and Marx.
341E. Literary and Social Content of Drama.

**FRENCH**

173. Symbolism.
371. Baudelaire.
373. La Critique littéraire au XIXème siècle.
389. Points de vue critiques au XXème siècle.

**GERMAN**

341. Schiller.

**PORTUGUESE**

191. Portuguese Literature I.
192. Portuguese Literature II.

**SLAVIC LANGUAGES AND LITERATURES**

146. Russian Literature of the Twentieth Century.
148. Russian Twentieth Century Prose.

**SPANISH**

161. Spanish Literature of the Sixteenth and Early Seventeenth Centuries.
186. Spanish American Literature I.
187. Spanish American Literature II.
195B. Mexican Literature of the Twentieth Century.
195C. Peruvian Literature of the Twentieth Century.
212. Spanish Literature of the Sixteenth Century.
216. Spanish Literature from 1905 to the Present.
217. Spanish Theater of the Golden Age.
251. Seminar (Pablo Neruda)
255. Contemporary Novelists of Spanish America.

**SPEECH AND DRAMA**

302. Seminar in Medieval Drama.
305. Seminar in Comedy.

**COMPUTER SCIENCE**

*Chairman:* George E. Forsythe

*Vice Chairman:* John G. Herriot


*Associate Professors:* Jerome A. Feldman (on leave 1970–71), Robert W. Floyd

*Assistant Professor:* Zohar Manna. *Acting:* Fred W. Dorr. *Visiting:* Cleve B. Moler

*Senior Research Associates and Lecturers:* Kenneth M. Colby, Arthur L. Samuel

*Lecturers:* Lester D. Earnest, John R. Ehrman, Bertram Raphael, Gjo Wiederhold

*Research Associates:* Edward A. Ashley, Alan W. Biermann, Bruce G. Buchanan, Franklin D. Hilf, Shigeru Igarashi, Alan Kay, David C. Luckham, Roger C. Schank, Georgia L. Sutherland
Affiliated Faculty:

Assistant Professor: Edward S. Davidson (Electrical Engineering)
Acting Assistant Professor: Thomas H. Bredt (Electrical Engineering)

OFFERINGS AND FACILITIES

The Department aims to acquaint 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.

The Department has competence in numerical analysis, combinatorial mathematics, mathematical programming, artificial intelligence, programming systems and languages, logical design of computer systems, mathematical theory of computation, computer control of external devices, graphic data processing, analysis of algorithms, and software engineering.

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. Courses in the theory of switching and the logic design of digital systems are mainly offered in the Electrical Engineering Department, whose program is closely coordinated with ours.

Special Ph.D. programs with other departments are possible, either as a Ph.D. in Computer Science or otherwise (see "Graduate Division Special Programs" in this bulletin). For example, a joint program with Operations Research is designed for students interested in numerical analysis techniques that arise in optimization theory. Students interested in special programs should apply for admission to the department of primary interest.

Since computer science is inherently interdisciplinary, graduate students of computer science are encouraged 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 106, 109 or 111, 137, 144A,B, and 155 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. For use in research and teaching, the Department has a PDP-6/10 time-shared computing system, and an HP-2116 computer.

The Department conducts a weekly colloquium, presented by the staff and visiting scientists, which covers a spectrum of current 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 Department offers two distinct programs. In either of these the candidate must attain at least a 2.50 average in his course work and a 3.00 (=B) average in courses taken in the Computer Science Department.

MASTER OF SCIENCE IN COMPUTER SCIENCE

A candidate is expected to complete a course program of 42 units, at least 36 of which will be in this Department, or selected from the list of courses in other departments which appears at the end of the course offerings in Computer Science. These 36 units must include 6 units of course 293 and 15 additional units of courses numbered 200 or above.

A candidate is also expected to pass a qualifying exam in an area pertaining to Computer Science. Any one of the Department's qualifying exams will automatically satisfy this requirement; approval of other qualifying exams must be obtained from the Computer Science Department's Committee on Graduate Study.

MASTER OF SCIENCE IN COMPUTER SCIENCE: COMPUTER ENGINEERING

The degree of "Master of Science in Computer Science: Computer Engineering" may be conferred upon students who have developed a competence in the design of substa-
tial software-hardware computer systems. This degree will be administered by the Committee on Computer Engineering, composed of faculty from the Computer Science and Electrical Engineering Departments. In 1969-70 the members are Thomas H. Bredt, Edward S. Davidson, Jerome A. Feldman, Gene H. Golub, and Edward J. McCluskey, Chairman.

A student should indicate his preference for his degree when he applies for admission. His Master’s program should include 42 units of work, of which at least 36 must be graded. These will normally come from the following courses: 135 (or both 137 and 138), 109, 111, 112 (or Electrical Engineering 281 and 282), 140A,B, 144A, 246, 206, 150 (or 155 or other course in discrete mathematics), Operations Research 252, 298 (or 6 units of 293 or Electrical Engineering 390), and Electrical Engineering 380.

This program is normally open to students with a bachelor’s degree in Mathematics, Statistics, Physics, or Engineering. A bachelor’s degree in another field may be accepted provided the applicant has a knowledge of calculus, linear algebra, and probability. Some knowledge of programming is required.

Students with very little background in programming should enroll in the basic programming course 106 during the Summer Quarter preceding entrance into this program. Mathematics 113 and Statistics 116, or their equivalents may be taken while the student is a candidate; however, these courses will not count towards the units necessary for this degree.

The Computer Engineering program will begin in Autumn Quarter each year to enable a full-time student to complete the degree in one academic year. Honors Cooperative students able to take two courses each quarter should be able to complete the program in two academic years and one Summer Quarter.

The degree of “Master of Science in Computer Science: Computer Engineering” is intended as a terminal degree. Students planning to obtain the Ph.D. degree are advised to apply directly for admission to the Ph.D. program.

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:

1. A student should plan and successfully complete a coherent program of study covering the basic areas of computer science and related disciplines. His adviser has the primary responsibility for the adequacy of the program, which is subject to review by the Graduate Study Committee of the Department.

2. Each student is expected to enroll in course 204 at the first opportunity to do so.

3. The student must pass certain qualifying examinations before admission to candidacy. The qualifying examinations, normally written but sometimes oral, cover the basic areas of computer science. Further information may be obtained from the Department’s academic secretary.

4. 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, analysis of algorithms, computer control of external devices, software engineering, and in certain applications of computers, such as in operations research, and logic.

5. As part of the training for the Ph.D., each student is required during one or more quarters to perform some teaching equivalent to that normally performed by teaching assistants, and during one or more quarters to carry out some research equivalent to that normally performed by 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. In addition the candidate must take and pass a special minor examination. Automatic approval will be given for any program comprising 15 quarter units, not including courses 105 or 106, but including 135 (or the 137, 138 sequence), 111 (or 109), and 206.

Teaching and Research Assistantships

There are graduate student assistantships available in the Computer Science Depart-
ment. Assistants receive a tuition scholarship for up to nine units of study per quarter during the academic year, and in addition receive stipends for the nine-month academic year ranging approximately from $2800 to $3200. Some may work full time in the summer for between $650 and $750 per month.

Duties in the academic year involve 20 hours of work per week. Teaching assistants help an instructor teach a course by meeting discussion sections, consulting with students, grading examinations, etc. Research assistants help 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.

Students with NSF fellowships and traineeships have the opportunity to earn $750 during the academic year as graduate student assistants.

Applicants for assistantships are expected to have a background in computing at least as deep as that achieved in course 106, together with some knowledge of a machine language. A deeper background is preferable. An applicant's major field may be computer science, mathematics, statistics, operations research, physics, psychology, electrical engineering, or other discipline in which there is significant research involving the use of automatic digital computers. Preference will generally be given to students of computer science.

Further information may be obtained from the Chairman 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 Chairman of the Computer Science Department of his desires to have an assistantship in computing and stating his desired major department.

**Courses**

The Department has renumbered its courses and made other changes. To assist people in the transition here is a key to the changes.

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New courses: 112, 125, 144B, 155, 234, 298.

**Courses for Undergraduate and Graduate Students**

105. Introduction to Computing — Design and construction of computer programs; use of a specific programming language to solve problems over a wide range of applications on a digital computer. The applications are selected from problem areas in which no detailed knowledge of mathematics is required. Some discussion sections are limited to freshmen and sophomores. Prerequisite: Mathematics 0 or equivalent.

3 units, Aut (——) lec. WF 10, discussions M 10
(——) lec. WF 2:15, discussions M 2:15
Win (——) lec. WF 2:15, discussions M 2:15
(——) lec. TTh 2:15, discussions by arrangement
Spr (——) lec. WF 11, discussions M 11
Sum (——) MTWTh 10

106. Introduction to Computing — Design and construction of computer programs; use of a specific programming language to solve problems over a wide range of applications on a digital computer. This course is essentially the same as 105 except that some of the applications are mathematical in nature. Prerequisite: Mathematics 21 or 42 or equivalent.

3 units, Aut (——) lec. WF 11, discussions M 11
(——) lec. WF 1:15, discussions M 1:15
Win (___) lec. WF 10,
discussions M 10
Spr (___) lec. TTh 10,
discussions by arrangement
Sum (___) MTWTh 9 or
MTWTh 11

109. Assembly Language Programming—Based on IBM System/360. Representation of numbers and other types of data. Binary arithmetic. Instruction execution. Assembly concepts: symbols; addressing expressions; data types and declarations; address resolution; binding times; macro instructions. Simple data structures: arrays, lists. Prerequisite: 105 or 106 or equivalent.

3 units, Aut (Ehrman) MWF 1:15


3 units, Win (McCluskey) MWF 1:15


3 units, Aut, Win

125. Nonnumerical Methods — This survey course is designed to acquaint students in the humanities, social sciences, and behavioral sciences with methods and techniques for solving scientific problems of a nonmathematical type on digital computers. Emphasis is given to practical problems and pragmatics. Program libraries are studied and used. Problems to be discussed include text processing, information retrieval, system simulation, graphics, elementary statistical calculations. Prerequisite: 105 or 106 or equivalent.

3 units, Win (___) TTh 11:00–12:15

135. Numerical Methods — This survey course is designed to acquaint students in science and engineering with methods and techniques for solving scientific problems of a mathematical type on digital computers. Emphasis is given to practical problems and pragmatics. Program libraries are studied and used. Problems to be discussed include interpolation and approximation of data, solution of differential equations, numerical integration, solution of linear and nonlinear systems of equations, fast Fourier transform. Pitfalls in automatic computation and their remedies are discussed. Prerequisites: 105 or 106; Mathematics 113 and 130; or equivalents.

3 units, Win (Forsythe) MWF 11

137. Numerical Analysis—This course and 138 are designed to acquaint students of computer science and mathematics with the analysis of methods for solving mathematical problems on digital computers. 137 is primarily concerned with functions of a single variable. Problems discussed include solution of nonlinear equations, interpolation and approximation of functions, numerical differentiation and integration, and solution of ordinary differential equations. Evaluation of functions, summation of series, including analysis of convergence and estimation of truncation and round-off errors. Pitfalls in automatic computation and their remedies are discussed. Assigned work will include both analytic problems and problems to be solved with the aid of a computer. Prerequisites: 105 or 106; Mathematics 130; or equivalents.

3 units, Win (Herriot) MWF 2:15

138. Numerical Analysis — Continuation of 137; includes also the numerical analysis of functions of several variables, including problems of linear algebra and least-squares approximation. Prerequisites: 137 and Mathematics 113, or equivalents.

3 units, Spr (Moler) MWF 2:15

140A,B. Systems Programming — This course deals with techniques used in construction of assemblers, compilers, operating systems, and other software systems. Prerequisite: 109 or 111 or equivalent.
140A. 3 units, Win (Bredt)  
TTh 9:30-10:45
140B. 3 units, Spr (Bredt)  
TTh 9:30-10:45

144A,B. Data Structures—This two-quarter sequence is intended for those who wish to study computer programming techniques intensively. Topics include basic concepts of data and its representation inside a computer; linear lists, strings; arrays, orthogonal lists; tree structures; data structures in programming languages. Detailed study of a variety of techniques for sorting and searching; use of external memory devices; data base management. Analysis of algorithms to determine which is more efficient in a given situation. Prerequisites: 109 or 111; Mathematics 11 or 41; or equivalents. Course 155 is recommended but not required as a prerequisite to 144B.

144A. 3 units, Aut (Knuth) MWF 3:15
144B. 3 units, Spr (Knuth) MWF 3:15


3 units, Aut (Dantzig) MWF 2:15

155. Concrete Mathematics — Finite difference calculus; manipulation of sums and products; properties of binomial coefficients, Stirling numbers, harmonic numbers, Fibonacci numbers; use of generating functions to solve complex recurrence relations; asymptotic expansions; analysis of computing algorithms. An emphasis on obtaining simple closed-form answers to problems when it is possible to do so. Prerequisites: Mathematics 22, 42, or equivalent.

3 units, Win (Knuth) MWF 3:15

199. Independent Work.  
Any quarter (Staff) by arrangement

Courses Intended Primarily for Graduate Students

204. Problem Seminar—Solution of various problems, numeric and symbolic, on a computer, using various languages. Emphasis on efficiency of programming, proofs of correctness, and clarity of documentation. Presentation of solutions by students. Limited to degree candidates in Computer Science.

3 units, Aut (Floyd) TTh 9:30-10:45

206. Computing with Symbolic Expressions —The LISP programming language. Computing wherein the data are symbolic expressions rather than numbers, including algebraic expressions (simplification, differentiation), graphs, compiling, applications in mathematics. Syntax-directed computation. Other list-processing systems. Prerequisite: 105 or 106 or equivalent.

3 units, Aut (——) TTh 11:00-12:15
Spr (——) MWF 11

211. Theory of Switching—(Enroll in Electrical Engineering 281.) 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, Win

212. Logic Design and Digital Systems — (Enroll in Electrical Engineering 282.) Characteristics of switching, memory, and input/output devices. Comparison of digital integrated-circuit families. Introduction to large-scale integration. Logic design of counters, shift registers, arithmetic circuitry, correlators, etc. Project in detailed design of a system such as a stored program computer, digital differential analyzer, desk calculator, or radar signal processor. Logic laboratory. Prerequisite: 211.

3 units, Win, Spr

224. Models of Thought Processes—Introductory survey of concepts and problems in artificial intelligence research; heuristic processes in problem solving, and heuristic programming; information processing models as explanations of human cognitive and affective behavior. Prerequisite: 105 or 106, or equivalent.

3 units, Aut (——) TTh 1:15-2:30

225. Artificial Intelligence Research — Intermediate-level examination of problems of
artificial intelligence research. Generality in problem-solving systems; theorem proving by computer; semantic information processing; problem representation; perceptual and effector processes; scientific reasoning processes. Not recommended for first-year graduate students. Research project involving computer program will be required. Prerequisites: 206 and 224 or equivalents.

3 units, Win (——) TTh 1:15-2:30

226. The Representation Problem in Artificial Intelligence — Formalisms for representing what a general intelligent program must know about the world including facts of causality, ability, knowledge. Programs for manipulating these formalisms. Prerequisite: 225.

3 units, Spr (McCarthy) TTh 11:00-12:15

234. Numerical Methods of Optimization—Introduction to the numerical analysis, data processing, and software problems associated with decision problems, which form a significant proportion of all scientific computation. Unconstrained and constrained minimization, gradient methods with special metrics, pivotal optimization techniques, solving large-scale systems, partitioning methods, combinatorial search procedures, shortest path and other graph algorithms. No prior knowledge of Operations Research is necessary. Prerequisite: 137 or equivalent.

3 units, Aut (——) MWF 9


3 units, Aut (Moler) MWF 9

237B,C. Advanced Numerical Analysis — Selected topics are covered in depth from the theory and practice of using automatic digital computers for solving ordinary and partial differential equations, approximating functions, and computing eigenvalues and eigenvectors. Testing and automation of methods on a digital computer. Prerequisite: 237A or consent of instructor.

237B. 3 units, Win (Dorr) MWF 9

237C. 3 units, Spr (Herriot) by arrangement

240A,B. Compiler Construction — Theory and practice of constructing translators for high-level programming languages. Scanning and parsing of formal languages; introductory theory of context-free languages and syntactic analysis. Object code generation and economization. Automatic generation of syntax analyzers, translator writing systems, extensible translators. Prerequisite: 144A or equivalent.

240A. 3 units, Win (——) TTh 2:40-3:55

240B. 3 units, Spr (——) TTh 2:40-3:55

246. Operating Systems—Organization and programming of executive control systems: multi-programming; time sharing; access control; file management; parallel processing; models of control; resource allocation; data flow control; control systems languages. Prerequisite: 240 B or equivalent.

3 units, Aut (——) MWF 11

249. Graphic Data Processing—Picture description languages, control languages, and data structures; picture recognition: pre-processing 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: 211, 240A.

3 units, Win (——) TTh 11:00-12:15


256A. 3 units, Win (——) MWF 10

256B. 3 units, Spr (——) MWF 10

293. Computer Laboratory — A substantial computational program is undertaken and well documented.

Any quarter (Staff) by arrangement

298. Software Engineering Laboratory — Students will work in teams of three or four on the development of a significant software system such as a time-sharing monitor, a data-terminal management and file system,
a graphic system, or a measurement and diagnostic system. Techniques acquired principally in 240A,B and 246 will be employed, with emphasis on performance, evaluation, software production methods, and management of the development process. Students must enroll for a minimum of 6 units in spring quarter or spring and summer quarters. Enrollment limited to 10 students.

6 units, Spr, Sum (Staff) by arrangement

311. Advanced Computer Organization — Machine algorithms for high-speed arithmetic. Analysis of hierarchical memory systems and their management. Data formats, instruction sets, addressing, and control. Comparison of advanced systems including multi-processors, stack-organized computers, and pipeline computers. Prerequisites: 111; 112 or 212 or equivalents.

3 units, Spr (McCluskey) MWF 9

331. Large Scale Systems in Mathematical Programming — (Enroll in Operations Research 341.)

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, (e) mathematical theory of computation. These seminars cover topics of current research in their respective areas.

1 to 3 units, any quarter (Staff)

by arrangement

390. Advanced Reading and Research.

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.

Discrete Mathematics — See Electrical Engineering 284.


Information and Communication Theory — See Electrical Engineering 376, 377A,B, 378, 379, 479.

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.


Recursion Theory — See Philosophy 293A, B,C.


Statistical Methods of Econometrics — See Economics 272.


Theory of Automata — See Philosophy 162 and Electrical Engineering 284, 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)

Director of Master's Program: S. Wing Chan (Professor, Chinese)

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, History, Philosophy, Political Science, Religion and Sociology.

A background on East Asia or its language is not required of applicants to the program, although some preparation is desirable. The Graduate Record Examination is required of all native English-speaking applicants.

The student normally completes this pro
gram 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 level 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. Three related courses in a department, including at least one seminar in which a research paper on East Asia is written.
2. Six courses numbered at least 100 and above 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, 551 Salvatierra, Stanford University, Stanford, California 94305.

OFFERINGS AND FACILITIES

The Department’s purposes are to acquaint students with the economic aspects of modern society, to familiarize them with techniques for the analysis of contemporary economic problems, and to develop in them an ability to exercise judgment in evaluating public policy. There is training for the general student as well as for those who plan careers as economists in civil service, private enterprise, teaching, or research. Associated with the Department are the Research Center in Economic Growth in Encina Hall, for research and graduate training in problems of economic growth in both industrialized and developing countries, and comparable facilities in Encina Hall for mathematical economics and econometrics.

The University Library is well supplied with literature in all fields of economics. The Hopkins Transportation Library holds 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 Hoover Institution, with its comprehensive collections of original and secondary materials on many foreign nations. The Food Research Library in Encina Hall is particularly valuable for International Trade and Economic Development.

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.

PROGRAMS OF STUDY

BACHELOR OF ARTS

Selected courses in the Food Research Institute and Engineering-Economic Systems count as economics courses in relation to all requirements for both the Bachelor of Arts and Honors in economics. A list of these courses is available in the Economics Department.

To be recommended by the Department for the degree of Bachelor of Arts in eco-
nomics, the student must have satisfied the following requirements:

1. Completion of 45 units in economics.
   a) Economics 51, 52, and 53 or their equivalent shall be included in the 45 units. Economics 51 and 52 should be completed if possible 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. No more than 5 units of credit will be given for the elementary course whether taken at Stanford or elsewhere.
   c) The 45 units shall include a minimum of 25 units in courses numbered 100 or above, of which 20 units must be taken at Stanford.

2. An average grade of C or better shall have been received for all units completed at Stanford in economics.

3. In addition, one of the following must be completed:
   a) Training in quantitative methods consisting of at least 20 units chosen from among mathematics courses numbered 10 or over, statistics courses other than Statistics 50, and courses in computer sciences and operations research.
   b) Training in complementary fields consisting of 30 units of 100-level courses chosen from no more than two of the following fields: cultural anthropology, history (in which courses numbered 47 or over will count), industrial engineering, philosophy, political science, psychology, and sociology. Food Research Institute courses not counted by the Economics Department as economics may be counted under cultural anthropology, history, political science, or sociology. Quantitative methods may also be offered as one field under this option, in which case all courses in mathematics, statistics, computer sciences, and operations research, and also Economics 90 and 91, will count toward the 30 units requirement.

Courses counted under requirement 3 may be taken on a pass-fail basis so long as this is compatible with the rules of the University.

Requirement 3 may be modified in exceptional cases. For this purpose a coherent substitute program must be submitted to and approved in writing by the Department’s Director of Undergraduate Studies before the end of the junior year.

Students who expect to undertake graduate study in economics, particularly prospective Ph.D. candidates, are strongly encouraged to take more than a minimum program in quantitative methods. Advice on appropriate courses in mathematics, statistics, and operations research will be supplied by the Department on request.

Students who completed Economics 5 and 10 under the previous requirements retain a choice of fulfilling either old or new versions of requirements 1 and 3. For these and other purposes, Economics 5 and 10 will be considered equivalent to 51 and 52, respectively.

The Undergraduate Honors Program — Two programs are offered which lead to a Bachelor of Arts with Honors in Economics. Both programs are designed to encourage a more intensive study of economics than is required for the normal major, together with course and research work of exceptional distinction.

The central feature of Honors Program I is completion of an honors thesis of appropriate quality. Honors Program II requires an especially high grade point average sustained through more than the usual number of units of economics, and also calls for the submission of at least two term papers of appropriate quality, in economics, written at any point in the student’s course work.

Both programs have as a common requirement training in quantitative methods or complementary fields equal to what is required of ordinary economics majors. Both programs also require a 3.0 average in all courses (except courses taken on a pass-fail basis) at Stanford.

The other requirements of Honors Program I are:

1. Completion of at least 55 units in economics, including Economics 51, 52, and 53 or the equivalent and at least 35 units in 100-level courses. This program will ordinarily include 10 units of Economics 199, taken in the senior year.
2. A grade point average of at least 3.0 in
economics courses other than Economics 199.


In Economics 199 the student has a choice of taking part in an honors seminar in which all the members write theses on closely related topics, or alternatively undertaking directed research on a topic of special interest to him. In the latter case, the research will be at least partly supervised by a member of the Economics 199 staff, and the students will register for Economics 199, but arrangements can be made for another member of the faculty to be consulted regularly.

Additional requirements of Honors Program II are:

1. Completion of at least 60 units in economics, including Economics 51, 52, and 53 or the equivalent and 40 units in 100-level courses.
2. A grade point average in economics of at least 3.3.
3. Submission of two term papers of appropriate quality. These will ordinarily have been written in economics courses. They must have been read and graded by a faculty member in economics before being submitted.

Prospective candidates of Honors Program I should advise the Departmental Director of Undergraduate Studies of their interest and plans no later than the Spring Quarter of the junior year. Notice of the instructors and topic or topics offered for the next year in Economics 199 will be made available whenever possible by the beginning of the Spring Quarter. Students are encouraged to sign up in advance and to indicate as early as possible if they plan to ask for individual directed research on another topic. Admission to this Program is not automatic and may have to be restricted if there are too many applicants.

Prospective candidates for Honors Program II are also encouraged to consult the Departmental Director of Undergraduate Studies before the end of the junior year. Applications for honors under this Program may be made at any time up to the end of the next-to-last quarter in which the student is enrolled. Potential applicants are responsible for saving copies of high-quality term papers for submission with the applications.

ADVANCED DEGREES

Graduate programs in economics are designed to provide students with a sound basis in modern theory, with a broad background in applied fields as well as specialization within fields of interest, with needed analytic and empirical tools, and with the perspective on the current state and uses of their discipline that is obtained by studying the development of economic thought and the economies of other cultures or other times. The department considers each of these objectives to be essential in the development of qualified researchers, teachers, and practitioners in economics. While departmental requirements for advanced degrees have been structured to secure these objectives, in the final analysis it is the responsibility of students to plan their studies so that these objectives are served.

A student who has been admitted to graduate standing in economics does not automatically become a candidate for a graduate degree. Rather, admission carries with it the expectation that students are preparing themselves for the Doctor of Philosophy degree. Admission to Candidacy and Recommendation for the Degree (and for the Master of Arts degree) occur subsequently, upon satisfaction of departmental requirements outlined below. Recommendation for the Degree and, especially, Admission to Candidacy are Departmental procedures separate from the formal procedures of the University Committee on Graduate Studies. The University's basic requirements for advanced degrees (residence, dissertation, etc.) are set forth in the section "Degrees" in this bulletin and must be satisfied along with the departmental requirements listed here.

An undergraduate major in economics or its equivalent is not required for admission to graduate standing, but is desirable and, in any event, some preparation in the social sciences is essential. Students admitted to graduate standing are expected to be prepared in mathematics at least to the level of one year's intensive study of calculus. Advanced calculus, linear algebra, differential equations, analysis, and mathematical statistics are useful preparations separately or collectively, and students are encouraged to continue the development of such analytic tools during their graduate study. Narrowly specialized undergraduate programs are not recommended.
Well prepared students proceeding toward the Doctor of Philosophy degree may expect to spend approximately two years in course work and another two years in seminars, independent study, and dissertation research, with some overlap in each direction. Exceptional progress may make a three-year program feasible and, occasionally, ambitious dissertation research cannot be completed within a four-year program.

Questions and petitions concerning admission to the program or the program itself should be addressed to the Director of Graduate Study, who together with his administrative assistants and the Graduate Studies Committee, of which he is chairman, has departmental responsibility for administering the graduate program. All entering students and second-year students are assigned individual faculty advisers, and where possible, an effort is made to assign advisers on the basis of sharing special interests within the field of economics. Students approaching their dissertation research are obliged to seek among the regular members of the Economics Department faculty a principal adviser who will supervise that research. Officers and members of the Graduate Economics Club actively participate in advising entering students and, in addition, provide an important channel through which student interests within the department are represented.

**Master of Arts**

The Department of Economics does not admit to advanced standing students who plan to terminate their graduate study with a Master of Arts degree. Students may (but need not) elect this degree in preparation for their Doctor of Philosophy degree. Students matriculated to graduate standing in other departments of the University may, however, be admitted to candidacy. The following are departmental requirements for the Master of Arts degrees:

**Admission to Candidacy**—Completion of the Stanford requirements for a Bachelor of Arts degree in economics, or approximately equivalent training, is required of students who undertake a program of study for the degree of Master of Arts in Economics. Admission to candidacy for the degree will be restricted to students whose record bears promise of successful graduate work.

**Recommendation for the Degree** — Students completing programs consistent with the departmental objectives listed in the introductory paragraph above will be recommended to the University Committee on Graduate Studies for the degree of Master of Arts in Economics, provided the following standards are satisfied:

1. Completion of a program of study at Stanford amounting to not less than 45 units of credit. Courses numbered below 100 and courses completed with a grade of less than C may not 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 additional units approved by the department.

**Doctor of Philosophy**

Programs of study leading to the Doctor of Philosophy degree are designed by the student, in consultation with his advisers and the Director of Graduate Study, to serve his particular interests as well as to achieve the general departmental objectives outlined above. Simple satisfaction of a set of requirements is necessary but not sufficient for Admission to Candidacy or Recommendation for the Degree. Rather, at each of these stages programs of study will be weighed individually according to the following departmental standards or requirements:

**Admission to Candidacy**—The Graduate Studies Committee will, as a matter of departmental procedure, admit students to candidacy for the degree of Doctor of Philosophy in Economics when three conditions have been satisfied:

1. The student has prepared himself in economic theory at least to the level of competence required in the two comprehensive field examinations in “Price and Allocation Theory” and in “Theory of Income and Econ...
economic Fluctuations.” These comprehensive examinations are normally offered to first-year students at the end of Spring Quarter and cover the subject matter of Economics 202, 203, 204, and 210, 211, and 212, respectively.

2. The student demonstrates competence in mathematics at least to the level of successful completion of Mathematics 43 with a grade of C or better or its equivalent (as judged by an examination administered by the department upon entrance). This standard should be satisfied as soon as possible after first graduate registration and those with little previous mathematical background are advised to register their first autumn quarter for Mathematics 41. Additional preparation in mathematics is strongly suggested, and students should consult with their advisers in choosing courses beyond the level of Mathematics 43.

3. The student in consultation with his adviser prepares, and the Graduate Studies Committee accepts, a proposed program of study satisfying the standards established below for Recommendation for the Degree. Students admitted to graduate standing are normally expected to satisfy the requirements for Admission to Candidacy by the end of their first year in residence. For this reason prior training in mathematics is strongly recommended.

Recommendation for the Degree — The Departmental Graduate Studies Committee will recommend to the University Committee on Graduate Studies that a student be granted the degree of Doctor of Philosophy in Economics when the student submits and the Graduate Studies Committee accepts a completed program of study which will satisfy the following set of standards. This summary list is elaborated upon below.

1. Qualification in six fields of study (if no minor subject is offered) or in three fields of study and a minor subject,
2. Fields of course work developing perspective with respect to the discipline,
3. Qualification in Econometrics,
4. Professional competence in a foreign language or course work developing a needed research skill,
5. Teaching experience,
6. Research training and specialized study in seminars,
7. University oral examination, and

It should be noted that the second and third standards need not (but may) involve course work in addition to that offered under the first. More detailed discussion follows:

1. Qualification in six fields of study (if no minor subject is offered) or in three fields of study and a minor subject. All candidates will be expected to qualify in “Price and Allocation Theory” and “Theory of Income and Economic Fluctuations.” Evidence of competence shall be at least equivalent to passing comprehensive examinations in each field.

Comprehensive field examinations will be scheduled 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. Successful candidates are expected to show distinction in at least one field of economics. Comprehensive examination papers become a part of each student's permanent file.

In addition to the two theory fields, students may select remaining fields according to the following options:

Option A—Without a Minor Subject. Consistent with the objectives of their program, students may choose to prepare themselves in four of the following fields of study:

- Monetary Theory
- Public Finance
- Structure of Industry
- Labor Economics
- Urban Economics
- International Economics
- Economic Development
- Economic History
- Econometrics
- Mathematical Economics

Alternatively students may choose to prepare themselves in three from the above list and complete the fourth field by assembling at least 15 units of graduate course work in economics or elsewhere which demonstrably contributes to the objectives of their program. Area studies in Economic Development are acceptable under this option, as is additional work in mathematical economics and related disciplines.

Normally, students complete at least five fields by the end of their second year in residence.

Option B—With a Minor Subject. Consistent with the objectives of their program, students may choose to prepare themselves
in at least one of the fields of study listed under Option A. In addition, students electing this option will complete requirements in their minor subject which must be approved in advance by the Graduate Studies Committee.

Normally, students complete their minor department requirements and their third field in economics by the end of their second year of study.

2. Under the third requirement for Admission to Candidacy, students must propose a program satisfying the departmental objective of obtaining perspective on the current state of their discipline and the range of its applications. To guide students in planning such a program, it is expected that at least two courses would be included from among the departmental offerings in History of Economic Thought, Comparative Economic Systems, Economic History. Course offerings of other departments (e.g., Economic Anthropology) may be accepted as appropriate for partial satisfaction of this standard in some circumstances. Courses offered as an alternative fourth field under Option A, however, normally may not be used to satisfy this standard.

3. Students shall submit evidence of competence in Econometrics at least to the level of Economics 171. Electing Econometrics as a field automatically satisfies this standard.

4. Consistent with the aims of his program, each student shall demonstrate research capability in a relevant foreign language or mastery of a body of specialized research methods other than Econometrics. Research competence in a foreign language will automatically satisfy this standard, but evidence of particular skills in other areas may be accepted as an alternative; e.g., computer science (programming, data analysis), statistics (sample theory), psychology (test theory of survey technique), mathematical and quantitative methods of demographic analysis, and advanced topics in mathematics may be accepted. Students must propose a program satisfying this standard under the third requirement for Admission to Candidacy.

5. 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 or more. It is not recommended that this requirement be satisfied during the first year of graduate study, and it will normally be satisfied by the end of the third year of residence.

6. Seminar studies are designed to develop independent research skills, to permit specialized study, and to foster dissertation research. Students are expected to participate in at least two seminars by the end of their third year in residence and to have written at least two research papers. Presentation of a well developed proposal for dissertation research should take place in one of these seminars or, alternatively, in a departmental workshop. A dissertation prospectus in addition to two research papers must be submitted as part of each student's permanent file. Students in the process of dissertation research and in residence shall maintain contemporaneous participation in at least one seminar.

7. When these standards have been satisfied and upon a recommendation from the student's dissertation adviser, the Director of Graduate Study will request that a University oral examination committee and time be set. The examination is based on the dissertation and on the field or fields of economics within which it lies.

8. Completion of a dissertation accepted by a departmental reading committee will be the final standard set in preparation for the Ph.D. degree.

Minor for the Degree of Doctor of Philosophy—To be recommended for the degree of Doctor of Philosophy with Economics as a minor subject, a student will 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 annually. The standard of achievement in these examinations is the same for minor as for major candidates.

Joint Programs Leading to Dual Degree—Attention is called to two joint programs. The Department of Economics and the Stanford Law School offer a joint program leading to the Doctor of Philosophy in Economics and the J.D. degree in law. The Department and the Stanford Graduate School of Business also offer a joint program leading to the Doctor of Philosophy in Economics and the Doctor of Philosophy in Business.

In each case, the student's program of
jectives must clearly justify such a joint program; decisions by the Departmental Graduate Studies Committee will govern. In each case, a student's program in Economics must satisfy the same standards as a Ph.D. degree in Economics taken with a minor in Law or Business Economics respectively. See the Law and Business School catalogues for descriptions of their participation in the joint programs. In each case, it is expected that dissertation research will cross departmental lines and that members of the dissertation committee will be drawn from both faculties.

Students may matriculate in Economics, Law, or Business initially. After one year of study, they may apply for admission to a joint program by petition to the two appropriate faculty committees.

Similar joint programs involving the Master of Arts degree in Economics may be arranged upon application and following standards set up for that degree.

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 of economics. Current stipends under these grants range up to $2600 for an academic year in addition to tuition allowance. Students whose record justifies continuation in the program may be assured of favorable consideration for further support for a period of up to three additional years.

Such support for subsequent years may take the form of employment as research assistants or as teaching assistants. The salary scale in each case depends upon experience and ability. In the case of research assistants, students are currently receiving $2700 plus an allowance for tuition. In the case of teaching assistants, students are currently receiving $2500, $2700, or $3000 per academic year, depending on appointment, in addition to a tuition allowance. In each case the appointments are for half-time employment.

Entering students are not normally considered for research or teaching assistantships.

Completed application forms for graduate fellowships should be filed before January 15 at the Office of Financial Aids at the same time as completed application forms for admission are filed with the Admissions Office.

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 1970-71.

1. Elementary Economics—The functioning of a modern market economy: the determination of national income and its distribution; the composition of output; growth of the economy.

5 units, Aut, Win, Spr (—) MTWThF 9
4 units, Sum (—) MTWThF 9

51. Economic Analysis I—The nature of economic systems; performance evaluation criteria. Consumer choice and production theory. The role of markets and prices in allocating resources in a decentralized system. Problems of equity and efficiency. (May be taken as 151 by graduate students.) Prerequisite: 1 or equivalent preparation.

5 units, Aut, Win, Spr (—) MTWThF 9

52. Economic Analysis II—An analysis of equilibrium and instability in the economic system as a whole. National accounts and aggregate relationships among stocks and flows in markets for goods, services, and financial assets. (May be taken as 152 by graduate students.) Prerequisite: 51 (or 5).

5 units, Aut, Win, Spr (—) MTWThF 9

53. Economic Analysis III—Application of micro- and macroeconomic analysis to comparative economic systems and selected aspects of economic growth. Centralized versus decentralized decision-making; questions of ownership; the performance of socialist economies. Growth as an economic goal. Sources of economic growth. Allocation of investment and growth performance in different systems. Term papers are required. (May be taken as 153 by graduate students.) Prerequisite: 52 (or 5 and 10).

5 units, Aut, Win, Spr (—) MTWThF 9

90. 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. (May be taken as 190 by graduate students.)

5 units, Aut, Win (——) MTWThF 8

91. 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 may not enroll. (May be taken as 191 by graduate students.) Prerequisite: 90.

5 units, Win, Spr (——) MTWThF 8

105. Intermediate Microeconomic Analysis—Theoretical models of market behavior including the impact of monopolistic influences; general equilibrium theory and input-output analysis; externalities; decision-making under uncertainty; and selected applications of microeconomic theory. Divergences between private and social profitability are discussed and analytical tools required for 158 are developed. Prerequisite: 51 (or 5).

5 units (——) MTWThF

111. Money and Finance—An investigation of financial processes, with an emphasis on the role of the banking sector and monetary policy. Implications for economic growth and stability are developed in the light of modern theory. Prerequisites: 51 and 52 (or 5 and 10).

5 units (——) MTWThF

113. Macroeconomic Prediction and Control—Use of econometric models for analyzing economic fluctuations and trends in industrialized countries, preparing and evaluating short- and long-term forecasts of economic activity, and appraising quantitative policies for stability and growth. Emphasis is on economic structure and use of simulation techniques for forecasting and control rather than on statistical estimation of models. Not offered every year. Prerequisite: 52 (or 5 and 10).

5 units (——) MTWThF

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. Prerequisites: non-majors 1; majors 51 and 52 (or 5 and 10).

5 units (——) MTWThF

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 industrial development, economic stability, and income distribution, including social and political influences thereon. Prerequisites: non-majors 1; majors 51 and 52 (or 5 and 10).

5 units (——) MTWThF

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: non-majors 1; majors 51 and 52 (or 5 and 10).

5 units (——) MTWThF

118. Developing Economies—Characteristics of less developed economies. Mechanisms and key features of the development process. Emphasis on theory, but attention will be given to policy problems and case studies. Prerequisite: 1.

5 units (——) MTWThF

120. The Marxist and Radical Tradition—Theories and ideologies in relation to practices in capitalist and communist economies. An analysis of the views of influential economic thinkers in the Marxist and radical tradition. Prerequisite: 1.

5 units (——) MTWThF

121. Economic Development in East Asia I—The economic development of China in this century, with emphasis on Communist China. The impact of Maoist ideology on economic development. Course also covers Korea, Taiwan, and Indonesia. Prerequisite: 1.

5 units (——) MTWThF

122. Economic Development in East Asia II—A case study in the modernization and industrialization of non-Western countries. Social change and economic growth in modern Japan since the Meiji Restoration. Special emphasis on the post-"takeoff" period. Pr
123. Economic Development in Latin America—Problems and principal features of economic development in Latin America. Emphasis is on the application of modern analytical methods and on policy implications of recent economic research. Prerequisite: 1.

5 units (MTWThF)

141. Public Finance and Fiscal Policy I—Effects of government expenditure, borrowing and taxation upon resource allocation, national income and employment, prices, and income distribution. Prerequisites: 51 and 52 (or 5 and 10).

5 units (MTWThF)

142. Public Finance and Fiscal Policy II—Continuation of 141 with emphasis on discussions, case studies, and individual research. Prerequisites: 51 and 52 (or 5 and 10) and 141.

5 units (MTWThF)

145. Economics of Labor—Analysis and description of United States labor force and labor markets. Wage determination; effects of unions and institutional forces on wages; causes and cures of unemployment. Brief history of American unionism and collective bargaining. Prerequisite: 1 and 51 (or 5).

5 units (MTWThF)

147. Economics of Human Resources—Models of educational processes. Analysis of rates of return to investment in human resources, including health and on-the-job training. Educational planning and economic growth. Prerequisite: 51 (or 5).

5 units (MTWThF)

148. Economics of Urbanization—Application of tools of economic analysis to public policy issues in such areas as housing, transportation, public services, financial problems of cities, and environmental control. Prerequisite: 1.

5 units (MTWThF)

158. Organization and Social Control of Industry—Methods of evaluating economic efficiency; anti-trust laws and attempts to preserve competition; economic regulation of public utilities, communications, and transportation. Emphasis on independent study. Prerequisites: 51 (or 5) and 105, or consent of instructor.

5 units (MTWThF)

165. International Economics I—Comparative advantage in production and trade among nations; the international monetary mechanism; domestic monetary, fiscal, and tariff policies and their relationship to foreign trade. Prerequisite: 1. Should be taken by majors after 51 and 52.

5 units (MTWThF)

166. International Economics II—Selected topics in international economics, with emphasis on discussions and individual study. Prerequisite: 165.

5 units (MTWThF)

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 correlation analysis. Prerequisites: 51 and 52 (or 5 and 10), Mathematics 41 or equivalent, Statistics 7 or equivalent, or consent of instructor.

5 units (MTWThF)

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. Prerequisite: 170.

5 units (MTWThF)

180. Mathematics for Economists—Training in areas of mathematics which have frequent applicability to economic problems. Intended for students who have already had some calculus but lack a strong mathematical background. Topics covered include: functions of several variables; partial derivatives and differentials; mean value theorem and Taylor’s theorem; elementary matrix algebra, determinants, and characteristic roots; quadratic forms; and maximization of a function of several variables subject to equality constraints. Selected applications in economics are discussed. Prerequisites: 51 (or 5) and Mathematics 41 or the equivalent.

5 units (MTWThF)

181. Optimization and Economic Analysis—The development of optimization techniques, including calculus, linear and non-
linear programming, the calculus of variations, and control theory. Emphasis on concepts and results rather than techniques and proofs. Examples will include static and dynamic theories of the household and the firm, and problems in aggregative planning and control. Prerequisites: 51 (or 5), 180 or Mathematics 43 or equivalent and an introductory statistics course.

5 units (_____) MTWThF

199. Senior Honors Research in Economics—Individual research leading to the writing of a senior honors thesis. One or more seminars will be offered with all members writing on related topics and meeting throughout the year under the guidance of one instructor. Maximum number of students in such a seminar is ten. Alternatively, by special arrangement, an Honors student may be permitted to write on a topic of his choice in consultation with an appropriate faculty member. Prerequisites: admission to Honors Program (see requirements for appropriate grade point averages) and consent of instructor.

Up to 10 units (_____)
ulation and manpower. Programming methods. Prerequisite: 215 or consent of instructor.

5 units (——)

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 (——)

223. Economic Development in Latin America—Emphasis on issues of development policy in relation to individual countries in the area. Given seminar style with individual research papers.

5 units (——)


10 units (——) by arrangement

C. ECONOMIC HISTORY

(Professors Abramovitz, David, and Milward)

*225. Historical Experience of Economic Growth—Topics in European economic history with emphasis on problems and issues relevant to growth. Change in preindustrial and industrializing economies in historical perspective.

5 units (——)


5 units (——)

227. European Economic History—Analysis of economic growth in western European countries from the 18th century onward, with special reference to aspects of 19th century industrial development.

5 units (——)

228. Postwar Growth in Industrialized Countries—Historical and analytical treatment of the postwar growth records of industrialized countries in the light of their longer term experience. Topics include the growth of resources and productivity, structural change in output, employment, and international economic relations and the interconnections of demand and potential output growth.

5 units (——)

325A,B,C. Seminar in Economic History.

10 units (——) by arrangement

D. MONETARY THEORY AND INSTITUTIONS

(Professors Gurley, Kolm, Scadding, and Shaw)

*230. Monetary Theory—Advanced topics in monetary theory with special reference to policy criteria and control techniques. Prerequisite: 211.

5 units (——)


10 units (——) by arrangement

E. PUBLIC FINANCE

(Professors Coen, Gurley, and Kolm)

*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 or consent of instructor.

241. 5 units (——)

242. 5 units (——)

243. Economic Analysis of Governmental Behavior—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.

5 units (——)

341A,B,C. Seminar in Public Finance—Pre requisite: 241 or consent of instructor.

10 units (——) by arrangement
F. ECONOMICS OF LABOR
(Professors Pencavel and Reder)


5 units (——)

248. Wages and Income Distribution — Wage levels, structure; income distribution, effects of education on earnings, special references to empirical data.

5 units (——)

*249. Urban Economic Analysis—Analysis of structure and functioning of economic activity in urban areas: location and growth of cities, transportation-communication and externalities, intra-metropolitan distribution of firms and residences, operations of land markets, planning local public services and fiscal problems, slums. Prerequisite: 204 or Engineering-Economic Systems 212.

5 units (——)

*250. Wealth and Poverty in the Urban Economy—Analysis of urban labor markets with special reference to problems of poverty; income sources of urban dwellers, wages, transfers, property income, income subsidies, and guaranteed employment; rural-urban migration; the family labor supply; local against national wage structures; ethnic and racial groups.

5 units (——)

345A,B,C. Seminar in Labor Economics.

10 units (——) by arrangement

G. ECONOMICS OF INDUSTRY
(Professors Manne and Rosse)

254. Economics of Industry I — Optimization of investment decisions; plant size, location, and time-phasing; equipment replacement; capital budgeting; pricing and investment policies for a multi-product public enterprise; relation between economics-of-scale and oligopoly problems; inter-industry analysis.

5 units (——)

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 (——)


10 units (——) by arrangement

II. INTERNATIONAL ECONOMICS
(Professors Despres, Keesing, McKinnon, and Tarshis)

*265. International Finance — Capital movements. Balance of Payments adjustments. Domestic economic effects of alternative international monetary institutions. Prerequisites: 204 and 212 or consent of instructor.

5 units (——)

*266. International Trade Theory—Causes of trade and its effects on the allocation of resources, income distribution, growth and development, commercial policies. Prerequisite: 265.

5 units (——)

365A,B,C. Seminar in International Economics.

10 units (——) by arrangement

I. ECONOMETRICS
(Professors Amemiya, Anderson, Lau, and Statistics Department)

*272. Econometrics I — Includes a review of classical least squares theory, problems pertaining to serial correlation of the residual, autoregressive models, distributed-lag models, and other single-equation methods and problems. Selected applications in economics. Prerequisites: Mathematics 113, Statistics 219 and 220, or the equivalent.

5 units (——)


5 units (——)

370A,B,C. Seminar in Econometrics.

10 units (——) by arrangement

J. MATHEMATICAL ECONOMICS
(Professors Kurz, Leland, and Majumdar)

280. The Economics of Uncertainty—A sys-
tematic examination of the implications of uncertainty on microeconomic behavior using axioms of choice under uncertainty and the expected utility theorem. Topics include optimal static and dynamic portfolio choices, insurance, the effect of uncertainty on savings and production decisions, stochastic stability of markets, and general equilibrium and welfare considerations under uncertainty. Prerequisites: 181, Statistics 116, or equivalents.

5 units ( )

281. Welfare Economics — General treatment of the theory of welfare economics; theory of second-best; social welfare functions; problems in planning theory. Prerequisites: 204, 181 or equivalent.

5 units ( )


5 units ( )

284. Advanced Dynamic Programming: Optimal Economic Growth—Current techniques for optimal policies of consumption and capital accumulation. Prerequisites: Mathematics 45, 113-114. Recommended: Mathematics 130 and Economics 283 or consent of instructor.

5 units ( )


5 units ( )

288. Special Topics — The topics for 1970-71 will be announced. May be repeated for credit. Prerequisites: consent of instructor and working knowledge of differential calculus.

5 units ( )

385A,B,C. Seminar in Mathematical Economics.

10 units ( ) by arrangement
writing requirement and should have taken at least one course in English or American literature (not including Freshman English).

Any student who declares an English major in the autumn quarter of 1970 or later should begin preparing to fulfill the Department's requirement of proficiency in a foreign language. [Information on how to satisfy this requirement should be obtained as early as possible from the Department office. Those whose earlier academic experience puts them at a serious disadvantage in satisfying the foreign language requirement may, with the approval of the Department, substitute certain alternative programs of study. For information, consult the chairman of undergraduate studies.]

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. The English Department recognizes that the interests of its majors are extremely various; for this reason the stated formal requirements are minimal. At the same time the Department strongly recommends that all English majors take courses with broad historical perspectives on language and literature such as English 102, 181, 182, 183, 184, 177, 178, and 179, and also more concentrated courses on the great major figures, notably courses in Chaucer, Milton, and Shakespeare. No one of these courses is mandatory, but those covering the background and the evolution of English and American literature, or focusing on the greatest writers, constitute the best preparation, not only of prospective candidates for admission to graduate schools of English, but of all students seriously interested in the study of English and American literature.

a) Language: English 100A, 102, 208, 209, 310; Anthropology 168.

b) Medieval: English 100B, 141, 181, 231.


e) Romantic and Modern: English 100E, 148, 149, 150, 152, 173, 184, 242, 244, 252, 253, 254, 275.


2. Students are required to take at least three additional courses (15 units) in English.

a) Students, except those majoring in Creative Writing, may select their 15 units from the six divisions above, from English courses numbered above 100 that fall outside any one of the six divisions, and (for a total of not more than 5 units) courses in a foreign literature read in the original.

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. The English Department regards the knowledge of a foreign language and some familiarity with its literature as a necessary part of any general University education, and as especially important for an intelligent understanding of the English language and its literature. Students majoring in English who declare their major in the autumn quarter of 1970 or later will be required to demonstrate proficiency in a foreign language.

4. 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.

Note: English courses that are given at Stanford Overseas Campuses, that are numbered over 100, and that deal in substantial part with English or American literature may normally be used to fulfill the elective requirements for the English major.

HONORS PROGRAM IN ENGLISH

Students who wish to undertake a more intensive and extensive program of study, in-
cluding seminars and independent work, are invited to apply for admission to the Honors Program during the spring quarter of their sophomore year. Applications during the junior year will sometimes be accepted. Admission will be selective.

Students admitted to the program will take one course in each of the six divisions required of English majors. In their junior year students in the program will take a Junior Honors Seminar (188A), focusing on the close reading of a literary text or series of texts. In exceptional cases, English 101AG may meet this requirement. In the autumn of their senior year students will take a Senior Honors Seminar (188B), focusing on fundamental questions of critical theory and practice. Each Honors student will consult with the Honors adviser to define a concentrated program of four additional courses (20 units) in one of the six required areas or, according to the student’s interests, in a combined field: for example, Middle English and Renaissance, Renaissance and Restoration, Neoclassic and Romantic, Drama, Fiction, Poetry. Alternatively, a student who wishes broad coverage may take one additional course in four of the six fields required of regular English majors.

Finally, in their senior year, students will write a Senior Honors Essay (191). They should submit to the Honors Committee a detailed prospectus, a short annotated bibliography, and a more extensive prospective bibliography during November of the senior year. The prospectus and bibliographies must be approved by the Honors Committee before the student receives credit for work on the Essay.

Students in the program will have completed a minimum of 70 units of work in English and American Literature, as follows:

- Area requirements (a through f) — 30 units
- Junior and Senior Seminars — 10 units
- Program of concentration — 20 units
- Senior Essay — 10 units

On the basis of their performance in the program as a whole, candidates for Honors will be awarded either ‘Highest Honors’ or ‘High Honors’ or ‘Honors.’

**Note:** Exceptional English majors who are not in the Honors Program but elect Senior Independent Study (199) may be invited in their senior year to apply for departmental ‘Honors.’

**Combined Major in Classics and English**

Students may with the consent of the Chairman 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 Chairmen of both departments.

**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 courses or their equivalents before they complete the program at the end of the fifth year. Undergraduates who are interested in preparing to teach English in public secondary schools should give first priority to the Departmental requirements for the A.B. with a major in English. But they should elect whenever possible some of the additional courses required for the “teaching major.” The courses in the following list are in keeping with the Guidelines for the Preparation of Teachers of English developed cooperatively by the Modern Language Association, the National Association of State Directors of Teacher Education and Certification, and the National Council of Teachers of English:

<table>
<thead>
<tr>
<th>Teaching Major</th>
<th>Units</th>
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<tbody>
<tr>
<td>Freshman English</td>
<td></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>
</tbody>
</table>
English 143A,B. Shakespeare 5
English 182. Introduction to the Renaissance 5
English 183. Introduction to the Neoclassic Period 5
English 184. Introduction to the Modern Period 5
Courses in American literature (preferably in the chief American poets and American novelists) 10
Education 184. Literature for Adolescents 3
Course in Speech, preferably Speech 30, Oral Interpretation 3
Speech and Drama 160, Theater Practice, or Speech and Drama 164, Fundamentals of Acting and Directing, or equivalent experiences in dramatics, or Journalism 100 and 102, Editorial Techniques and Lab 4
Electives (courses in literature of Black America and literary criticism are strongly recommended)

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 Units
Freshman English
English 204. Advanced Exposition 3
English 102. Introduction to the English Language or English 209 5
English 143A,B. Shakespeare 5
English 184. Introduction to the Modern Period 5
Courses in American literature 10
Elective, preferably in the English novel or English 208, Introduction to Modern Linguistics 5

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 249. College Curriculum and Instruction (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 Grom-
mon, 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 college-level 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.

Normally, this program should be completed in four years. The first year should be devoted to full-time graduate study; the second and third years to half-time graduate study and half-time teaching; the fourth year to writing the dissertation. Teaching is considered an essential part of the Ph.D. program.

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, in different genres and periods as approved by the adviser.

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. A student may petition to take an oral examination instead of the written examination, and a student coming to Stanford from graduate work in another university, where he took a qualifying examination and received an A.M., may petition for exemption from the qualifying examination here. However, all petitions are subject to rulings by the Graduate Examination Committee.

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 (1) the field of concentration (as defined by the student and his adviser, subject to the approval of the Departmental Graduate Study Committee) and (2) plans for the dissertation 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 312, except that the candidate may substitute 311 for 312 if he has already had sufficient work on the development of the English language.

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.

3. 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. A student may petition to take an oral examination instead of the written examination, and a student coming to Stanford from graduate work in another university, where he took a qualifying examination and received an A.M., may petition for exemption from the qualifying examination here. However, all petitions are subject to rulings by the Graduate Examination Committee.

4. 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.

The Ph.D. program in English and Comparative Literature is designed for students wishing an extensive knowledge of the literature, thought, and history of England and of at least one foreign country, for one period. Approximately half of the student’s course work and reading will be devoted to this period, with the remainder of his time given to other periods of English and American literature since 1350.

This degree, administered by the Department of English, is to be distinguished from the new Ph.D. in Comparative Literature. Beginning in 1970–71, Stanford will offer a program leading to the Ph.D. in Comparative Literature. This program is intended for students unusually well prepared in foreign languages, and will involve advanced work in three literatures, of which one may be English. It will be possible for a few students who began graduate work in the English Department in the autumn quarter of 1969 to transfer to this new program in 1970. Students interested should consult Professor Herbert Lindenberger, Chairman of the Committee on Comparative Literature.

The requirements for the Ph.D. in English and Comparative Literature are as follows:

1. A knowledge of English and American literature since 1350 comparable to that demanded of candidates for the Ph.D. in English literature. Candidates will take the qualifying examination at the end of the summer after the first year of graduate work; they will not be expected to answer questions dealing with literature before 1350. A student may petition to take an oral examination instead of the written examination, and a student coming
Stanford from graduate work in another university, where he took a qualifying examination and received an A.M., may petition for exemption from the qualifying examination here. However, all petitions are subject to rulings by the Graduate Examination Committee.

2. A knowledge of the basic structure of the English language 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. No particular courses are required of all students.

3. A knowledge of one foreign language comparable to that demanded under the basic program and an advanced reading knowledge of a second language.

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 foreign. 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, would normally be taken no later than the winter quarter of the third year of graduate study. However, those who spend the third year studying abroad may take this examination after their return early in the fourth year.

**Language Requirements**—All candidates for the Ph.D. degree (except those in English and Comparative Literature, for whom special language requirements prevail) must demonstrate a reading knowledge of two foreign languages. Candidates in the earlier periods must offer Latin and French or German, and may be asked, in some instances, to offer all three; candidates in the later periods (i.e., after the Renaissance) must offer two of the following: Latin, French, or German. Any substitution of another language for purposes of research must be approved by the Graduate Studies Committee.

The candidate must satisfy one language requirement by the end of the first year (that is, before Registration in the following year), and the other by the end of the third year.

Foreign language requirements for the Ph.D. may be fulfilled in any 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.
3. Passage of a departmental examination in languages not tested by the Educational Testing Service (e.g., Latin, Italian). The Latin examination will be given before registration in the autumn quarter in order to permit those who need the course to register for Latin 5. It will also be given in the eighth week of the winter and spring quarters, along with other departmental examinations for languages not tested by the Educational Testing Service.

**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 Chairman 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 proved by the Graduate Studies Committee.
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, see the section “Humanities Special Programs.”

**GRADUATE PROGRAM IN MODERN THOUGHT AND LITERATURE**

Stanford also offers a Ph.D. degree in Modern Thought and Literature. Under this program students devote approximately half of their time to a modern literature from the Enlightenment to the present, and the other half in interdisciplinary studies. For 1970-71 this program is open only to graduate students already at Stanford. Students interested should see the section “Modern Thought and Literature” and consult Professor Albert Guerard in the English Department.

**COURSES NUMBERED 1 THROUGH 99 ARE DESIGNED PRIMARILY FOR FRESHMEN AND SOPHOMORES IN THE WHOLE UNIVERSITY**

1, 2. *Freshman English* — Writing, chiefly expository, emphasizing the control of meaning through critical and creative thinking, and through mastery of style. These courses satisfy the University writing requirement. (Rebholz, Director and Staff)

1. 3 units, Aut, Win, Sum
2. Continuation of 1.
3 units, Win, Spr, Sum

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* — Creative writing. Open by invitation to a limited number of students who have already shown (in English 1 or 2, or the equivalent) the capacity to write lucid expository prose. There will be small groups devoted to various kinds of writing, including fiction and poetry. This course may replace, for those invited, one quarter of regular Freshman English.
3 units, Win, Spr (Rebholz, Director and Staff)

5. *Narration* — Basic problems of narrative and imaginative writing. Prerequisite: completion of Freshman English requirement.
3 units, Aut (Young) (I) MWF 10
(Rubin) (II) MWF 11;
(Moffat) (III) MWF 11;
(Packer) (IV) MWF 1:15;
Win (Young) (I) MWF 10;
(Moffat) (II) MWF 11;
(——) (III) MWF 11;
(Rubin) (IV) MWF 1:15
Spr (——) (I) MWF 10;
(Moffat) (II) MWF 11;
(——–) (III) MWF 11;
(Young) (IV) M 1:15, W 7:15 p.m.
Sum (——) MWF 1:15

6. *Reading and Writing Poetry* — An introductory course in the understanding and writing of poetry. Prerequisite: completion of Freshman English requirements.
3–5 units, Aut (Taylor) MWF 11
Win (Taylor) MWF 11
Spr (Young) MWF 10

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, Aut (Riggs) MTWTh 9
Spr (Evans) MTWTh 9

8. *Masterpieces of American Literature* — Intensive study of a few masterpieces of American literature, including poetry, drama, the essay, the novel.
4 units, Win (W. Chace) MTWTh 11

43. *Shakespeare* — A reading of 12 to 14 representative comedies, histories, and tragedies; designed to introduce the general student, as well as the prospective English major, to Shakespeare's art.
4 units, Aut (N. Ford) MTWTh 10
Win (Sensabaugh) TWThF 11
Spr (Riggs) MTWTh 1:15
Sum (——)

74. *Literature of Black America* — A survey of Afro-American literature from James Weldon Johnson to the contemporary black
theater, concentrating on the Harlem Renaissance, the great novels of the twentieth century, and the various works of LeRoi Jones.

4 units, Spr (Williams) MTWTh 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 — The objectives of this course are twofold: to present the novel as a significant, distinct genre of literature, and by encouraging close, sympathetic reading to increase the student’s appreciation of the individual novels.

4 units, Aut (Scowcroft) MTWTh 10

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 (Lindenberger) MTWTh 11
Spr (Mellor) MTWTh 11

77. Introduction to the Drama — Principal dramatic forms; development of dramatic art; masterpieces of the theater from various periods, countries.

4 units, Aut (Riggs) MTWTh 1:15
Win (Lindenberger) MTWTh 1:15

81. Literature and Revolution — The basic aim of the course is to develop an understanding of the culture of 20th-century social revolution by studying theories of revolutionary culture and some examples of literature produced by the Russian, Chinese, and Cuban revolutions and by the revolutionary movement in the United States. Authors to be read include Mao Tse-tung, Che Guevara, Ho Chi-Minh, Lenin, Brecht, Malraux, Frantz Fanon, and Malcolm X. Open to all undergraduates and, by special arrangement, to graduate students in all departments.

4 units, Spr (Franklin) MTWTh 10

99. 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.

4 units, Win (N. Ford) MTWF 10


Courses Numbered 100 through 199 are LARGELY, THOUGH NOT EXCLUSIVELY, DESIGNED FOR ENGLISH MAJORS

Note: Students who wish to take a course numbered 100-199 for graduate credit should receive permission of the instructor and should register for English 395.

100A-G. Basic Seminars — Basic seminars on the scholarly and critical study of literary texts; given each quarter and strongly recommended for beginning English majors. English 100A-F will satisfy the appropriate area requirements A-F (see program for Bachelor of Arts, 1, above). The subject matter of English 100A will be mainly linguistic history; of English 100B, medieval literature; of English 100C, Renaissance literature; and so on. The subject matter of English 100G, which will count as one of three required electives (see program for Bachelor of Arts, 2, above), will be mainly the theory of literary genres. This course is limited to sophomores and upper division students who have previously declared an English major and have taken at least one course in English or American literature (not including Freshman English). Students wishing to take the course must sign up during the previous preregistration period. (Instructors: Carnochan, Chace, Evans, Felstiner, Fifer, Friedlander, B. Gelpi, Loftis, Rebholz, Ruotolo, Sensabaugh, Stone, Watt, Whitaker, Williams.)

5 units, Aut, Win, Spr. Consult the Time Schedule for specific offerings.

102. Introduction to the English Language — Studies in the evolution of the English language as a medium of literary expression.

5 units, Win (Robinson) MTTh 1:15
Spr (———) MWF 11

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 taken twice. Prerequisite: 5.

3 to 5 units,
Aut (Packer) (I) MW 2:15-4:05;
(Abrahams) (II) TTh 2:15-4:05
134. Directed Writing: Poetry—Intermediate course in writing various types of verse. May be repeated for credit.

3-5 units, Win (Gunn) MWF 1:15
Spr (Taylor) MWF 11

135. Fiction Writing — May be taken only by permission of the instructor. Samples of writing should be submitted not later than registration day.

3-5 units, Aut (Guerard) MW 4:15-6:05

138. Literature and the Performing Arts—Studies in the relationship of literature to theater, film and dance, with practical work in sections.

5 units, Win (Friedlander) TTh 4:15-6:05

141. Chaucer — Enrollment in any given term limited to 70. Each student must sign up in the Department office during May preregistration for a place in one of the sections taught the following year.

5 units, Aut (Ackerman) MTWF 9
Win (Brown) TWThF 10
Spr (Brown) TWThF 9

142. Spenser and the Renaissance Tradition.

5 units, given alternate years

143A. Shakespeare — Intensive study of eight plays. Selections will include histories, tragedies, and comedies from the major periods of Shakespeare’s art. Either 143 A or B satisfies the requirement for English majors in the Renaissance division.

5 units, Win (Whitaker) MTWF 9

143B. Shakespeare—Similar to 143A, except that eight different plays are studied, and under a different instructor. Students who desire extended study of Shakespeare’s plays at this level may take both 143A and 143B, in either order.

5 units, Spr (Friedlander) MTWF 11

144. Milton.

5 units, given 1971-72

145. Donne and Jonson.

5 units, given alternate years

146. Swift and Pope.

5 units, given alternate years

147. Johnson and His Circle.

5 units, Spr (Fifer) MTWTh 10


5 units, given alternate years

149. Byron, Shelley, and Keats.

5 units, Spr (N. Ford) MTWF 10

150. Dickens and Trollope.

5 units, given alternate years

152. Browning and Tennyson.

5 units, given alternate years


5 units, given alternate years

171. Contemporary Drama — Post World War II theater, with emphasis on Brecht, Ionesco, Genet, Beckett, and Pinter.

5 units, Spr (Friedlander) TTh 2:15-4:05


5 units, Win (Guerard) MTWTh 11

173. Twentieth Century English Fiction.

5 units, Aut (Ruotolo) MTWTh 10

174. The Portrayal of Afro-American Characters in American Literature — Beginning with several important nineteenth-century images (in works by Frederick Douglas, Harriet Beecher Stowe, Mark Twain), the course will concentrate on characterization in works by Afro-American writers from Du Bois to the present.

5 units, Win (Levin) MTWF 10

177. American Literature to 1855.

5 units, Aut (Levin) MTWF 9

178. American Literature, 1855-1917.

5 units, Win (Moser) MTWF 9

179. American Literature 1917 to the Present.

5 units, Spr (W. Chace) MTWTh 1:15

181. The Earliest English Literature—Cultural backgrounds, reading (in translation) and critical analysis of Anglo-Saxon heroic legend, elegies, and other forms.

5 units, Aut (——) MTWTh 1:15
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 (Ryan) MWF 10; seminars by arrangement

183. Introduction to the Neoclassic Period.  
5 units, Win (Loftis) MWF 10; seminars by arrangement

184. Introduction to the Modern Period.  
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 (Williams) TTh 4:15-6:05

188B. Senior Honors Seminar.  
5 units, Aut (Ecakes) Th 2:15-4:05

189. Individual Work — Advanced undergraduates who wish to study a subject or an area not covered by regular courses may, with permission, enroll for individual work under the supervision of some member of the Department. No more than five units of credit will be given for English 189 and/or English 190 in any one quarter. English 189 may not be used to fulfill Departmental area or elective requirements without permission. Group seminars are not considered appropriate to English 189.

Any quarter, by arrangement

190. Ad Hoc Undergraduate Seminars — In a given quarter a group of undergraduates (at least three but preferably more) who wish in the following quarter to study a subject or an area not covered by regular courses may plan an informal seminar and approach a member of the Department to supervise it. A syllabus for the course should be submitted to the chairman of undergraduate studies at least two weeks before the end of the previous quarter. No more than five units of credit will be given for English 190 and/or English 189 in any one quarter. English 190 may not be used to fulfill Departmental area or elective requirements without permission.

Any quarter, by arrangement

192, 196. Senior Seminars.  
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 (——) MW 2:15-4:05;  
Win (——) (I) TTh 2:15-4:05;  
(——) (II) MW 4:15-6:05  
Spr (——) (I) TTh 2:15-4:05;  
(——) (II) MW 2:15-4:05

196. Seminar in American Literature.  
5 units, Win (——) MW 2:15-4:05

198. Development of the Short Story—Required of senior creative writing students in fiction. Open to others as space allows. Involves reading and discussion of American, British, and Continental short stories, with emphasis on changes and developments in the form. Several short papers plus a term paper.

5 units, Win (Stegner) MW 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)

Courses numbered from 200 through 299 are designed primarily for advanced students of literature and for graduates.

Note—Graduate students in other departments who wish to broaden their programs will find many of these courses useful. 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 composi-
tion of poetry. First- and second-year students may be admitted to this course. Consent of the instructor required. May be repeated for credit.

3 to 5 units, Aut (Davie) MW 2:15-4:05  
Win (Gunn) MW 2:15-4:05  
Spr (Davie) 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 their writing with the Creative Writing secretary at least ten days before the beginning of each quarter.

3 to 5 units, Aut (Scowcroft) TTh 2:15-4:05  
Win (Stegner) TTh 2:15-4:05  
Spr (Scowcroft) TTh 2:15-4:05

204. Advanced Exposition — Advanced course dealing with problems of writing expository prose. Prerequisite: 2 or the equivalent.

3 units, Aut (——) (I) MWF 10;  
(——) (II) MWF 3:15  
Spr (——) MWF 4:15  
Sum (——) MWF 10

205. The History of Literary Theory.  
5 units, given alternate years

206. Introduction to Modern Linguistics—Detailed study of aspects of the semantic, syntactic, and phonological structure of English, with some attention to their applications in the teaching of English. Prerequisite: Introductory Linguistics course or consent of instructor.

5 units, Win (Traugott) MWF 2:15


5 units, Sum (Ackerman) MTWThF 11

230A. Medieval to Renaissance: The Development of Literary Forms.  
5 units, given alternate years

230B. Continuation of 230A.  
5 units, given alternate years

231. Middle English Literature—An introduction to the literature of the Middle English period, exclusive of Chaucer. Emphasis on major works, most of which will be read in the original language (often in simplified texts). Prerequisite: 141 or equivalent.

5 units, Spr (Brown) TWThF 11

5 units, given alternate years

236. Advanced Study of Shakespeare—Detailed study of four or five plays, including attention to sources, staging, and important criticism. Extensive prior study of Shakespeare’s works is assumed. Prerequisite: 43 or 143A or B or equivalent.

5 units, Aut (Rebholz) MWF 9

5 units, given alternate years

238. Drama of the Restoration and Eighteenth Century.

5 units, Spr (Loftis) MTWTh 11

240. Eighteenth Century Prose—The study of a limited number of representative prose writers (excluding the major novelists) of the eighteenth century such as Swift, Addison, Steele, Johnson, Goldsmith, Reynolds, and Burke.

5 units, Spr (Fifer) MTWTh 9

241. The English Novel through the Eighteenth Century—Study of the most significant novels, with emphasis on development of the form.

5 units, Win (Watt) 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 (Polhemus) MWTh 9

244. The Impressionist and Experimental Novel—Graduate students and qualified undergraduates. Lectures and seminars. A few students will be permitted to submit creative work instead of a critical term paper. Limited to 45.

5 units, given alternate years

248. Poetry and Ideas: Johnson to Blake.  
5 units, given alternate years

251. The English Lyric — Historical examination of lyric poetry considered in respect to distinctions and historical relationships of schools and movements.

5 units, Win (Davie) MWF 11

5 units, Aut (Mellor) MTWThF 11

253. Victorian Prose—A study of Victorian
PROPHESTS IN THEIR DUAL ROLE: INTERPRETING THEIR SOCIETY, FORESHADOWING OURS.

5 UNITS, WIN (B. GELPI) MW 2:15-4:05

254. MODERN BRITISH COMIC WRITERS—READ-ING AND DISCUSSION OF WRITERS SUCH AS LEWIS CARROLL, WILDE, SHAW, BEERBOHM, JOYCE, BECKETT, BURGESS, PINTER.

5 UNITS, WIN (FELSTINER) MWF 10

259. COMPARATIVE LITERATURE: YEATS, ELIOT, NERUDA — THE INDIVIDUAL PERSPECTIVE ON POLITICS AND MYTH. INTRODUCTION BY WAY OF YEATS, FOLLOWED BY INTENSIVE READING OF "FOUR QUARTETS" AND "ALTURAS DE MACCHU PICCHU." PREREQUISITES: A COURSE IN MODERN POETRY, KNOWLEDGE OF SPANISH. LIMITED TO 15. (PLEASE SEE INSTRUCTOR BEFOREHAND.)

5 UNITS, AUT (FELSTINER) MW 2:15-4:05


5 UNITS, AUT (FRANKLIN) MTWTH 1:15

263. EMERSON, WHITMAN, AND EMILY DICKINSON.

5 UNITS, AUT (A. GELPI) MTWTH 10

264. VARIETIES OF AMERICAN ROMANTICISM.

5 UNITS, GIVEN ALTERNATE YEARS

265. HAWTHORNE AND MELVILLE — AN INTENSIVE STUDY OF THE DEVELOPMENT OF THESE TWO WRITERS, THROUGH CLOSE ATTENTION TO THEIR BEST WORKS AND THROUGH COMPARISON.

5 UNITS, SPR (LEVIN) MTWFL 11

266. CHIEF AMERICAN POETS, FROM 1630 TO THE PRESENT.

5 UNITS, GIVEN ALTERNATE YEARS

267. EMERSON AND THOREAU.

5 UNITS, GIVEN ALTERNATE YEARS

268. MAJOR AMERICAN HISTORIES AND AUTOBIOGRAPHIES—SELECTED WHOLE WORKS FROM 1630 TO THE PRESENT. READINGS RANGE FROM WILLIAM BRADFORD AND BENJAMIN FRANKLIN TO HENRY ADAMS, GARRETT MATTLINGLY, MALCOLM X, AND NORMAN MAILER.

5 UNITS, GIVEN ALTERNATE YEARS

269. TWAIN, HOWELLS, AND JAMES.

5 UNITS, WIN (SIMPSON) MTWTH 11

270. FORMS OF THE MODERN NOVEL. — (SEE ENGLISH 172.)

270B. AMERICAN LITERATURE OF THE 1930'S.

5 UNITS, WIN (FRANKLIN) MTWTH 1:15

271. MODERN SOUTHERN WRITERS.

5 UNITS, GIVEN ALTERNATE YEARS

272. TWENTIETH CENTURY BRITISH AND AMERICAN POETRY—CLOSE READING OF CERTAIN MODERN POETS WHO HAVE IN COMMON A FUNDAMENTALLY ROMANTIC THEORY OF POETRY. POETS USUALLY COVERED INCLUDE T. S. ELIOT, W. B. YEATS, HART CRANE, WALLACE STEVENS, THEODORE ROETHKE, DYLAN THOMAS, W. H. AUDEN.

5 UNITS, AUT (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 ALTERNATE YEARS

274. RICHARD WRIGHT, RALPH ELLISON, AND LEROGI JONES—A CLOSE STUDY OF THE NOVELS, PLAYS, POEMS, AND SOME OF THE STORIES, WITH ATTENTION ALSO PAID TO THE CRITICAL STATEMENTS MADE BY EACH MAN. ENROLLMENT LIMITED TO 30.

5 UNITS, AUT (W. CHACE) MTWTH 11

275. BRITISH DRAMA SINCE 1945.

5 UNITS, GIVEN ALTERNATE YEARS

276. AMERICAN POETRY SINCE 1945.

5 UNITS, SPR (A. GELPI) MTWTH 10

278. POPULAR BALLAD AND FOLKSONG.

5 UNITS, SPR (SIMPSON) MTWFL 11

279. SCIENCE FICTION.

5 UNITS, SPR (FRANKLIN) MTWFL 1:15

280. COMPARATIVE LITERATURE: TOWARDS AN UNDERSTANDING OF MODERNISM — STUDY OF SUCH MAJOR STRAINS IN MODERN LITERATURE AS THE SYMBOLIST AESTHETIC, PSYCHOANALYSIS, AND EXISTENTIALISM, WITH EMPHASIS ON THEIR ORIGINS IN THE 19TH CENTURY. PREREQUISITE: ONE COURSE IN MODERN LITERATURE, EITHER ENGLISH OR EURO-
pean. Reading knowledge of French or German desirable.

5 units, given 1971–72

290. Workshop in Verse Translation — In collaboration with foreign language departments. Graduate students and qualified undergraduates. Prerequisite: consent of instructor.

5 units, Win (Davie) MW 2:15–4:05

299. Advanced Work in Writing and Criticism.

Any quarter, by arrangement

Curriculum and Instruction in Secondary School English I—See Education 262.

Courses numbered 300 through 399 are designed primarily for graduate students

Note—Some of these courses are relatively broad in scope; some focus on a single theme or genre. Students should consult the instructor before registering for any course in this category.

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, given alternate years

303. Seminar on Linguistics and Literature—Emphasis on the applicability of Prague School linguistics and transformational theory to literary criticism. Prerequisite: 208 or consent of instructor.

4 units, given alternate years

304. Comparative Literature Seminar: Major Modern Critics—Although planned as a sequence, 304A and 304B may be taken independently.

304A. Modern Anglo-American Criticism.

4 units, Aut (Lindenberger)
TTh 2:15–4:05

304B. Modern Continental Criticism.

4 units, given 1971–72

305. Seminar in the History of Literary Theory.

305A. Classical Backgrounds — 305A may be taken independently of 305B.

4 units, given alternate years

305B. The Middle Ages and the Renaissance — Prerequisite: 305A.

4 units, given alternate years

306. Seminar in the Criticism of Poetry.

4 units, given alternate years


307A. Critical Analysis.

4 units, given alternate years

307C. Conrad.

4 units, given alternate years

307E. The Modern Novel — Problems of structure and style. Students must be free to attend a number of the lectures in English 172.

4 units, Win (Guerard) TTh 2:15–4:05

309. Early Welsh.

4 units, given alternate years

310. Old English—Elements of Old English grammar; critical reading of short poems and selected prose in Old English.

4 units, Aut (—) MTWTh 9
Win (Robinson) MTWTh 10
Sum (Ackerman) MTWThF 9

311. Beowulf — Reading and critical analysis of Beowulf with some attention to other heroic poetry in Old English. Prerequisite: 310 or equivalent.

4 units, Spr (Robinson) MTWTh 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 9


4 units, given alternate years

316. Seminar in Elizabethan Language—Vocabulary, pronunciation, grammar, orthography of the period. Prerequisite: 312 or equivalent.

4 units, given alternate years

317. Readings in Medieval English Literature.

4 units, given alternate years
318. Seminar in Middle English Literature.—Prerequisite: 312 or equivalent.
4 units, Aut (Ackerman) MW 2:15-4:05

319. Seminar: Linguistic Problems in the interpretation of Literary Texts.—A consideration of the development of English from Elizabethan times to the present with primary attention to the relevance of language history to literary interpretation.
4 units, Spr (Robinson) MW 2:15-4:05

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 (Brown) TTh 4:15-6:05

325. Shakespeare Seminar — Prerequisites: the equivalent of 43 or 143A,B; 182 or 330; and 237.
4 units, Spr (Whitaker) TTh 2:15-4:05

327. Comparative Literature Seminar: Historical Drama—Uses of history, from Shakespeare and Corneille to Büchner and Brecht, to define relation of the individual to political forces. Prerequisites: considerable previous study of Shakespeare and/or European drama; reading knowledge of French or German.
4 units, given alternate years

330. English Literature of the Sixteenth Century.
4 units, given alternate years

331A. Sir Philip Sidney and His Circle.
4 units, given alternate years

331B. Ben Jonson.
4 units, given alternate years

331F. English Poetry From 1590 to 1620.
4 units, given alternate years

4 units, given alternate years

332B. Francis Bacon and His Times.
4 units, given alternate years

332C. Marlowe and His Contemporaries.
4 units, given alternate years

334. Literature of the Seventeenth Century: Backgrounds, Forms, Styles.
4 units, Aut (Sensabaugh) TWTThF 11

4 units, Spr (Evans) MW 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, given alternate years

341B. Studies in Dryden, Swift, and Pope.
4 units, given alternate years

341C. Johnson and His Circle.
4 units, Aut (Fifer) MW 2:15-4:05

341D. Literature and Society in the Eighteenth Century — Themes such as: death, sexuality, censorship, witchcraft, apocalyptic, industrialization.
4 units, Win (Carnochan) TTh 2:15-4:05

341E. Literary and Social Content of Drama.
4 units, Spr (Loftis) TTh 2:15-4:05

350. English Literature in the Nineteenth Century.
4 units, Aut (N. Ford) MW 4:15-6:05

351. Literary Problems of the Romantic Period—Prerequisite: 184 or 350, or equivalent treatment of Romantic period.

351B. Romanticism: Fact or Fiction?
4 units, given alternate years

351C. Nineteenth Century Poetry.
4 units, given alternate years

351D. Romantic Irony — An attempt to define the notion of Romantic Irony by studying the theoretical formulations of F. Schlegel, Schiller, and Coleridge and the ways in which such a philosophical attitude determines the structure and content of the poetry of Blake, Coleridge, Shelley, Byron, Keats, and Yeats, and the novels of Lewis Carroll, Virginia Woolf, and Joyce Cary.
4 units, Win (Mellor) TTh 2:15-4:05

354. Victorian Prose.
4 units, given alternate years

355. Pater and the Pre-Raphaelites.
4 units, given alternate years

358. Seminar: Literary Problems of the
Nineteenth Century—Prerequisite: 184 or 350, or equivalent.

358A. Nineteenth Century Comic Fiction.
4 units, Aut (Polhemus) TTh 4:15–6:05

358D. The Bloomsbury Group.
4 units, given alternate years

358E. The Nineties—Studies in such writers as James, Shaw, Wilde, Yeats, Beerbohm.
4 units, given alternate years

4 units, given alternate years

360. British Poetry since Hardy—Authors considered include Auden, Muir, Dylan Thomas, R. S. Thomas, Hugh Macdiarmid, Austin Clarke. Prerequisite: 359 or 272 or equivalent.
4 units, Aut (Davie) TTh 2:15–4:05

361. The Modern Tradition—Introduction to the interdisciplinary study of modern thought and literature. Limited to 15. (Same as Modern Thought and Literature 361.)
4 units, Aut (Guerard) TTh 4:15–6:05

The following courses, listed separately in this catalog under Modern Thought and Literature, may be of interest to graduate students in English:

Modern Thought and Literature 362. Dynamic Psychology.

Modern Thought and Literature 363. The Search for Identity in Psychology and Literature.

Modern Thought and Literature 364. Structuralism.

Modern Thought and Literature 365. Alienation and Disenchantment.

Modern Thought and Literature 366. Psychoanalysis and History.

4 units, given alternate years

A number of English courses also offer an interdisciplinary approach to modern thought and literature: English 265B (Melville and Marx), English 279 (Science Fiction), English 341D (Literature and Society in the Eighteenth Century), English 381B (Politics and Society in America, 1880–1930), English 382 (Utopian and Anti-Utopian Literature), English 383 (The Existential Hero in Modern Literature), English 386 (The Enlightenment and Its Traditions).

369. Seminar in American Critics.
4 units, given alternate years

4 units, given alternate years

4 units, given alternate years

4 units, given alternate years

377. Seminar in American Literature of the Colonial Period.
4 units, given alternate years

381. Seminar in Problems in American Literature of the Nineteenth and Twentieth Centuries.

381A. James, Conrad, and Ford.
4 units, Aut (Moser) MW 2:15–4:05

381B. Politics and Society in America, 1880–1930.
4 units, given alternate years

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, Spr (Levin) MW 4:15–6:05

381D. Faulkner.
4 units, given alternate years

381E. Ezra Pound.
4 units, given alternate years

381F. William Carlos Williams.
4 units, Spr (A. Gelpi) TTh 2:15–4:05

381G. Politics and Society in American Literature, 1880–1930.
4 units, Win (Simpson) MW 2:15–4:05

382. Utopian and Anti-Utopian Literature and Society—Representative works of utopian and anti-utopian fiction studied in relation to revolutionary theory and practice.
Authors to be read include Plato, Thomas More, Engels, E. A. Abbott, Edward Belamy, Lenin, Eugene Zamiatin, Mayakovsky, Jorge Luis Borges, Ivan Yefremov, and Mao Tse-Tung. Prospective students are urged to read Engels' *Socialism: Utopian and Scientific* before registering for the seminar.

**4 units, Aut (Franklin) TTh 2:15-4:05**

383. The Existential Hero in Modern Literature.

**4 units, Win (Ruotolo) TTh 4:15-6:05**

384. Literature of World War I.

**4 units, Spr (Stone) MW 4:15-6:05**

386. Comparative Literature Seminar: The Enlightenment and Its Literary Traditions—Eighteenth century social and philosophical backgrounds in relation to various forms of fictional, historical, and confessional writing. A seminar designed for students in Comparative Literature and Modern Thought and Literature programs as well as in English. Readings to include works by Boswell, Anne Radcliffe, Hume, Godwin, Diderot, Rousseau, De Sade, Lessing, Goethe, Kant.

Reading knowledge of French or German required.

**4 units, Spr (Watt) TTh 4:15-6:05**

395. Research Course—Student pursues a special subject of investigation under supervision of some member of Department. Thesis work not to be registered under this course.

Any quarter, by arrangement

396. Ad Hoc Graduate Seminars—In a given quarter, a group of graduate students (at least three but preferably more) who wish in the following quarter to study a subject or an area not covered by regular courses and seminars may plan an informal seminar and approach a suitable member of the Department to supervise it, either on a graded or pass/fail basis.

**399. Seminar in the Teaching of Composition—Open only by consent of the Director of Freshman English.**

**2 units, Spr (Rebholtz) W 7-9 p.m.**

For additional offerings in literature, see Comparative Literature, and Modern Thought and Literature.

The English Review Club meets twice quarterly to discuss recent publications and creative work of interest to graduate students in English.

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**FRENCH and ITALIAN**

**Emeriti:** Georges E. Lemaitre, Roberto B. Sangiorgi (Professors); Jessie E. Smith (Assistant Professor)

**Chairman:** Raymond D. Giraud


**Associate Professors:** William C. Calin (on leave Autumn 1970), Ralph M. Hester

**Assistant Professors:** Marc Bertrand, Michael T. Cartwright. **Acting:** Michael Leone

**Senior Lecturer:** John G. Barson

**Lecturers:** Marguerite Bauer, Clio P. Dorr, Leda S. Missio, Annamaria Napolitano, Jacqueline Ollivier, Emily M. Olmsted, Jeanne-Françoise Rouffianges

The Department accepts candidates for the degrees of Bachelor of Arts and Master of Arts in French and in Italian, and Doctor of Philosophy in French.

**Programs of Study**

**Bachelor of Arts in French**

Candidates should normally have completed the series of first- and second-year courses in French through French 24 or its equivalent. Regularly given placement tests enable students who have begun their study of French elsewhere to be granted advanced standing.

All candidates are expected to take a minimum of 3 advanced language courses (111, 112 and 121), and also the series of introductory courses to French literature (130, 131, 132). Beyond this French majors must take a minimum of seven courses in French literature, all numbered above 132. These may be freely chosen with the sole proviso that they be distributed so that at least one quarter's course be taken in each century from the sixteenth to the twentieth (inclusive).

Students who contemplate a teaching career in college or university should note that most graduate schools require for the doctorate in French a reading knowledge of
Latin and proficiency in at least one additional modern language.

**Bachelor of Arts in Italian**

Candidates must have completed the first- and second-year courses in reading, composition, and conversation (or their equivalent).

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.

**Departmental Program at the University of Orléans-Tours**

Each year French majors, in their sophomore or junior year, as well as other students with an adequate command of the French language, may apply for the Departmental program at the University of Orléans-Tours 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 information may be obtained from the Department.

**Intensive Language Work in European Study Centers**—(Open to all students.)

Each student accepted by the Committee on General Studies for work at a Stanford center in Tours, France or Florence, Italy, will complete twelve units of Intensive French or Italian during the six months of his residence abroad. The intensive work is oriented to the development of the student’s individual ability to understand, speak, write, and read French or Italian. All courses regardless of the level at which the work is completed bear the designation French 80 or Italian 80, with the successive levels, the lowest 2 and the highest 6, indicated as second digit. Assignment to a particular level is made by the director of each center.

**Advanced Degrees in French**

Candidates should read carefully the general regulations governing advanced degrees in the section “Degrees” in this bulletin. Applicants for admission to graduate studies must have an undergraduate major in French with an average grade of B (or the equivalent). They should have reached a high level of speaking proficiency, to be demonstrated either through a personal interview or by a tape recording forwarded to the Department. They must also have a minimum of two years of high school Latin or the equivalent and pass examinations testing their ability to read Latin and either German or one additional Romance language, normally Italian or Spanish, before taking the written and oral examinations for the Ph.D. Another language may be substituted for German if it is required for the student’s projected research.

In general, only applicants who seem fully qualified to attempt the Ph.D. will be admitted to graduate standing in the Department (except for candidates for the Master of Arts in Teaching). The course requirements for the A.M. are prerequisite for the Ph.D., but the degree of Master of Arts is not a prerequisite, and the program for the A.M. is maintained primarily for graduate students who may wish to write a Master’s thesis or who may for one reason or another find themselves unable to continue to the Ph.D.

**Master of Arts: French**

1. Language requirements. Reading knowledge of a second 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>
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<tr>
<td>c) Five graduate courses in literature</td>
<td>15</td>
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<tr>
<td>d) One seminar</td>
<td>3</td>
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<tr>
<td>e) French 399 (thesis) or electives to</td>
<td>6</td>
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<td>be chosen with the approval of the graduate</td>
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<td>adviser</td>
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Total: ............................................................................. 36

**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.** See above.

2. **Course requirements.** A total of no less than 72 units of graduate work, exclusive of French 399 (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 graduate courses in literature (beyond those required for the A.M.); 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 of their choice from each group.

4. **Submit a doctoral dissertation worthy of publication as a contribution to study in the field.**

5. **Teaching experience is normally required of all candidates as a condition of receiving the Ph.D. degree. Teaching assistantships are available to help candidates fulfill this requirement.**

**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.

**Minor in Comparative Literature** — Students working toward the doctorate in French Literature may, after their first quarter of graduate work at Stanford, apply for admission for a minor in Comparative Literature. For more detailed information and also for additional course offerings in literature see the section “Comparative Literature.”

**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**

**FRENCH**

50. **Courtly Love in the Middle Ages** — The development of courtly love as it is embodied in masterworks of medieval literature.

3 units (Calin), given 1971-72

55. **Highlights of the French Renaissance** — Rabelais, Gargantua; Montaigne, Essays; the poems of Ronsard.

3 units, Spr (Lapp) MW 10

60. **Molière** — Representative comedies of Molière in English translation.

3 units, Aut (Weinstein) given 1972-73

70. **The Nineteenth Century French Novel** — The major novelists of the century, including Stendhal, Balzac, Hugo, Flaubert, Huysmans, and Zola.

3 units, Aut (Giraud) TTh 11

71. **Contemporary French Novelists** — Significant authors of contemporary France: Proust, Gide, Malraux, Sartre, Camus, etc. Lectures, readings in English.

3 units, Win (Cohn) TTh 11
78. The Writing of Albert Camus.
3 units, Aut (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: Montesquieu, Voltaire, Stendhal, Anouilh, Sartre. Background reading in modern and intellectual French history.
3 units, Spr (Weinstein) TTh 1:15

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 24, 28, 30, and October 5 (for autumn quarter); November 13, January 4 and 6 (for winter quarter); February 19, March 29 and 31 (for spring quarter); May 17 (for summer and autumn quarters). 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

4. 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 8

20. Conversation française premier degré—Prerequisite: 3 or equivalent.
2 units, Aut, Win, Spr (Staff) MTTh

22. Second-Year French I—Prerequisite: 3.
4 units, Aut, Win, Spr (Staff) MTWTh

4 units, Aut, Win, Spr (Staff) MTWTh

24. Second-Year French III—Travaux pratiques de langue et appréciation de textes contemporains. Prerequisite: 23 or equivalent.
4 units, Aut, Win, Spr (Staff) MTWTh

26. Intensive Second-Year French—(Equivalent to 22 and 23.) Prerequisite: 3 or equivalent. Enrollment limited to 15.
8 units, Spr (Staff) MTWThF 11 and one additional hour

30. Conversation française deuxième degré—Prerequisite: 23 or equivalent.
2 units, Aut, Win, Spr (Staff) MTTh

82-86. Intensive French — Given only at Stanford in France.
6 units for any two quarters, Aut-Win, Spr-Sum (Staff) MTWThF, 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 (Hester), given 1971-72

111. Langue et Civilization I—Prerequisite: 24 or equivalent.
3 units, Aut (Barson) MWF 9
Win (Bauer) MWF 9
Spr (Barson) MWF 9

112. Langue et Civilization II — Continuation of 111.
3 units, Win (Barson) MWF 9

120. Séminaire sur des problèmes contemporains—Conversation et discussion sur des problèmes actuels à partir des journaux, revues ou films français. Prerequisite: 30 or 82 through 86 or equivalent.
2 units, Aut, Spr (Staff) TTh 2:15

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-Age et 16ème siècle; choix de textes, explication de textes, composition littéraire. Prerequisite: 24 or equivalent.
3 units, Aut (Hester) MWF 1:15
131. Introduction à la littérature française — 17ème et 18ème siècles. Prerequisite: 24 or equivalent.
3 units, Aut (Cartwright) MWF 1:15
Win (Hester) MWF 11

132. Introduction à la littérature française — 19ème et 20ème siècles. Prerequisite: 24 or equivalent.
3 units, Win (Cartwright) MWF 1:15
Spr (Hester) MWF 1:15

Note — Prerequisites for the following courses are normally 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 units, Spr (Hester) MWF 10

150. Le XVIIème siècle I — Poésie et roman; les poètes baroques, Théophile de Viau, Saint-Amant, Tristan l'Hermité; les Fables de La Fontaine; Mme de La Fayette: La Princesse de Clèves.
4 units, Aut (Lapp) given 1971-72

151. Le XVIIème siècle II — La tragédie; Racine: Andromaque, Athalie, Britannicus, Iphigénie; Corneille: Horace, Cinna, Polycute, Nicomède.
4 units, Win (Lapp) M 2:15-4:05 and T 2:15

152. Le XVIIème siècle III — La Comédie: Corneille et Molière; Pascal, Pensées; La Rochefoucauld, Maximes.
4 units (Lapp) given 1971-72

4 units, Spr (Cartwright) MWF 2:15

161. Le XVIIIème siècle II — Roman et théâtre. Roman: Prévoet, 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, given 1971-72

170. Le XIXème siècle I — Le Romantisme. Étude du romantisme français jusqu'à 1830.
Lectures principales: Lamartine, Vigny, Musset, Hugo.
4 units (Giraud) given 1971-72

4 units (Giraud) given 1971-72

4 units (Giraud) given 1971-72

173. Symbolism — Characteristic poems of Baudelaire, Mallarmé, Rimbaud, and Verlaine will be discussed in the context of the late 19th-century literary and artistic climate in France. Lectures in English; readings in French.
4 units, Spr (Cohn) MWF 11

175. Le Théâtre au dix-neuvième siècle— Lectures principales: Dumas père, Hugo, Vigny, Musset, Dumas fils, Augier, Becque, Rostand.
4 units, Aut (Weinstein) MWF 1:15

180. Le XXème siècle I — La Poesie francaise de Valéry au Surrealisme.
4 units (Newman-Gordon) given 1971-72

181. Le XXème siècle II — Le Théâtre francais de Giraudoux a Ionesco.
4 units (Newman-Gordon) given 1971-72

182. Le XXème siècle III — Le Roman en France depuis 1898.
4 units (Newman-Gordon) given 1971-72

183. Individu et société dans le roman français contemporain— De La Peste de Camus au "roman de contestation" actuel.
4 units, Spr (Bertrand)

4 units, Win (Bertrand) given in departmental program at Tours

190. Introduction à la poésie française — Analyse et étude de poèmes choisis, thèmes, images, versification, technique descriptive, depuis le XVIème siècle jusqu'à nos jours.
4 units, Aut (Lapp) M 2:15-4:05 and T 2:15

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, any quarter (Staff) by arrangement
ADVANCED UNDERGRADUATE AND GRADUATE COURSES

205. Modern French—Phonology, morphology, and syntax.
   3 units, Win (Juilland) TTh 1:15

   3 units, Aut (Juilland) TF 2:15

215. French Existentialist Writers—With special emphasis on Sartre, Camus, Gabriel Marcel, Merleau-Ponty, Malraux, and Simone de Beauvoir.
   3 units, Win (Juilland) F 2:15-4:05

   3 units (Juilland) given 1971-72

295. French Literature and Cultural Expression in Black Africa—Study of representative works from Black Africa written in French, including writings of Camara Laye, Mongo Beti, Hamidou Kane, Sembene Ousmane, Yambo Ouologuem, Senghor, Rabemananjara, and others. (Same as History 102H.)
   3 units (Calin and Johnson) given 1971-72

325. Cours de méthode—Méthodes critiques et bibliographiques; Explication de texte.
   3 units, Spr (Lapp) T 10-12

   3 units (Calin) given 1971-72

341. La Renaissance en France I—Les Poètes; Rabelais et Montaigne.
   3 units, Aut (Hester) MW 11

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 1971-72

350. Graduate Seminars.
   The Chansons de Geste.
   3 units, Spr (Calin) F 2:15-4:05

Medieval Allegory: Le Roman de la Rose.
   3 units (Calin) given 1971-72

Ronsard and d'Aubigné.
   3 units, Win (Calin) T 4:15-6:05

Montaigne.
   3 units, Spr (Lapp) M 2:15-4:05

Corneille.
   3 units (Lapp) given 1971-72

Molière.
   3 units (Weinstein) W 2:15-4:05

La Fontaine.
   3 units (Lapp) given 1971-72

Le Roman au XVIIIème Siècle.
   3 units, Spr (Cartwright) W 4:15-6:05

Flaubert.
   3 units, Win (Giraud) Th 2:15-4:05

Proust.
   3 units, Spr (Cohn) M 4:15-6:05

Stendhal.
   3 units, Aut (Weinstein) W 2:15-4:05

Rimbaud.
   3 units, Aut (Cohn) M 2:15-4:05

Balzac.
   3 units (Weinstein) given 1971-72

351. La poésie de Malherbe à La Fontaine
   3 units, Aut (Lapp) T 10-12

GRADUATE COURSES

304. Etudes de style — Etude stylistique de l'œuvre de Céline.
   3 units (Juilland) given 1971-72

310. Introduction to Romance Linguistics—Problems in historical and structural linguistics.
   3 units, Aut (Juilland) Th 2:15-4:05

311. Old French Texts—Reading and interpretation of selected old French texts. Prerequisite: 310.
   3 units, Win (Calin) M 10 and Th 4:15-6:05

312. Histoire de la langue française depuis le Moyen Age jusqu'à présent — Prerequisite: 311.
   3 units, Win (Juilland) Th 10-12

315. Grammaire historique de la langue française.
   3 units (Juilland) given 1971-72

321. Histoire de la langue française depuis le Moyen Age jusqu'à présent — Prerequisite: 315.
   3 units, Win (Juilland) Th 10-12

325. Cours de méthode — Méthodes critiques et bibliographiques; Explication de texte.
   3 units, Spr (Lapp) T 10-12

   3 units (Calin) given 1971-72

341. La Renaissance en France I—Les Poètes; Rabelais et Montaigne.
   3 units, Aut (Hester) MW 11

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 1971-72

350. Graduate Seminars.
   The Chansons de Geste.
   3 units, Spr (Calin) F 2:15-4:05

Medieval Allegory: Le Roman de la Rose.
   3 units (Calin) given 1971-72

Ronsard and d'Aubigné.
   3 units, Win (Calin) T 4:15-6:05

Montaigne.
   3 units, Spr (Lapp) M 2:15-4:05

Corneille.
   3 units (Lapp) given 1971-72

Molière.
   3 units (Weinstein) W 2:15-4:05

La Fontaine.
   3 units (Lapp) given 1971-72

Le Roman au XVIIIème Siècle.
   3 units, Spr (Cartwright) W 4:15-6:05

Flaubert.
   3 units, Win (Giraud) Th 2:15-4:05

Proust.
   3 units, Spr (Cohn) M 4:15-6:05

Stendhal.
   3 units, Aut (Weinstein) W 2:15-4:05

Rimbaud.
   3 units, Aut (Cohn) M 2:15-4:05

Balzac.
   3 units (Weinstein) given 1971-72

351. La poésie de Malherbe à La Fontaine
   3 units, Aut (Lapp) T 10-12
352. **Le Théâtre au 17ème siècle**: Théophile de Viau, Tristan l'Hermite, Rotrou, Corneille, Racine—Continuation of 351.
   3 units, Win (Lapp) T 10-12

353. **Le Théâtre classique français** — Corneille, Molière, Racine.
   3 units (Weinstein) given 1972-73

   3 units, Win (Cartwright) T 2:15-4:05

357. **Le Romantisme** — Poètes et romanciers romantiques: Chateaubriand, Lamartine, Hugo, Vigny, Musset, Sand, and others.
   3 units (Weinstein) given 1971-72

358. **Baudelaire**
   3 units, Win (Cohn) W 2:15-4:05

359. **The Symbolist Poets.**
   3 units, Win (Cohn) W 2:15-4:05

360. **La Critique littéraire au XIXème siècle** — Sainte-Beuve, Taine, Brunetière, and others.
   3 units, Win (Weinstein) M 2:15-4:05

363. **Post-World War II Theatre in France** — Sartre, Camus, Beckett, Ionesco, Adamov, Genet and others.
   3 units, Spr (Giraud) Th 2:15-4:05

   3 units (Newman-Gordon) given 1971-72

366. **Giraudoux** — Homme de théâtre: de Siegfried à La Folle de Chaillot.
   3 units (Newman-Gordon) given 1972-73

367. **Jules Laforgue** — Le Sanglot de la Pierre; Les Complaintes; L'Imitation de Notre-Dame la Lune; Derniers Vers.
   3 units (Newman-Gordon) given 1972-73

368. **Apollinaire** — Alcools et Calligrammes.
   3 units (Newman-Gordon) given 1971-72

369. **Points de vue critiques au XXème siècle** — De Valéry à la Nouvelle Critique.
   3 units, Spr (Bertrand) T 2:15-4:05

   3 units (Bertrand) given 1971-72

375. **The Don Juan Legend** — (Same as Comparative Literature 310.)
   3 units, Win (Weinstein) W 4:15-6:05

380. **A la “grande génération”** — Proust, Gide, Péguy, Claudel, Romain Rolland, Valéry.
   3 units (Newman-Gordon) given 1971-72

383. **Corso di Conversazione** — Prerequisite: 3 or equivalent, or consent of instructor.
   2 units, Aut, Spr (Staff) MTTh

388. **Apollinaire** — Alcools et Calligrammes.
   3 units (Newman-Gordon) given 1971-72

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

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 consent of instructor.
   2 units, Aut, Spr (Staff) MTTh

82-86. **Intensive Italian** — Given only at Stanford in Italy.
   6 units for any 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
3 units, Aut (Leone) MWF 1:15

3 units, Win (Leone) MWF 1:15

3 units, Spr (Leone) MWF 1:15

150. Dante, La Divina Commedia — Inferno.
3 units, Aut (Leone) MWF 2:15

151. Dante, La Divina Commedia — Purgatorio.
3 units, Win (Leone) MWF 2:15

152. Dante, La Divina Commedia — Paradiso.
3 units, Spr (Leone) MWF 2:15

160. Boccaccio e la novella.
3 units, Win (Leone)

166. Il Romanzo moderno—Study and interpretation of the most important novelists of the Novecento.
3 units, Aut (Leone)

168. Romanziere e Poeti del Novecento — Ungaretti, Montale, Quasimodo; Moravia, Vittorini, Pavese ed altri. Studio e interpretazione.
3 units (Leone), given 1971-72

170. Letteratura della Resistenza—Study analysis of representative novels of the characteristics socio-political of the Italian Resistance.
3 units, Spr (Leone)

199. Individual Work—Open only to majors in Italian and with special permission from the Department. May be repeated for credit 1 to 3 units, any quarter (Staff) by arrangement

LINGUISTICS AND PHILOLOGY COURSES
207. Old Italian — Phonology, morphology of Old Italian; preliterary linguistic monuments. Introduction to Italian dialectology.
3 units (Politzer) given 1971-72

250. Seminar in Romance Linguistics—Prerequisite: 204 or equivalent.
3 units (Juillard) given 1971-72

TEACHER TRAINING COURSES
288. Methods of Teaching French—(Same as Education 288.)
3 units, Win (Politzer) M 4:15–6:05 and by arrangement

GEOGRAPHY
Undergraduate courses in Geography will be offered by the Food Research Institute.

GERMAN
Emeriti: Helmut R. Boening, Kurt
Reinhardt, F. W. Strothmann (Professor
Chairman: Edgar Lohner
Professors: Edgar Lohner, Walter F. 
Lohnes, Kurt Mueller-Vollmer, Gertraud L. Schuelke, Walter F. Sokol
Associate Professor: A. Peter Foulkes
Assistant Professors: Joachim Bark, John Flores, Peter C. Ober
Senior Lecturer: Gertrude Mahnholz
Lecturers: Peter R. Frank, Luise Schippon
Instructor: Margarete Eifler
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 Overseas Campuses Program 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 such programs as German History, Humanities, Art History, or Musicology. 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

After completion of the courses offered for first- and second-year students (1, 2, 3, 51, 52, 53), majors in German normally select, with the help of their adviser, a minimum of two German courses per quarter. The total requirement for the Bachelor of Arts degree in German is a minimum of 45 units of work in courses numbered 53, 100, or higher.

By expressing the requirement for graduation in terms of units rather than in terms of specific courses, the Department wants to make sure that the program offered is flexible. Students are expected to make the best use of this flexibility by emphasizing one of three possible areas of concentration: German language, German creative literature, and German thought. Students interested primarily in German as a language, for instance, should take the language work listed under "Advanced and Graduate Courses." Students concentrating on German literature should take the complete 150-series in sequence as soon as possible. Students interested in German thought should take the Geistesgeschichte-series and the two Senior Seminars.

Students can select their field of concentration in complete freedom. On the other hand, they should formulate their plans in quarterly consultation with their adviser.

Students 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 in a literature course. The essay will represent nine units of additional academic work in German.

MASTER OF ARTS

This program is designed for those students who do not intend to continue their studies through the Ph.D. degree. By University regulation, students desiring the A.M. degree must complete a minimum of 36 units of graduate work. If students enroll for three quarters for an average of 12
units per quarter, they can fulfill the A.M. requirements in one year—which they are strongly advised to do. The A.M. program must include:

<table>
<thead>
<tr>
<th>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>201. Language and Style</td>
<td>2</td>
</tr>
<tr>
<td>202. Principles of German Composition</td>
<td>2</td>
</tr>
<tr>
<td>205. Introduction to Modern German</td>
<td>3</td>
</tr>
<tr>
<td>228. Middle High German</td>
<td>4</td>
</tr>
<tr>
<td>302. Methods of Teaching German</td>
<td>2</td>
</tr>
<tr>
<td>Two courses in German literature</td>
<td>8</td>
</tr>
<tr>
<td>Two courses in German thought</td>
<td>6</td>
</tr>
<tr>
<td>One seminar</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
</tr>
</tbody>
</table>

To this must be added five units of electives chosen from graduate level courses in German.

**DOCTOR OF PHILOSOPHY**

By definition, a Ph.D. program in any field involves a high degree of specialization, and the desirable balance between “depth” and “breadth” is difficult to achieve.

On the one hand, the Department feels obliged to introduce its graduate students not only to German as a modern language but also to the history of this language as documented by its earlier dialects, to German creative literature from its beginning to the present day, and to German thought, i.e., to a close study of those intellectual movements and individual thinkers that have been of significance not only for the German-speaking countries but for all of modern civilization.

On the other hand, it would be an illusion to believe that graduate students will become omniscient Germanists who speak German with native fluency, who read Gothic, Middle High German, and Medieval Latin as easily as Modern German, who have read everything from the *Hildebrandslied* to Kafka, and who are thoroughly familiar with such philosophical phenomena and trends as *Mystik*, *Reformation*, *Aufklärung*, and *Phänomenologie*. Both the shortness of time available for graduate studies and the divergence of individual interests make such omniscience impossible.

Any scholar—and graduate students are future scholars—must specialize, not too narrowly, but enough to make graduate study a meaningful experience rather than a frustration. We therefore recognize three legitimate and equally desirable areas of specialization: language studies, creative literature, and German thought. However, a fruitful concentration on one of these areas does not assume total exclusion of the other two areas.

Students should choose their areas of specialization in complete freedom after having seriously searched their own interests and capabilities. Naturally they can ask for advice, but the choice is theirs, and it must be based on their own inclinations. Each student, at some time before the beginning of his second year, should also choose his adviser—again in complete freedom, but from the staff members representing his area of specialization. If the interests of a student change—and they sometimes do, no apologies are necessary—he is advised to also change his adviser, for the adviser will become the sponsor of his dissertation. At some time during the third year, each student should formulate a topic for his dissertation. The fourth year is the “dissertation year” and should be kept free of all course work.

The first year of graduate work, which leads to the A.M. degree, is non-specialist in nature and does not leave much room for electives. It is designed to introduce each student to the three major areas of study, so that his eventual choice will not be a blind choice. However, all students, regardless of their future field of concentration, are expected to acquire near-native proficiency in German and a thorough knowledge of the grammatical structure of German. Ability to handle German as a tool and proficiency in teaching is a *conditio sine qua non* for the Ph.D. in German. During the first year at Stanford, all graduate students will be given the MLA-Cooperative Foreign Language Proficiency Tests (designed for teachers and advanced students) to give them an indication of their achievement in listening-comprehension, speaking, reading, and writing. The Department expects all of its Ph.D. candidates to work toward a “certificate of teaching proficiency in German” which will be issued to each student when, in the judgment of the Department, the candidate has developed a degree of teaching skill which merits recommendation. Experience shows that this takes at least a year of supervised teaching; very often it takes longer. All graduate students are also strongly advised to start developing skill in the teaching of literature by participating, on a voluntary basis, in the teaching of the undergraduate literature courses. They should contact the
instructors of these courses before the start of the quarter and make the necessary arrangements. Students can earn up to three units of graduate credit for practice teaching in literature.

The requirements for the Ph.D. are: (1) a minimum of 36 graduate units during the first year of graduate study (which fulfills the requirements for the A.M. degree) and a minimum of 9 units per quarter during the six quarters following the first year; (2) a reading knowledge of one modern language other than English or German, and a working knowledge of either Latin or an additional modern language; (3) the writing of a dissertation.

During the first year, all graduate students normally take the following program:

<table>
<thead>
<tr>
<th>Units</th>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>201. Language and Style</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>205. Introduction to Modern German</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>228. Middle High German</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>241. Deutsche Geistesgeschichte I</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>242. Deutsche Geistesgeschichte II</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>300. Proseminar</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Two courses in German literature</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>One seminar (325, 350, 375, or 400)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>

To this must be added five units of electives chosen from graduate level courses in German.

1. **Concentration in Language Studies**

   Students choosing this concentration will specialize in such fields as: the older dialects and medieval literature, comparative diachronic linguistics centering on early Germanic dialects, linguistics and language teaching. Detailed plans of study are available on request.

2. **Concentration in Literature**

   Students concentrating in Literature will take, during the autumn quarter of their second year, 302. Methods of Teaching German. The other course requirements are: a minimum of two courses or seminars per quarter for at least four of the six quarters following the first year. The Department will make a strong attempt to arrange the offerings in Literature each quarter around such epochs as Von der Mystik zum Barock, Von der Aufklärung zur Klassik, Von der Romantik zum Realismus, Probleme des Modernismus. The lecture courses are not survey courses but introductions to topics within these epochs. Lecture courses and colloquia will require final examinations but not term papers. Seminars, of which the student is expected to take a minimum of two after his first year, will require research papers.

   Three units of Individual Work (course 301) may be used to read, under the supervision of the student's adviser, the "Reading List for Ph.D. Candidates in Literature."

   By carefully planning their programs, students may choose a minor by participating in the Graduate Humanities Program, in the Comparative Literature Program, or in the Modern Thought Program, and work toward a Ph.D. in German and Humanities, German and Comparative Literature, or German and Modern Thought. Usually such minors require more than a total of 9 quarters of course work.

3. **Concentration in German Thought**

   After completing the requirements for the first year, students concentrating in German Thought will take 302. Methods of Teaching German in the autumn quarter of the second year. The other requirements are a minimum of two courses per quarter, including four courses or seminars in the 351–375 and 376–400 series, and four additional courses or seminars from the 326–350 and 376–400 series. Seminars, of which the student is expected to take a minimum of two after his first year, will require research papers. Students are advised to take some electives outside the Department.

   Three units of Individual Work (course 301) may be used to read, under the supervision of the student's adviser, the "Reading List for Ph.D. Candidates in Literature."

   By carefully planning their programs, students may choose to participate in the Graduate Humanities Program, in the Comparative Literature Program, or in the Modern Thought Program, and work toward a Ph.D. in German and Humanities, German with a minor in Comparative Literature, or German with a minor in Modern Thought. Usually such programs require more than a total of 9 quarters of course work.

### General Courses

(120–139; given in English)

The courses in this section are given in English and do not require a knowledge of German. They are open to all students. Ger-
man majors taking these courses as a part of their requirements must do the assigned readings in German.

120A. Germany Today—Lectures and readings on cultural, social, and political trends in German-speaking countries; emphasis on West and East Germany.
3 units, Win (Eifler) TTh 9

121A. Goethe's Faust.
3 units (Ober) given every third year

122A. Nietzsche.
3 units (Sokel) given every third year

124A. The Modern German Novel—Reading and discussion of works selected from such authors as Thomas Mann, Heinrich Mann, Grass, Böll, Hesse, Frisch, Seghers, Düblin, Musil, and others.
3 units (Flores) given every third year

126A. Contemporary German Literature.
3 units (Flores) given every third year

128A. Kafka.
3 units (Sokel) given every third year

130A. Brecht and the Modern Drama—The place of Brecht’s dramatic theory and practice in the development of the modern drama. Ibsen, Strindberg and Expressionism, Pirandello, Brecht, Beckett and the Theater of the Absurd.
3 units, Spr (Flores) MWF 10

132A. The Existential Quest in the Continental Novel — Reading and discussion of works by Dostoevsky, Rilke, Kafka, Sartre, Camus, and Frisch.
3 units (Sokel) given every third year

134A. Art and Utopia — Thematic reading and discussion of specific works from Kant and Schiller to Freud and Marcuse which deal with the dynamic function of aesthetics in political theory.
3 units (Flores) given every third year

136A. German Thought of the Twentieth Century—Trends in Psychoanalytical Existentialist and Neo-Marxist Thought. A close reading and discussion of certain texts by Freud, Jung, Heidegger, Jaspers, Bonhoeffer, Benjamin, Adorno, and Marcuse that have had a decisive influence in contemporary Europe and America.
3 units (Sokel) given every third year

GERMAN COURSES

UNDERGRADUATE COURSES

(1–199)

First- and second-year language courses are 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
5 units, Aut, Win, Spr (Staff)

2. First-Year German—Continuation of 1.
5 units, Aut, Win, Spr (Staff)

3. First-Year German—Continuation of 2.
5 units, Aut, Win, Spr (Staff)

5. Intensive First-Year German — Equivalent of 1, 2, and 3 combined. Enrollment limited.
12 units, Sum (Staff) MTWThF 8:00–9:30 and 10:30–12:00

10. German Reading — An accelerated course for beginners who want to learn how to read expository German. Open to seniors and graduate students. No auditors permitted.
4 units, Aut, Win (Mahrholz) MTWTh 8
Sum (Staff) MTWTh 9

51. Second-Year German—This course introduces the student to a wide variety of contemporary literary prose. Speaking and writing are emphasized as well as listening and reading. Prerequisite: 3.
5 units, Aut, Win, Spr (Staff)

51H. Second-Year German Honors Section—Equivalent to 51, but limited to students with grades of A or B in 3.
5 units, Aut (Bark) (1) MTWThF 9
(Lohnes) (11) MTWThF 10

51W. Second-Year German—Equivalent to 51 but also fulfills requirement of one quarter of Writing Experience in English. Limited to freshmen.
5 units, Aut (Ober) MTWThF 9

52. Second-Year German—Continuation of 51 and 51H. This course broadens the scope of 51 by including poetry and expository prose.
5 units, Aut, Win, Spr (Staff)
52W. Second-Year German—Continuation of 51W. Limited to freshmen.
5 units, Win (Foulkes) MTWThF 9

53. Second-Year German—Continuation of 52 and 52W.
5 units, Win (Staff) MTWThF 9
Spr (Lohnes) MTWThF 10

82-86. Intensive German—Given only at Stanford in Austria and Germany.
6 units, any two quarters

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: 52 or equivalent.
3 units, Aut (Schipporeit) MWF 9
Spr (Eifler) MWF 10

101. German Composition.
3 units, Win (Mahrholz) TTh 11

102. German Composition — Continuation of 101.
3 units, Spr (Mahrholz) TTh 11

105. German Newspapers — Current newspapers from East and West Germany will be read and discussed in German. This course may be repeated once. Prerequisite: 51 or equivalent.
3 units, Aut (Eifler) TTh 11
Spr (Eifler) MWF 10

141–146. Courses in the 140-series introduce the student to German literature in various genres. Prerequisite: 51 or equivalent.

141. Poetry from Goethe to Nietzsche.
3 units, given in 1971–72

142. Poetry from Nietzsche to the Present.
3 units, Win (Staff) MWF 11

143. Drama from Storm and Stress to Expressionism.
3 units, Aut (Eifler) MWF 11

144. Drama from Expressionism to the Present.
3 units, given in 1971–72

145. The Novelle—Shorter prose works from the Romantic Period to the 20th century.
3 units, given in 1971–72

146. Modern Fiction.
3 units, Spr (Foulkes) MWF 11

151–153. 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. Prerequisite: 52 or consent of instructor.

151. The Classical Period.
4 units, Aut (Staff) MTWTh 10

152. Romanticism and Realism.
4 units, Win (Staff) MTWTh 10

153. From Naturalism to the Present.
4 units, Spr (Staff) MTWTh 10

199. 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: 3 or consent of instructor.
1 or 2 units, any quarter (Staff)
by arrangement

ADVANCED AND GRADUATE COURSES
(200–299)

201. Language and Style — Prerequisite: qualifying examination.
2 units, Aut (Lohnes) TTh 11

2 units, Win (Lohnes) TTh 11

204. History of the German Language.
3 units, Aut (Schuelke) MWF 9

205. Introduction to Modern German — Contrastive analysis of English and German morphology and syntax. The linguistic foundations of literary writing.
3 units, Spr (Lohnes) MWF 11

228. Middle High German.
4 units, Win (Foulkes) MTWTh 10

241–243. These courses introduce the student to the continuum of German intellectual and cultural history, and its relationship to the intellectual life of the other nations of Europe from the 18th century to the present. Emphasis is given to authors whose ideas have had a significant influence on shaping the thinking of our modern world. Prerequisite: 52 or consent of instructor.

241. Deutsche Geistesgeschichte I—Von der Aufklärung zur Romantik.
3 units, Aut (Bark) MWF 11
242. Deutsche Geistesgeschichte II — Von der Romantik bis Nietzsche.
   3 units, Win (Bark) MWF 11

   3 units, Spr (Bark) MWF 1:15

251. Goethe's Faust.
   3 units (Staff) given every third year

253. Novalis.
   3 units (Staff) given every third year

255. Hölderlin.
   3 units (Lohner) given every third year

256. Heine und das Junge Deutschland.
   3 units, Aut (Mueller-Vollmer) MTTh 3:15

257. Grabbe and Büchner.
   3 units (Mueller-Vollmer) given every third year

259. Rilke.
   3 units (Staff) given every third year

261. Kafka.
   3 units, Spr (Foulkes) MWF 9

263. Thomas Mann.
   3 units (Staff) given every third year

265. Brecht.
   3 units (——) given every third year

275. Deutsche Literatur in Ost und West.
   3 units (Flores) given every third year

276. Frisch und Dürrenmatt.
   3 units, Win (Eifter) MWF 9

290–291. Senior Seminars — May be elected by non-majors who have completed three German literature courses.

290. Senior Seminar — Literatur und Literaturdeutung in der Zeit des Nationalsozialismus.
   3 units, Win (Bark) T 2:15–4:05

291. Senior Seminar — To be announced.
   3 units, Spr (Staff) T 2:15–4:05

299. 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

299H. Individual Work — Exclusively for undergraduate students in the Stanford Hamburg Program.
   1 to 8 units, Spr, Sum (Staff) by arrangement

GRADUATE COURSES
(300 – 400)

300. Proseminar.
   4 units, Aut (Lohner, Frank) W 2:15–4:05

301. Individual Work — Exclusively for graduate students in German working on thesis or engaged in special work.
   1 to 12 units, each quarter (Staff) by arrangement

301H. Individual Work — Exclusively for Hamburg University courses completed by graduate students in the Stanford Hamburg Program.
   1 to 10 units, Spr, Sum (Staff) by arrangement

LANGUAGE STUDIES (302–325)

302. Methods of Teaching German — (Same as Education 291.)
   2 units, Aut (Lohnes) MWF 11

303. Curricular Problems — Given on request only.
   3 units (Lohnes) by arrangement

310. Gothic and Historical Germanic Grammar — Development of Germanic languages; reading of selected texts from the Gothic Bible.
   4 units, Aut (Schuelke) MTWTh 10

312. Old Norse — Introduction to the language; reading of selected texts.
   4 units, Win (Schuelke) MTWTh 2:15

313. Old Icelandic Sagas — Study of the sagas; reading of one or more in the original. Prerequisite: 312.
   4 units, Spr (Schuelke) MTWTh 2:15

314. Earliest German Documents — Introduction to the language and literature of Old High German and to the Old Saxon Helian. 4 units (Schuelke) given every third year

316. Advanced Middle High German — Advanced work in the language; reading of Parzival. Prerequisite: 228.
   4 units (Schuelke) given in 1971–72

319. Early New High German — Introduction to the language and literature 1350–1600. Prerequisite: 228.
   4 units (Schuelke) given every third year
322. Recent Developments in German Linguistics.
4 units (Lohnes) given every third year

325. Seminar — All seminars dealing with linguistic or philological problems will be listed under this number. The topics will be announced each year.

GERMAN LITERATURE (326–350) (See also Courses 228, 313, and 316)

326. Problems of Literature Teaching — Students may enroll for practice in literature teaching on a voluntary basis.
1 to 3 units, each quarter (Staff) by arrangement

328. Hartmann von Aue — Prerequisite: 228.
4 units, Win (Ober) MWF 10

329. Gottfried von Strassburg — Prerequisite: 228.
4 units (Ober) given every third year

4 units, Spr (Schuelke) MTWTh 10

335. Drama des Barock.
4 units, Aut (Lohner) M 4:15–6:05 and W 4:15

336. Lyrik des Barock.
4 units (Lohnes) given every third year

4 units (Lohnes) given every third year

340. Der späte Goethe.
4 units (Lohnes) given every third year

341. Schiller — Das dramatische Werk im Zusammenhang mit den philosophischen und ästhetischen Schriften Schillers.
4 units, Spr (Sokel) MWF 2:15

4 units (Sokel) given every third year

4 units (Sokel) given every third year

4 units (Sokel) given every third year

4 units, Win (Lohnes) W 4:15–6:05 and one hour by arrangement

4 units (Sokel) given every third year

4 units (Sokel) given every third year

350. Seminar — All seminars dealing primarily with creative literature will be listed under this number. The topics will be announced each year. Planned for 1970–71:

To be announced.

4 units, Aut (Staff) W 2:15–4:05

Goethes Faust.
4 units, Win (Lohnes) M 4:15–6:05

To be announced.
4 units, Spr (Foulkes) M 4:15–6:05

GERMAN THOUGHT (351–375)
In this section will be listed courses and seminars on such topics as: Medieval Mysticism, Martin Luther, Der Pietismus, Religionskritik des 19. Jahrhunderts, Von Nietzsche bis Heidegger, and others.

352. Medieval Thought.
4 units (Ober) given every third year

353. The Forms of Medieval Mysticism — Representative texts of Meister Eckhart will be studied and compared with the work of Mechthild von Magdeburg and a small number of non-Christian sources in an attempt to analyze the nature of the mystic experience. Prerequisite: 228.
4 units, Aut (Ober) T 4:15–6:05 and one hour by arrangement

4 units, Spr (Bark) T 4:15–6:05

375. Seminar — All seminars dealing primarily with German Thought will be listed under this number. The topics will be announced each year. To be offered in 1970–71:

Humboldts Sprachphilosophie und der Strukturalismus.
4 units, Spr (Mueller-Vollmer) W 4:15–6:05

COURSES DEALING WITH GERMAN THOUGHT AND LITERATURE (376–400)
378. Lessing, Wieland und die Aufklärung.
   4 units, Aut (Mueller-Vollmer) MTTh 1:15
380. Herder und der Sturm und Drang.
   4 units, Win (Sokel) MWT h 3:15
382. Die Romantik.
   4 units (Mueller-Vollmer) given every third year
384. Humboldt.
   4 units (Mueller-Vollmer) given every third year
   4 units (Sokel) given every third year
395. Existentialismus und Literatur.
   4 units (Sokel) given every third year
400. Seminar — All seminars in this group will be listed under this number. The topics will be announced each year.

Heideggers Existenzphilosophie und die Literatur — This seminar may also be taken as a colloquium, for which an examination will be required rather than a research paper.
   4 units, Win (Sokel) Th 4:15–6:05

HISTORY

Chairman: George H. Knoles
Visiting: Philip A. Crowl, Richard M. Morse

Lecturers: Margot Drekmeier, Tsutomu Ouchi, 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.

PROGRAMS OF STUDY

BACHELOR OF ARTS

The Department's program for the undergraduate major in history emphasizes breadth of training yet allows the student to concentrate his studies in a selected field of history.

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 one small group course — undergraduate colloquium (reading and discussion involving an explicit historical theme) or undergraduate seminar (introduction to the principles of historical research), (3) and should complete at least twelve courses in history, with an average grade not below C, and with a minimum of three units each. Only two civilization courses, e.g. African Civilizations, East Asian Civilizations, Western Civilization may be counted toward the total of twelve courses.

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. Western Civilization courses may not be
used to meet the field requirement. Colloquia may meet the field requirement; the instructor may designate the field for which the colloquium is appropriate. The Department issues a detailed list indicating how each specific course is classified as to field.

Also, all History majors will be expected to demonstrate proficiency in a foreign language (the completion of two years of a single language at the college level or equivalent, e.g. passing a placement examination). There is 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 two options leading to Honors in History: (a) a special program of senior research, and (b) comparative studies in history. Students accepted for this program who elect program (a), 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. Students completing program "a" will be eligible for Honors or High Honors in History, depending upon the quality of work performed. Students electing program "b" will be eligible to receive Honors in History provided the work performed is of Honors quality. 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 seven courses of this work must be in History Department courses, and at least two of the seven courses must be graduate seminars or colloquia. A candidate whose undergraduate training in history is inadequate, however, must complete nine courses of graduate work in the History Department. 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 in the Graduate Division of the University. 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 the University oral examination. The major fields are:
   - Europe, 300–1400
   - Europe, 1400–1789
   - Europe Since 1700
   - Russia
   - Eastern Europe
   - Near East
   - Middle East
   - Late Traditional and Modern Japan and China, 1600 to the present
   - Africa
   - Britain and the British Empire Since 1460
   - Latin America
   - The United States (including Colonial America)

2. The Department seeks to provide a core colloquium in every major field. In his first year of graduate study, the student will normally enroll in the core colloquium in his major field.

3. The student is required to take two research seminars, at least one in his major field. Normally, research seminars should be taken in the second year.

4. The student, in consultation with his adviser, defines a secondary field lying outside the major field in one of three ways: (a) a field selected from the list given below; (b) one national history from an appropriately early date to the present, but excluding countries (such as the United States) with comparatively short histories; (c) comparative study of a subject across countries or periods.

   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
One national history may be selected as a portion of the major field to encompass much of that country’s history as a secondary field, when that history is sufficiently long to span chronologically two or more major fields. Thus, for example, a student choosing Europe since 1700 as a major field may elect France from about 1000 to the present as a secondary field.

The subject matter and scope for a comparative study are to be determined by the student in consultation with his adviser.

Secondary fields (a) and (b) may be completed either by taking two graduate courses relevant to the field, or one such graduate course and a written examination. Field (c) is completed by taking one relevant graduate course and writing a 6,000 word comparative essay acceptable to the student’s adviser. The secondary field must be completed before the student may take the general examination in his major field.

(5) Each student should plan in consultation with his adviser a supporting program of courses outside the Department. Although the Department does not prescribe the number, subject matter, or kind of courses, the program should have coherence and either add to the student’s technical competence as historian or broaden his approach to the problems of his research field.

(6) Each student, before the Ph.D. is conferred, is required to teach for one quarter a small class of undergraduates. Normally this will be done in the third graduate year, and, normally, it will consist of leading two weekly discussion sections in a course given by a faculty member.

(7) There is no university or departmental foreign language requirement for the Ph.D. degree. A reading knowledge of one or more foreign languages is required in fields where appropriate. The faculty in the major field prescribes the necessary languages. In no field will a student be required to take examinations in more than two foreign languages; and examinations, administered by the appropriate language departments, must be passed before taking the oral examination in the major field.

(8) The student is expected to take the University oral examination in his major field early in his third graduate year.

(9) 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.

**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 and World War II are being augmented for the post-1945 period. The materials include government documents, newspaper and serial files, and organization and party pub-
lications (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 three course sequences providing general overviews of African Civilizations, East Asian Civilizations, and of Western Civilization. Western Civilization surveys the development of the Western world from earliest times to the present and supplies a foundation for additional work in the Department. 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. African Civilizations explores the varieties of cultural expression in Africa and in the new world. Students will find this course a useful introduction to advanced work in African and Afro-American history.

4. through 9. Thematic approaches to the basis of Western Civilization in the ancient world, with emphasis on the Judaeo-Christian and Greco-Roman traditions. (Students who have taken History 1 or its equivalent will not receive credit for any of these courses; credit will be given for only one course in the series 4. through 9.)

5 units, Aut (Staff)

10. through 15. Thematic approaches to the development of Western Civilization, from the Middle Ages to the eve of the French Revolution. (Students who have taken 2 or its equivalent will not receive credit for any of these courses; credit will be given for only one course in the series 10. through 15.)

5 units, Win (Staff)

16. through 21. Thematic approaches to the history of Western Civilization from the French Revolution to the present. (Students who have taken 3 or its equivalent will not receive credit for any of these courses; credit will be given for only one course in the series 16. through 21.)

Several undergraduate colloquia (priority given to freshmen) will be offered. For a more detailed description of themes and colloquia, see the *Time Schedule* for each quarter.

32. 20th Century Europe — Introductory survey of major trends and problems. Lectures and discussion groups.

5 units, Aut (Wright)

47. African Civilizations.

5 units, Win (Jackson, G. W. Johnson)


5 units, Spr (Jackson, G. W. Johnson)
II. ADVANCED COURSES

Courses numbered 100 through 103 (undergraduate seminars and colloquia) are open only to juniors and seniors majoring in history. Requests for admission to 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

During 1970-71, a number of colloquia will be offered for undergraduate History majors. Each will ordinarily consist of reading and discussion involving an explicit historical theme. Short papers, reports, and a final examination may be required. A number of undergraduate seminars will also be offered during 1970-71. A seminar differs from a colloquium principally by its concentration on materials and methods of historical research rather than on reading and discussion of a given body of historical literature. The student will write a research paper based to a substantial degree upon original sources. In doing so, he has the opportunity to learn how historians arrive at their conclusions, as well as what the results of their work are. In this sense, the subject matter handled in any given seminar is less important than the process of investigation, analysis, and writing. "How do you know?" becomes more important than "What do you know?" (See Time Schedule each quarter for a more detailed listing.)

100B. Undergraduate Seminar: Race and Educational Equality. 5 units, Aut (Tyack)

100C. Undergraduate Seminar: History and Psychoanalysis. 5 units, Win (M. Drekmeier)

100D. Undergraduate Seminar: Minorities. 5 units (Degler) given 1971-72

100E. Undergraduate Seminar: War and the Intellectuals—World War I. 5 units (Knoles) given 1971-72

100F. Undergraduate Seminar: The Cold War. 5 units (B. Bernstein) given 1971-72

100G. Undergraduate Seminar: American History. 5 units, Aut (Fehrenbacher)

101A. Undergraduate Colloquium: Religion and Social and Political Change, 16th and 17th Century England. 5 units (Seaver) given 1971-72

101B. Undergraduate Colloquium: Twentieth Century France. 5 units (Wright) given 1971-72

101C. Undergraduate Colloquium: European Socialisms in the Nineteenth and Twentieth Centuries. 5 units, Win (Wright)

101D. Undergraduate Colloquium: Intellectual History of the Twentieth Century. 5 units (Craig) given 1971-72

101E. Undergraduate Colloquium: Politics, Society, and Art in Modern European History. 5 units, Spr (Craig and Paret)

101F. Undergraduate Colloquium: Race and Sex in the United States. 5 units, Spr (Degler)

101G. Undergraduate Colloquium: Dissent and Rebellion in Pre-Modern China and Europe. 5 units, Spr (Kahn)

101H. Undergraduate Colloquium: The Chinese Communist Movement—Problems of Interpretation. 5 units, Aut (Van Slyke)

101I. Undergraduate Colloquium: Topics in Modern Intellectual History. 5 units, Aut (Robinson)

102A. Undergraduate Colloquium: Ideas and Society in the Progressive Period. 5 units, Aut (Knoles)

102B. Undergraduate Colloquium: The Russian Revolutionary Movement. 5 units, Spr (Emmons)
102C. Undergraduate Colloquium: Christianization of Europe.  
5 units, Spr (Langmuir)

102D. Undergraduate Colloquium: The Nature and Purpose of History.  
5 units (Bark) given 1971–72

102E. Undergraduate Colloquium: Social Classes in Modern History.  
5 units, Win (Smith)

102F. Undergraduate Colloquium: The United States in the 20th Century. Prerequisite: 169, 170, 171, or equivalent.  
5 units, Aut (Kennedy)

102I. Undergraduate Colloquium: Topics in Byzantine History.  
5 units, Win (Vucinich)

5 units, Spr (——)

103A. Undergraduate Colloquium: Russian Foreign Relations.  
5 units, Win (Lederer)

103B. Undergraduate Colloquium: Colonial Latin American History.  
5 units, Spr (Bowser)

103C. Undergraduate Colloquium: Contemporary Latin American History.  
5 units, Win (Wirth)

103D. Undergraduate Colloquium: The Presidency from Washington to Lincoln.  
5 units, Aut (Fehrenbacher)

103E. Undergraduate Colloquium: Reconstruction.  
5 units, Aut (Potter)

103F. Undergraduate Colloquium: Realism, Romanticism, and the African Intellectuals.  
5 units, Aut (Jackson)

103I. Undergraduate Colloquium: Communism and Nationalism.  
5 units (Vucinich) given 1971–72

103W. Undergraduate Colloquium: Shaping of Twentieth Century America.  
5 units, Spr (B. Bernstein)

200. Honors Reading Course in Comparative History.  
5 units each for two quarters; Aut, Win, Spr (Staff)

B. THE ANCIENT WORLD
See Classics, Section V, Courses 102, 103, 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 1971–72

4 to 5 units, Win (A. Bernstein)

4 to 5 units, Spr (A. Bernstein)

108. The Genesis of Antisemitism—Examination of the antecedents and development of the oldest ethnic prejudice in Western civilization in the light of recent psychological and sociological theories of prejudice.  
5 units, Win (Langmuir)

5 units, Aut (Spitz)

110. Age of the Reformation — Europe in early modern times with special emphasis on the Protestant Reformation and Catholic reform.  
5 units, Win (Spitz)

115. Senior Honors: Research in Medieval History.  
1 to 5 units (Langmuir) by arrangement
117. Senior Honors: Research in Renaissance-Reformation History.
   1 to 5 units (Spitz) by arrangement

D. MODERN EUROPE

120A. Russia, 1700–1861.
   4 to 5 units, Aut (Emmons)
120B. Russia, 1861–1917.
   4 to 5 units, Win (Emmons)
121. Twentieth Century Russia.
   4 to 5 units, Spr (Lederer)
126. Eastern Europe Since 1914.
   4 to 5 units, Win (Vucinich)
128. Germany and Austria in the Nineteenth Century.
   4 to 5 units, Win (Craig)
128A. War and Society—An analysis of military affairs and of their interaction with intellectual, social, economic, and political history since the Renaissance.
   5 units, Win (Paret)
129. Germany in the Twentieth Century.
   4 to 5 units, Spr (Craig)
129B. Europe in the 17th and 18th Centuries.
   5 units, Aut (Paret)
130. The Ancien Régime in France (1589–1789).
   4 to 5 units (Dawson) given 1971–72
131. The Age of Revolution in Europe, 1780–1840.
   4 to 5 units (Dawson) given 1971–72
132. Modern France, 1848 to the Present.
   5 units, Spr (Wright)
134A. Scientific Revolution and Social Change: 17th Century Western Europe.
   5 units, Aut (M. Drekmeier) given 1971–72
134B. The Enlightenment.
   5 units, Aut (M. Drekmeier)
135. Diplomatic Revolution of Our Time—
    An investigation of the problems raised by the collapse of the traditional system of Western diplomacy as a result of two world wars, the expansion of the diplomatic community, the breakdown of its internal homogeneity, the emergence of new nations, tensions between great and small powers, negotiations between states with conflicting national and cultural traditions, the functions and limitations of international organizations, and the new dimensions of diplomacy that have emerged since 1945.
   4 to 5 units, Win (Lederer)
135C. How Nations Deal with Each Other—
    An introductory course in international relations, emphasizing the interaction of political, economic, social, and cultural factors, and exploring the various dimensions of national power.
   5 units, Aut (Crowl, Paret, Craig, George, Lederer, Meier)
136A. European Intellectual History: Nineteenth Century.
   4 to 5 units, Win (Robinson)
136B. European Intellectual History: Twentieth Century.
   4 to 5 units, Spr (Robinson)
138A,B. Problems of Arms Control and Disarmament. (See Political Science 138A,B.)
   5 units, Win, Spr (Barton, Craig, Crowl, T. Ehrlich, Lewis, W. Panofsky, Paret, Peterson)
139. Senior Honors: Research in Modern European History.
   1 to 5 units (Lederer, Paret, Robinson, Wright) by arrangement

E. THE BRITISH COMMONWEALTH AND EMPIRE

140. England to 1460.
   5 units, Aut (Langmuir)
   4 to 5 units (Seaver) given 1971–72
142. Stuart England.
   4 to 5 units (Seaver) given 1971–72
143. Britain, 1688–1867—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 (Stansky) given 1971–72
144. Britain Since 1867—See description of 143 (above).
   4 to 5 units (Stansky) given 1971–72
146. Senior Honors: Research in British History.
   1 to 5 units (Seaver and Stansky) given 1971–72
F. AFRICA

147A. The History of Pre-Colonial Africa—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, Spr (Jackson)


5 units, Aut (G. W. Johnson)

148A. The History of 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.

5 units, Aut (G. W. Johnson)

148C. The History of East Africa.

5 units (Jackson) given 1971–72

149B. Senior Honors: Research in African History.

1 to 5 units (G. W. Johnson)

G. THE UNITED STATES

150. The Colonial Period.

4 units, Aut (Miller)

151. The Revolution, Confederation and Constitution.

5 units, Win (Miller)

152. United States Constitutional History, Revolution to the Civil War.

4 units (Fehrenbacher) given 1971–72

153. Interpretive Overview of United States History—The influence of land and class on American society; development of an industrial economy; evolution of the party system; changing place of minority groups; nature of the American religious experience; the transition of the United States from isolation to world power.

5 units (Degler) given 1971–72

154. Social Thought in America—Examination of the major American writings on social and political theory from the time of the Revolution to the 20th century. Readings will include selections from the Federalist Papers, John Adams, William James, Daniel Bell, and C. Wright Mills. An attempt will be made to place each writer in historical context as well as to develop the notion of a tradition of American social thought.

5 units, Win (Kennedy)

157A. Black Community and Leadership, 1739–1877.

5 units, Win (——)

157B. Black Community and Leadership, 1877–Present.

5 units, Win (——)

159. The Ante-Bellum Period.

4 to 5 units, Win (Fehrenbacher)

160. History of the American South, 1815–1900—The rise and decline of southern separateness. Emphasis on social and economic history.

5 units, Aut (Degler)

162. Nineteenth Century America.

4 units (Fehrenbacher) given 1971–72

163. The American Character.

4 to 5 units, Aut (Potter)

165. American Society from Underdevelopment to Maturity, 1830–1900.

5 units, Spr (Degler)


4 to 5 units (Knoles) given 1971–72

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 1971–72

168. American Social History to 1860—Development of American society from the first settlements to the decade leading to the Civil War. 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 (B. Bernstein)
169. American Social History 1860–1970—Development of American society from the Civil War 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 (B. Bernstein)

170. The United States, 1890–1929.

4 to 5 units (Kennedy) given 1972–73

171. The United States, 1929–Present.

4 to 5 units (Kennedy) given 1972–73

172. The Era of the Civil War, 1846–1865.

4 to 5 units (Potter) given 1971–72

175. Senior Honors: Research in United States History.

1 to 5 units (Bernstein, Degler, Fehrenbacher, Kennedy, Knoles, Miller, Potter) by arrangement

H. LATIN AMERICA

176. Latin America to 1825 — Discovery, conquest, growth of political, social, economic institutions; Wars of Independence in Spanish, Portuguese America.

4 to 5 units, Spr (Bowser)

177. Modern Latin America—Political, social, economic institutions in leading republics since independence.

4 to 5 units, Win (J. Johnson)


5 units, Aut (Wirth)

181. Contemporary Brazil—Politics and society in transition from agrarian to industrial bases, the rise of nationalism, and Brazil’s role in the hemisphere and international organizations.

4 to 5 units, Spr (Wirth)

182. Latin America and the African.

4 to 5 units, Win (Bowser)

185. Senior Honors: Research in Latin American History.

1 to 5 units, Spr (Bowser, J. Johnson, Wirth) by arrangement

I. MIDDLE EAST


4 to 5 units, Aut (Vucinch)


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.

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 (Rentz) given 1971–72

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 1972–73

J. EAST ASIA

190. Chinese Social Thought—Problems in the history of Chinese social theory, with special attention to Confucianism and Maoism.

3 units, Spr (Mancall)

191. Aspects of Late Traditional Chinese History—Selected problems of the Ming and Ch’ing periods (to ca. 1850) with emphasis on political, social, and intellectual history.

4 to 5 units, Aut (Kahn)

192. Modern China —1800 to the present. Emphasis on rebellions, reforms, revolutions, and resistance to changes.

4 to 5 units, Spr (Van Slyke)

193. Chinese Intellectual History—Late traditional Chinese thought and its transformation in the modern era. Emphasis on the relation between thought and society. Familiarity with modern Chinese history will be assumed.

4 to 5 units, Win (Van Slyke)

194A. Japan, 1600–1890 — Development of institutions and thought; early relations with the West; the Meiji Restoration and the be-
ginnings of modernization. Emphasis on latter half of the period.

3 to 5 units, Win (Smith)

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 5 units, Spr (Smith)

196. China and the United States—Conceptions of and relations between the two countries, as seen from both shores of the Pacific. Emphasis on the twentieth century.

4 to 5 units, (Van Slyke) given 1971–72

199. Senior Honors: Research in Far Eastern History.

1 to 5 units (Kahn, Mancall, Smith, Van Slyke) by arrangement

III. GRADUATE COURSES

Courses numbered 300–399 are intended primarily for first-year graduate students, but other graduate students may be admitted by consent of the instructor.

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, Oksenberg, Skinner, Van Slyke) by arrangement


5 units, Win (Bowser)

305. Graduate Colloquium: History and the Social Sciences.

5 units, Win (Wright, Robinson)

308. Graduate Colloquium: Topics in Medieval History.

5 units, Aut (Langmuir)

312. Graduate Colloquium: Paleography, Codicology, and Textual Criticism.

5 units, Aut (A. Bernstein)

314. Directed Reading in Medieval History.

Units by arrangement (Staff)

315. Research Techniques in Medieval and Renaissance History.

5 units (A. Bernstein) given 1971–72

316. Directed Reading in Renaissance and Reformation.

Units by arrangement (Spitz)

317. Graduate Research in Renaissance and Reformation.

Units by arrangement (Spitz)

318. Graduate Colloquium: Interpretations of the Reformation.

5 units, Spr (Spitz)

319. Graduate Colloquium: Humanism and the Reformation.

5 units, Aut (Spitz)

321. Graduate Colloquium: Topics in Tudor-Stuart History.

5 units, (Seaver) given 1971–72

321A. Graduate Colloquium—Problems in 19th Century British History.

5 units, Aut (Stansky) given 1971–72

322A. Graduate Colloquium: Non-Russian Peoples of the Soviet Union.

5 units, (Vucinich) given 1971–72

323. Graduate Colloquium: 18th and 19th Century Russian History.

10 units, Aut, Win (Emmons) given 1971–72

324. Graduate Colloquium: Modern Russia, Nineteenth and Twentieth Centuries.

5 units, Aut (Lederer)

325. Graduate Colloquium: Eastern Europe.

5 units, Win (Vucinich)

328. Graduate Colloquium: Topics in Modern European History.

5 units, Aut (Craig)


5 units, Spr (M. Drekmeier)

331. Graduate Colloquium: Seventeenth and Eighteenth Century Europe.

5 units (Dawson) given 1971–72

336. Graduate Colloquium: Latin European Intellectual History.

5 units, Aut (Robinson)
338. Directed Reading in Modern European History.
   Units by arrangement (Lederer and Wright)
339. Graduate Research in Modern European History.
   Units by arrangement (Lederer and Wright)
345. Directed Reading in British History.
   Units by arrangement (Seaver, Stansky) given 1971–72
346. Graduate Research in British History.
   Units by arrangement (Seaver, Stansky) given 1971–72
347. Graduate Colloquium: Stratification and Class in Pre-Colonial Africa.
   5 units, Win, Spr (Jackson)
348. Graduate Core Colloquium: The Interpretation of African History.
   5 units, Aut (G. W. Johnson)
349A. Directed Reading in African History.
   Units by arrangement (Jackson, G. W. Johnson)
349B. Graduate Research in African History.
   Units by arrangement (Jackson, G. W. Johnson)
351. Joint Graduate Colloquium in American History.
   30 units, Aut, Win, Spr (Staff)
   5 units, Spr (Potter)
354. Graduate Colloquium: Politics from Jackson to Lincoln.
   5 units, Spr (Fehrenbacher)
   5 units, Spr (Miller)
   5 units (Knoles) given 1971–72
359. Graduate Colloquium: Social and Political Thought in the 20th Century Black Community.
   5 units, Win (——)
363. Graduate Colloquium: Modern America, 1890–1950.
   5 units (B. Bernstein) given 1971–72
374. Directed Reading in United States History.
   Units by arrangement (B. Bernstein, Degler, Fehrenbacher, Kennedy, Knoles, Miller, Potter)
375. Graduate Research in United States History.
   Units by arrangement (B. Bernstein, Degler, Fehrenbacher, Kennedy, Knoles, Miller, Potter)
380. Graduate Colloquium: Latin American History.
   5 units, Aut (J. Johnson)
381. Graduate Colloquium: Studies in Latin American Urban History.
   5 units, Win (Morse)
382. Graduate Colloquium: Brazilian History.
   5 units, Spr (Wirth)
   5 units (Bowser) given 1971–72
384. Directed Reading in Latin American History.
   Units by arrangement (Bowser, J. Johnson, Wirth)
385. Graduate Research in Latin American History.
   Units by arrangement (Bowser, J. Johnson, Wirth)
389. Directed Reading in the Middle East and in the Islamic World.
   Units by arrangement (Rentz)
390A. Graduate Colloquium: Topics in Late Traditional and Modern Chinese History—the Late Traditional Period.
   5 units, Aut (Kahn)
390B. Graduate Colloquium: Topics in Late Traditional and Modern Chinese History—The Modern Period.
   5 units, Win (Van Slyke)
   5 units, Win (Ouchi)
   5 units, Spr (Smith)
398. Directed Reading in Far Eastern History.
   Units by arrangement (Kahn, Mancall, Smith, Van Slyke)
SCHOOL OF HUMANITIES AND SCIENCES

399. Graduate Research in Far Eastern History.
Units by arrangement (Kahn, Mancall, Smith, Van Slyke)

IV. ADVANCED GRADUATE COURSES

Courses numbered 400–499 are intended primarily for second- and third-year graduate students, but other graduate students may be admitted by consent of the instructor.

401B. Graduate Seminar in Educational History: Urban Education.
3 to 5 units, Spr (Tyack)

409. Graduate Seminar: Later Medieval History.
5 units, Spr (A. Bernstein)

410. Graduate Seminar: Europe.
10 units, Win, Spr (Spitz)

419. Graduate Seminar: Comparative Foreign Policy: Eastern Europe—(See Political Science 336.)
5 units, Spr (Lederer and Triska)

421. Graduate Seminar in Russian History.
10 units (Emmons) given 1971–72

422. Graduate Seminar: Russian Foreign Relations.
5 units, Spr (Lederer)

425. Graduate Seminar in Eastern Europe.
5 units, Spr (Vucinich)

5 units, Win (Craig)

10 units (Dawson) given 1971–72

432. Graduate Seminar: The History of Military Thought, Institutions, and Policy.
5 units, Spr (Paret)

5 units, Win (Paret)

436. Graduate Seminar: Western Europe in the 20th Century.
5 units, Spr (Wright)

440. Graduate Seminar in Medieval History.
5 units, Win (Langmuir)

10 units (Seaver) given 1971–72

5 units (Stansky) given 1971–72

444. Graduate Seminar: Churchill.
5 units, Aut (Stansky)

447. Graduate Seminar on Oral Historical Traditions in Africa.
5 units (Jackson) given 1971–72

448A. Graduate Seminar: Francophone Africa.
10 units, Win, Spr (G. W. Johnson)

5 units (Miller) given 1971–72

452. Graduate Seminar: Nineteenth Century United States History.
5 units (Fehrenbacher) given 1971–72

5 units, Spr (———)

454. Graduate Seminar: American Liberalism from Progressivism to the Cold War.
5 units, Aut (B. Bernstein)

5 units, Win (Potter)

5 units (Knoles) given 1971–72

5 units, Spr (Degler)

460. Graduate Seminar in History of the South.
5 units (Degler) given 1971–72

5 units, Aut (Kennedy)

480. Graduate Seminar in Modern Latin American History.
5 units, Spr (J. Johnson)

482. Graduate Seminar in Modern Brazilian History.
5 units, Aut (Wirth)
5 units (Bowser) given 1971–72

489. Graduate Seminar in Chinese History: The Ch’ing Period.
5 units, Win (Kahn)

490. Graduate Seminar in Modern Chinese History.
5 units, Spr (Van Slyke)

492. Graduate Seminar in the History of Japan.
5 units, Spr (Smith)

HUMANITIES SPECIAL PROGRAMS

Emeritus: John W. Dodds (Professor)
Chairman: William A. Clebsch

Professors: Robert M. Brown (Religion), William A. Clebsch (Religion and Humanities), Edwin M. Good (Religion; University Fellow), Paul H. Kocher (English and Humanities), B. Davie Napier (Religion), Philip H. Rhinelander (Philosophy and Humanities) (on leave 1970–71), Lawrence V. Ryan (English and Humanities), Jeffery Smith (Humanities and Philosophy) (on leave 1970–71). Visiting: Raeburne S. Heimbeck (Humanities)

Associate Professor: Lawrence V. Berman (Religion)

Assistant Professors: Jerry A. Irish (Religion), Alan L. Miller (Religion), Mary K. Wakeman (Religion), Lee H. Yearley (Religion)

Humanities Special Programs include:
1. Humanities Honors Program.
2. Graduate Program in Humanities.

HUMANITIES HONORS PROGRAM


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 persons 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 normally the condition of admission to the Program and is required for graduation with Honors in Humanities.

Freshmen and Sophomores interested in the Program should consult with the Director or Associate Director. The consultation should take place at the earliest opportunity, preferably during freshman year, and in every case before beginning the junior year.

The Program is open to majors in every field, and may be taken in addition to a departmental major or as a minor.

A student who is admitted to the Program may enroll as a Humanities major:

1. If he is taking the pre-medical curriculum,
2. If he chooses a major in Humanities concentrating in one of the following:
   (a) American Studies
   (b) Comparative Literature (see p. 245)
   (c) Religious Studies (see p. 315)
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. Examples: Classical Studies, East Asian Studies, Medieval Studies, the Modern Novel, and Renaissance Studies.

Students who wish to major in Humanities must enter the Program and plan the concentration before registering for the first quarter of the junior year. Competence in a foreign language is required of Humanities majors.

REQUIREMENTS OF THE PROGRAM

1. World Literature—Humanities 61, 62, 63—15 units, freshman or sophomore year.
2. Humanities Seminars 191 and 192 or 193 or 194—10 units, junior year.

3. Honors Essay—A critical essay on a topic of general importance and approved by the Committee (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.

COURSES

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, Win (Smith) given 1971–72

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.


5 units, Aut (Edwards, Staff) TWTh 11 and two hours by arrangement

62. Medieval and Renaissance Literature —Boethius, Arthurian romance, Dante, Castiglione, Marlowe, Montaigne, Cervantes.

5 units, Win (Evans, 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 (Sokel, Staff) MWF 11 and two hours by arrangement

175. Individual Work — For students with definite objectives not met by current course offerings.

2 to 5 units, any quarter (Staff) by arrangement

191, 192, 193, 194. Interdepartmental Seminars on the Nature of the Humanities—Students in the Humanities Honors Program are required to complete 191 and either 192, 193, or 194. These seminars are open to a limited number of other students only by permission of the Director.

191. Principles and Methods of Humanistic Study.

5 units, Aut (Halliburton, Heimbeck) by arrangement
Win (Clebsch) by arrangement
Spr (Heimbeck) 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 (Good), Spr (Heimbeck) by arrangement

193. Philosophy and History as Humanities—Prerequisite: 191.

5 units, Win (Kennedy) by arrangement
Spr (Mellor) by arrangement


5 units, Win (Lindenberger) by arrangement


12 units (Staff) by arrangement

GRADUATE PROGRAM IN HUMANITIES

Committee in Charge: William A. Clebsch (Director), Raeburne S. Heimbeck, Kurt Mueller-Vollmer, David S. Nivison, Lawrence V. Ryan

The Graduate Program in Humanities supplements the Ph.D. programs of certain Stanford students, especially in Classics, Comparative Literature, English, French and Italian, German, History, Modern Thought and Literature, Philosophy, Religious Studies, 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. in "Classics and Humanities," "English and Humanities," "German and Humanities," etc.

Because the Graduate Program in Humanities supplements, and does not substitute for, departmental specialties, its members must have been accepted for graduate work by a Ph.D.-granting program or department at Stanford, and their application
must have been approved by the Committee in Charge.

Application for entrance into the Program should be made to the Director; selections are made to give broad representation to the participating departments. Members of the Program are given first preference in registration for all courses offered by the Program. The normal pattern of the Program involves one Humanities course in each of six successive quarters, but no particular pattern is enforced.

Graduate students who are not members of the Program may enroll, by consent of the Director, in courses whose enrollments are not filled by members of the Program. Limits: 25 in Humanities 301-305; 18 in Humanities 306.

REQUIREMENTS

1. Continued satisfactory work in the student’s major field, in accordance with Departmental requirements.
2. Completion of the five historical courses (Humanities 301-305) in the Western Tradition series, for any one or two of which other academic work may be substituted, if approved by the Committee in Charge; completion of Humanities 306, unless special exemption is given by the Committee in Charge.
3. Regular attendance and active participation in the bi-weekly, informal Humanities Colloquium for at least one academic year.
4. Reading knowledge of at least one foreign language, ancient or modern.
5. Passing the University Oral Examination, with one representative of the Graduate Program in Humanities designated by the Director, as a member of the examining committee.
6. Submission of a Ph.D. dissertation that is acceptable to a committee which includes one representative of the Graduate Program in Humanities, designated by the Director.

COURSES

251. Basic Humanistic Problems—Open to graduate students and to advanced undergraduates with consent of the instructor; required of M.A.T. candidates whose teaching field is Humanities.
   4 units, Win (Heimbeck) TTh 2:15-4:05

275. Directed Reading.
   2–5 units (Staff) by arrangement

301, 302, 303, 304, 305, 306. The Western Traditions — Required of students in the Graduate Program in Humanities. Open to other graduate students only by consent of the Director.
   301. The Classical Period.
      4 units, Aut (Heimbeck) TTh 4:15–6:05
   302. The Roman and Early Christian Period.
      4 units, Win (Raubitschek) TTh 4:15–6:05
   303. The Middle Ages.
      4 units, Spr (Calin) TTh 4:15–6:05
   304. The Renaissance.
      4 units, Aut (Ryan) MW 4:15–6:05
   305. The Early Modern Period.
      4 units, Win (Goheen) MW 4:15–6:05
   306. Modernism and the Consciousness of the Humanities—Normally taken after completion of 301–305.
      4 units, Spr (Mueller-Vollmer) MW 4:15–6:05

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.

UNDERGRADUATE MAJOR

A limited number of students taking the Humanities Honors Program may declare majors in Humanities with concentration in Religious Studies. The declaration is made only after the student has planned, in consultation with a Religious Studies faculty member (who must submit the plan to the Religious Studies faculty for approval and for any subsequent alteration), a 40-unit concentration in Religious Studies, including any corollary courses in other departments. Application and presentation of the plan should be made early in the Sophomore year, and in no case later than the first week of the first quarter of the Junior year.

The plan should include a range of courses involving various modes of the study of re-
ligion, and should comprise a coherent scheme of studying a particular aspect of religion.

Normally the plan will be related to the subject of the student's Honors Essay in Humanities.

Each student who majors in Humanities with Concentration in Religious Studies shall include Religious Studies 190 (Seminar in Religion) in his plan.

DOCTOR OF PHILOSOPHY IN RELIGIOUS STUDIES

University regulations regarding this degree are found in the section "Degrees" in this Bulletin. The following requirements, dealing with residence, fields, courses, examinations, languages, and the dissertation are in addition to the University basic requirements for the Ph.D.

Residence: 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 of Arts degree. He will be expected to offer at least 90 units of graduate work in addition to his dissertation, of which at least the last 60 units must be taken at Stanford.

Field of Study: The Program, relying in part on other graduate offerings in the University, offers specialized work in the humanistic study of religions in the following fields of concentration: classical religious literature, Near Eastern religions, medieval religious thought, Western religious thought, modern theology, Far Eastern religions.

Courses: Each student plans his work subject to the approval, and writes his dissertation under the direction of the faculty member designated as his adviser and sponsor. One advanced seminar in preparation for each part of the second-year preliminary examinations must be completed satisfactorily before those examinations are taken.

Examinations:

1. All students take a three-hour written qualifying examination during the third quarter of their first year of graduate study at Stanford. In order to continue beyond the first year of the program, the student must pass this examination, which is designed to test his orientation to graduate humanistic study of religion.

2. Written preliminary examinations are set for all students at the end of their second year of graduate study. These examinations are offered in the methodologies of the following four areas: exegesis of religious literature; the history of religious movements; the religious thought of two major writers, ancient or modern; the comparison of religions. Prior to these examinations the student submits to his adviser the body of literature from which he will be examined in exegesis and the names of six major writers, at least two ancient, on whose religious philosophy he is prepared to be examined, and the religious movement on whose history he is to be examined. A student may substitute a group of approved courses for at most one of the four examinations. The preliminary examinations may be taken no more than twice, and are taken by the end of the third year of graduate study. After passing these examinations, the student applies for degree candidacy.

3. The University oral examination.

Dissertation: After passing the preliminary examinations, the candidate engages in a colloquium on his proposed dissertation topic, demonstrating his readiness to proceed with the dissertation. An acceptable dissertation must be a contribution to the humanistic study of religion and be written in acceptable English style. The dissertation is written under the direction of the candidate's sponsor and at least two other members of the faculty, at least one of whom shall be a member of another department.

Language requirements: All candidates for the Ph.D. degree must demonstrate by examination a reading knowledge of German and French before beginning the second full year of graduate work at Stanford. Before the written preliminary examinations, each candidate must demonstrate a reading knowledge of Latin or Greek or Hebrew, or, if especially relevant to the dissertation, some other ancient or modern language. Use of additional languages may be required for some areas of concentration and dissertations.

Supporting programs: A coherent supporting program of not fewer than 24 units (included in the 90-unit requirement) shall be taken in advanced and graduate courses as a graduate student in other departments of the University.

JOINT PH.D. IN RELIGIOUS STUDIES AND HUMANITIES

The Program in Religious Studies participates in the Graduate Program in Humani-
ties leading to the joint Ph.D. degree in Religious Studies and Humanities. For a description of that program see the section of "Humanities Special Programs" in this Bulletin.

COURSES

(Courses numbered 10–99 are suitable for all undergraduates.)

5 units, Spr (Napier) MW 2:15–4:05

21, 22, 23. History of Christian Theology — The theological history of Christianity; representative theologians, central issues, and the relation of the theologies to the culture of the times. Enrollment for one part of the series is permitted.

5 units, Aut (Clebsch) MTWTh 10

5 units, Win (Yearley) MTWTh 10

23. Christian Theology Since the Enlightenment.
5 units, Spr (Irish) MTWTh 10

32. American Religion — Religious movements and thinkers of various periods; the rise of religious pluralism.
5 units, Spr (Clebsch) MW 2:15–4:05

34. Judaism — 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, Aut (Berman) MTWTh 11

54. Christian Ethics — The ethics of such figures as Augustine, Aquinas, Calvin, Kant, Rauschenbusch, and Niebuhr, examined in theological context and as employed in decision-making.
5 units, Win (Irish) MTWTh 11

61. Christian Theology — A systematic examination of the major topics of Christian thought, presented in ecumenical perspective.
5 units, Aut (Brown) MTWTh 9

72. Theology and Contemporary Literature — Theological issues raised by contemporary writers, such as Auden, Beckett, Camus, Greene, Silone, Warren, and others.
5 units, Spr (Brown) MTWTh 9

81. The Comparative Study of Religions — The nature and variety of religion; interpretations by certain formative comparativists.
5 units, Aut (Miller) given 1971–72

85. Myths of the Ancient World — Cultural and religious uses of myth and motifs such as creation, death and resurrection, fertility, cosmic struggle, as they appear in various types of literature; material from Mesopotamian, Egyptian, Canaanite, Anatolian, and Greek settings.
5 units, Win (Wakeman) MTWTh 9

86. Hinduism — The history of thought and practice in the "great tradition" of India; selected Hindu scriptures.
5 units, Spr (Miller) MTWTh 11

87. Buddhism — The history of Buddhist thought and practice; selected scriptures.
5 units, Win (Miller) MTWTh 11

(Courses numbered 100–199 are suitable for undergraduates at 5 units and for graduates at 4 units.)

5 units, Spr (Wakeman) MTWTh 11

105. The Prophets of Israel — The Hebrew prophets as poets and activists.
5 units, Aut (Wakeman) MTWTh 10

106. Wisdom in the Ancient Near East — The Wisdom literature of Mesopotamia, Egypt, and Israel, such as: A Dialogue about Human Misery, The Instruction of Amen-em-opet, the Book of Job.
5 units, Spr (Wakeman) given 1971–72
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: consent of instructor.

5 units, Win (Good) given 1971-72

108. Early Israelite Religion — Critical examination of the traditions of Israel’s “heroic age” with the help of archeological and extra-Biblical literary evidence.

5 units, Spr (Wakeman) TTh 2:15-4:05


5 units, Aut (Berman) given 1971-72

120. Religion in the Ancient Near East — Development of and relations between Sumerian, Babylonian, Assyrian, Egyptian, Canaanite, Hittite, and Israelite cultures.

5 units, Aut (Wakeman) TTh 2:15-4:05

124. Islamic Theology and Philosophy — The thought of leading theologians and philosophers with consideration of the influence of the Greek philosophical tradition.

5 units, Aut (Berman) TTh 2:15-4:05

125. Medieval Jewish Thought I — 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 4:15-6:05

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) MW 4:15-6:05

127. Aquinas — The thought of Aquinas in its historical setting.

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

128. Augustine — The thought of Augustine in its historical setting.

5 units, Win (Yearley) given 1971-72

129. Maimonides — 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 1971-72


5 units, Spr (Clebsch) given 1972-73

136. Judaism and Islam — Comparison of the two religions throughout the course of their historical development, with some reference to early Christianity and Iranian religion; prophecy, law, religious philosophy, mysticism, and reform movements.

5 units, Spr (Berman) MTWTh 10

145. The Ecumenical Movement — The development of ecumenical concern in the twentieth century in both Protestantism and Roman Catholicism. Prerequisite: consent of instructor. Topic for 1970-71: The Church and Revolution.

5 units, Aut (Brown) TTh 4:15-6:05

148. Modern Catholic Thought — The main figures and problems in modern Catholic thought centering on the attempt to meet the apologetic and systematic questions posed by the modern world; Newman, Rahner, de Lubac, Berdyaev, Farrer, and others.

5 units, Aut (Yearley) given 1971-72

162. Problems in Christian Theology — Historical and systematic analyses of one or more major subjects of Christian theology. Topic for 1971-72: Different views on the character of Christ and his function in the Christian salvation experience; e.g., Christ as teacher, as bringer of immortality, as revealer of love, in Kierkegaard, Rahner, Anselm, Paul, etc.

5 units, Aut (Yearley) given 1971-72


5 units, Spr (Irish) MW 2:15-4:05

165. Modern Catholic Theologians — Topic for 1970-71: Analysis and comparison of the theologies of Rahner and Newman as two examples of possible Catholic approaches to modern theological problems, like the nature of faith and the distinctiveness of Christianity.

5 units, Win (Yearley) TTh 2:15-4:05
167. **Topics in Islamic Thought**—Examination of a central problem, a major thinker, or a religious movement in the context of later Near Eastern intellectual history. Topic for 1971–72: Sufism.

5 units, Spr (Berman) given 1971–72

174. **Philosophical Theology**—Problems in traditional theism and consideration of process philosophy as an alternative conceptual framework for the Christian understanding of God in the writings of A. N. Whitehead, Charles Hartshorne, and other contemporary philosophers and theologians.

5 units, Aut (Irish) TTh 2:15–4:05

178. **Modes of Religious Thought**—Comparative analysis of modes of religious thought on a specific issue with examples drawn from both the Eastern and Western traditions. Topic for 1970–71: religious ethics, Christian, classical Greek, Taoist, Confucian, etc.

5 units, Spr (Yearley) TTh 2:15–4:05

182. **Religion in Primitive Societies**—The structure and meaning of myth, ritual, and religious institutions in non-literate societies; ethnographic data and interpretative theories of anthropologists and scholars of religion.

5 units, Spr (Miller) TTh 2:15–4:05

183. **Confucianism and Taoism**—Concentration on writings from the classic period: Confucius, Mencius, the *Tao Te Ching*, the *Chuang Tzu*, and others.

5 units, Spr (Yearley) MTWTh 9


5 units, Win (Irish) TTh 4:15–6:05

188. **Religion in Japan**—The development of religion in Japan from the earliest records through the flowering of Buddhism.

5 units, Aut (Miller) MW 4:15–6:05

189A. **Religious Traditions of the Far East**—The thought, practice, and institutions, in mutual interaction, of one Far Eastern religious tradition. Enrollment limited to 15 students. Topic for 1970–71: Ch'an/Zen Buddhism in China and Japan. Comparison of various interpreters of Zen to the West. Prerequisite: consent of instructor.

5 units, Win (Miller) TTh 2:15–4:05

190. **Seminar in Religion**—Required of majors in Humanities with concentration in Religious Studies. Enrollment limited to 15 students. Prerequisite: consent of instructor.

5 units, Spr (Brown) by arrangement


5 units, Aut (Miller, Yearley) MTWTh 11

194. **The Holy Man in China and Japan**—Human and divine embodiments of the major “Ways” of the religious life in the Far East, as seen in history, legend, and myth; in China, the Confucian chün tzu (virtuous man) and the Taoist hsien (immortal); in Japan, the *hijiri* (holy man) and the *shōnin* (saint).

5 units, Spr (Miller) given 1971–72

199. **Individual Work.**
(Staff) by arrangement

(Courses numbered 200 or above are primarily for graduates; advanced undergraduates may enroll by consent of instructor.)

201. **Graduate Seminar: The Exegesis of Texts**—Required of all doctoral students in Religious Studies; may be repeated for credit. Prerequisite: consent of instructor.

4 units, Aut (Good) MW 2:15–4:05

203. **Directed Reading in Ancient Near Eastern Religious Texts.**
(Good, Wakeman) by arrangement

205. **Directed Reading in Old Testament Interpretation.**
(Good, Napier, Wakeman) by arrangement

212. **Graduate Research in Arabic Philosophical and Theological Texts.**
(Berman) by arrangement

213. **Graduate Research in Hebrew Philosophical and Theological Texts.**
(Berman) by arrangement

216. **Directed Reading in Japanese Religious Texts.**

4 units, Aut (Miller) by arrangement

221. **Graduate Seminar: Topics in the History of Religious Thought**—Required of all doctoral students in Religious Studies; may
be repeated for credit. Prerequisite: consent of instructor.

4 units, Aut (Staff) given 1971-72

228. Graduate Research in Medieval Religious Thought and Movements.
4 units, Win (Berman, Yearley)

231. Directed Reading in English and American Religious Thought.
4 units, Spr (Clebsch) by arrangement

233. Graduate Research in Nineteenth and Twentieth Century Religious Thought.
(Brown, Clebsch, Irish, Yearley)
by arrangement

241. Graduate Seminar: Systems of Religious Thought — Required of all doctoral students in Religious Studies; may be repeated for credit. Prerequisite: consent of instructor.
4 units, Win (Brown) MW 2:15-4:05

244. Graduate Research in Medieval Islamic Thought.
(Berman) by arrangement

247. Graduate Research in Medieval Jewish Thought.
(Berman) by arrangement

248. Graduate Research in Topics in Theology.
(Yearley) by arrangement

261. Graduate Seminar: Comparisons of Religions—Required of all doctoral students in Religious Studies; may be repeated for credit. Prerequisite: consent of instructor.
4 units, Win (Staff) given 1971-72

263. Directed Reading in Ancient Near Eastern Religions.
(Good, Wakeman) by arrangement

273. Graduate Research in Buddhism.
(Miller) by arrangement

277. Directed Reading in Far Eastern Religions.
4 units, Spr (Miller, Yearley)

299. Directed Reading for Graduate Students.
(Staff) by arrangement

INTERNATIONAL RELATIONS, SPECIAL OFFERINGS FOR UNDERGRADUATES

Committee in Charge: Committee on International Relations, a subcommittee of the Committee on International Studies, Peter Paret (History); Richard A. Brody (Political Science); Gordon A. Craig (History); Thomas Ehrlich (School of Law); Alexander L. George (Political Science); Ivo J. Lederer (History); Gerald M. Meier (Graduate School of Business)

To assist undergraduates in studying contemporary political, social, and environmental problems that transcend national boundaries, the Committee on International Studies is sponsoring several innovative courses in 1970-71. They take an interdisciplinary, problem-oriented approach and are also listed in the programs of study of the relevant departments. They are designed to supplement related offerings in a wide variety of departments, institutes, and schools, described in other sections of this catalog, and are not intended to constitute the basis for an academic major. The members of the Committee on International Relations are available to advise students on work in international relations throughout the University.

1. How Nations Deal with Each Other—(Enroll in History 135C.)
5 units, Aut (Crowl, Craig, George, Paret, Lederer, Meier)

5 units each, Win, Spr (Barton, Craig, Crowl, T. Ehrlich, Lewis, Panofsky, Paret, A. Peterson)
3. Conflict Development and Resolution—
(Enroll in Political Science 136C.)
5 units, Win (Noel)

4. The Diplomatic Revolution of Our Time—
(Enroll in History 135.)
4-5 units, Win (Lederer)

5. Force and Diplomacy in Recent U.S. Foreign Policy—
(Enroll in Political Science 145A.)
5 units, Spr (George)

6. War and Society—(Enroll in History 128A.)
5 units, Win (Paret)

7. Peace-Keeping in International Relations. Freshman Seminar.
5 units, Spr (T. Ehrlich)

8. The Unity of Poverty: Domestic and International—Freshman Seminar.
5 units, Win (Paret)

9. Politics, Society, and Art in Modern European History—(Enroll in History 101E.)
Undergraduate Colloquium.
5 units, Spr (Craig and Paret)

LANGUAGE LABORATORY

Phillip B. Petersen, Director
Tian-Yee Lam, Assistant Director and Lecturer

The Language Laboratory and Language Laboratory Annex of a combined one hundred and twenty-two Type III (listen-respond-record) student positions offer varied programs in Arabic, Cantonese, Czech, English as a foreign language, French, German, Hausa, Indonesian, Italian, Japanese, Mandarin Chinese, Norwegian, Persian, Polish, Portuguese, Russian, Spanish, Swahili, Vietnamese and Yoruba.

Whether engaged in formal language studies or not, students are invited to use the Language Laboratory for listening, repetition, recording and self-evaluation. As an additional aid, departmental monitors in the major languages taught at the University are supplied for individual work. The Language Laboratory is open daily.

215. Language Laboratory Techniques—
(Same as Education 295.)
3 units, Spr (Lam) TTh 1:15
Sum (Lam) MTWThF 11 short term

CENTER FOR LATIN AMERICAN STUDIES

Committee in Charge: The Committee on Latin American Studies, a subcommittee of the Committee on International Studies.

Chairman of the Committee and Director of the Center: To be announced.

The Center for Latin American Studies administers three principal programs. They are the graduate A.M., the undergraduate A.B., and the Stanford campus in Mexico.

The A.M. program in Latin American Studies provides an interdisciplinary approach to the study of Latin America. The Departments of Anthropology, Economics, History, Political Science, Sociology, Spanish and Portuguese, and the Food Research Institute 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 Director of the Center and with the 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.

A new interdisciplinary A.B. program with an emphasis on independent study is now also possible. Each program will be designed to fit the individual needs of the students who will, however, be required to demonstrate language competence at the level of third year or higher in Spanish or Portuguese and a year of training in the second language by the time of graduation.

The Center will begin operating a campus in Mexico in the autumn quarter of 1970-71 which will stress study in the social sciences. The program will be open only to undergraduates.

Inquiries concerning these programs should be directed to the Director, Center for 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) M 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, Aut (Breedlove) W 7:30 p.m.

**Summer Intensive Language Program in Spanish and Portuguese—See Spanish and Portuguese.**

**LINGUISTICS**


**Professors:** Charles A. Ferguson (on leave 1970–71); Visiting: Wallace L. Chafe

**Associate Professor:** Clara N. Bush

**Assistant Professors:** Andrew M. Devine; Acting: John B. Eulenberg, Roger C. Schank, Stanley Wanat

**Lecturers:** Eve Clark, Dinguri N. Mwaniki, Elizabeth C. Traugott

**Acting Instructor:** Mohamed Accra Tairu

**English for Foreign Students:**

**Director:** Clara N. Bush

**Acting Assistant Professor:** Stanley Wanat

**Instructor:** Frieda N. 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 4 quarter units of university-level work in each of the following: (a) linguistics; (b) for
eign 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, phonetics, psycholinguistics, sociolinguistics, statistical linguistics, comparative-historical linguistics, grammatical theory).

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 Linguistics, 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, comparative-historical linguistics, grammatical theory).

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 pre-final 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.


5 units, Aut (Diebold) MWF 1:15

200. Historical Linguistics—Introduction to the principles and methods of historical linguistics; the development of modern schools and trends of historical linguistics in the 20th century. Prerequisite: consent of instructor.

4 units, Aut (Traugott) MWF 11

201. Introduction to Comparative Linguistics (Indo-European)—The emphasis is on phonology and special attention is paid to the development of Latin and English.

3 units, Aut (Devine) W 4:15–6:05

207. Comparative Grammar of Greek and Latin—(Same as Classics 207.)

4 units, Win (Devine) by arrangement

208. Comparative Grammar of Greek and Latin—(Same as Classics 208.)

4 units, Spr (Devine) by arrangement

211A,B,C. First-Year Sanskrit—Introduction to the phonology and grammar of classical Sanskrit. Reading of selected texts from the Panchatantra and Mahabharata.

5 units, Aut, Win, Spr (Devine) MWF 2:15–3:45, alternate years, given 1971–72

212A,B. Second-Year Sanskrit—Grammar and reading of texts.

5 units, Aut, Win (Devine) MWF 2:15–3:45

221. History of Linguistics—The course will consist of a survey of Graeco-Roman and Medieval theories of language, followed by readings on the speculative and universal grammarians. There will also be some examination of 19th and 20th century linguistic theories in Europe.

4 units, Spr (E. Clark) TTh 3:15–4:45

225. Research Seminar in the Psychology of Language: Linguistic and Cognitive Processes in Reading—(Same as Psychology 185.) The analysis of the process of reading. The seminar will consider recent experimental studies of reading in the light of various linguistic models. The discussions will try to develop experimental programs to resolve some of the crucial questions in the psychology of language.

3 units, Win (Wanat) MTh 2:15

261. Phonetic Theory—(Same as Hearing and Speech Sciences 212.) 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

262. Instrumental Phonetics (Same as Hearing and Speech Sciences 221.) Techniques of instrumental research in speech perception and production. Theory and instrumentation for analysis and manipulation of speech signals. Laboratory course. Prerequisite: consent of instructor.

2 units, Aut (Huntington) Th 3–5
263. Grammatical Theory — Discussion of various theoretical approaches to grammatical description. Practice in the application of such theories to specific linguistic data. Prerequisite: elementary linguistic course or consent of instructor.
5 units, Spr (——) TTh 2:15-4:05

266. Transformational Grammar I — Introduction to the transformational theory of linguistic competence. Practical experience in forming and testing linguistic hypotheses.
4 units, Aut (Traugott) MWF 1:15

267. Transformational Grammar II — Emphasis on recent models of transformational grammar. Role of phonology and semantics in grammar. Prerequisite: 266.
4 units, Win (Traugott) MWF 11

268. Generative Phonology — Discussion of the use of phonological rules to relate abstract morphophonemic representations to phonetic realizations. Study of the phonological component of transformational grammars; redundancy and markedness theory; the relationship of universal phonetics to the description of particular languages. Prerequisite: 266 or consent of instructor.
4 units, Spr (——) MWF

269. Introduction to Special Linguistic Topics — (Same as Anthropology 169.) Topically, 269 is a continuation of 168. Speech surrogates and the history of writing. Introduction to historical linguistics. Selected topics in psycholinguistics, sociolinguistics, and "language-and-culture." Prerequisite: 168 or consent of instructor.
5 units, Win (Diebold) MWF 1:15

299. Independent Study.
One or more units, any quarter (Staff) by arrangement

300. Seminar in Historical Linguistics — Historical linguistics in the perspective of generative grammar; emphasis on syntactic and semantic change in English and in Banhu language-group. Prerequisites: 200 and 266, or consent of the instructor.
3 units, Win (Traugott) given 1971-72

301, 302, 303. Seminar in Structural Linguistics — Lectures, readings, and reports on the principles, methods, and techniques of the structural approach to language.
3 units, Aut (Juilland) by arrangement, given 1971-72

302. The Concept of Word.
3 units, Win (Juilland) by arrangement, given 1971-72

303. Linguistics and Statistics.
3 units, Spr (Juilland) by arrangement, given 1971-72

3 units, Aut (Schank) TTh 1:15-2:45

311. Seminar in Indo-European Linguistics — Each year devoted to a selected language or topic in Comparative Indo-European, e.g., reading of texts in Lithuanian or Classical Armenian, Italic inscriptions, problems in morphology. May be repeated for credit.
3 units, Spr (Devine) by arrangement, alternate years, given 1970-71

315. Seminar on Syntax — Topics in the theory of syntax, including the relationship of syntax and semantics. Material from English and other languages. Prerequisite: 266.
3 units, Spr (Eulenberg) MWF 1:15

321. Linguistics and the Teaching of English — (Same as Education 282.) Implications of linguistics for broader psychological and sociological aspects of the teaching of English. Attention will be paid to teaching English as a foreign language, standard English for dialect speakers, and English as subject matter for native speakers.
3 units, Spr (Wanat) MWF 10

332A,B,C. Beginning Hausa.
5 units, Aut, Win, Spr (Eulenberg) given 1971-72

5 units, Aut, Win, Spr (Eulenberg)

334A,B,C. Beginning Swahili.
5 units, Aut, Win, Spr (Mwaniki)

335A,B,C. Intermediate Swahili.
5 units, Aut, Win, Spr (Mwaniki)

342A,B,C. Beginning Yoruba.
5 units, Aut, Win, Spr (——)
SCHOOL OF HUMANITIES AND SCIENCES

343A,B,C. Advanced Yoruba.
5 units, Aut, Win, Spr (given 1971-72)

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 (——) TWTh 9

368. Semantics—The place of semantics in linguistic theory. Meaning as the basis for linguistic analysis. The history of the analysis of meaning. Current semantic theories. Prerequisite: Some course in linguistic theory or consent of instructor.
4 units, Win (Schank)

369. Seminar in Semantics — A generative approach to semantic theory.
4 units, Spr (Schank)

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 (E. Clark) TWTh 11

4 units, Spr (——) TWTh 9

372. Sociolinguistics — Selected topics on language and society, including language and social stratification, language standardization, language and national development.
4 units, Spr (——) 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, Win (——) TWTh 11

399. Directed Research.
(Staff) 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. Those students whose English proficiency is so limited that they are required to take 47, 48 or 58 should normally expect to follow subsequent courses in the sequence during succeeding quarters. Courses in spoken and written English up to a maximum of 8 units will be offered during summer session. These are open to all regularly enrolled Stanford students. For details, see Summer Session Bulletin. A program in Intensive English and Orientation for Foreign Graduate Engineers and Scientists is also offered in the summer. The latter program is open to qualified graduate students who have been admitted to degree programs at other U.S. institutions as well as to those who have been admitted to Stanford for the following Autumn quarter.

47. Spoken English I — Basic review and practice of grammatical patterns of spoken English with additional assigned practice in language laboratory. Students enrolled in 47 are expected to enroll concurrently in Pronunciation class (50). Prerequisite: consent of instructor.
5 units, Aut (Politzer) MTWThF 9

48. Spoken English II — Intermediate review and practice of grammatical patterns of spoken English with emphasis on comprehension and intelligibility. One additional hour per week required in language laboratory. Prerequisite: consent of instructor.
3 units, Aut, Win (Staff) MWF by arrangement

49. Spoken English III—For students with some facility in spoken English. Emphasis on fluency, idiom and current usage, with the opportunity to make informal oral presentations. Upon recommendation of adviser, course may be repeated for a total of 6 units. Prerequisite: consent of instructor.
2 units, Aut, Win, Spr (Staff) TTh by arrangement

50. Pronunciation—Review and practice of pronunciation patterns of spoken English with special attention to stress, rhythm, and intonation. Prerequisite: consent of instructor.
2 units, Aut, Win, Spr (Staff) 3 hours per week by arrangement

52. Aural Comprehension — Graded exercises in listening to lectures, dialogs, and discussions with evaluation of comprehension. Prerequisite: consent of instructor.
3 units (Staff) by arrangement
58. Written English I—Intermediate work in expository writing with special attention to correct grammatical usage. Prerequisite: consent of instructor.

2 units, Aut, Win (Staff) by arrangement

59. Written English II—For students with some facility in written English. Emphasis on fluency, idiomatic usage, and style. Special attention given to mechanics and form appropriate to academic papers. Upon recommendation of adviser, course may be repeated for a total of 6 units. Prerequisite: consent of instructor.

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

62. Reading Comprehension—Graded exercises in reading English as a foreign language, with class discussion and comprehension tests based on the readings.

3 units (Staff) by arrangement

GENERAL COURSES

ANTHROPOLOGY
167. Language and Culture.
169. Special Linguistic Topics.
260. Languages of the Pacific.
264. Typology and Universals of Language.
266. Seminar: Linguistic Ways to Prehistory.
269. The Languages of Africa.

COMMUNICATION
211. Theory of Communication.

EDUCATION
281. Linguistics for Teachers of Modern Languages.
283. Spanish Linguistics (Same as Spanish 190.)

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 to Romance Linguistics.
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
205. Modern German.
228. Middle High German.

HEARING AND SPEECH SCIENCES
212. Phonetic Theory.
220. Psychology of Speech.
221. Instrumental Phonetics.
223. Speech and Language Development.
230. Physiology of Speech Production.
231. Acoustic Characteristics of Speech.
252. Aphasia.
253. Aphasia in Children.
330. Special Topics in Phonetic Theory.
340. Seminar in Biological Approaches to Language.

ROMANCE LINGUISTICS AND PHILOLOGY
(See French and Italian)

207. Old Italian.
250. Seminar in Romance Linguistics.
304. Etude de style.

PHILOSOPHY
157A. Introduction to Logic.
157B. Intermediate Logic.
181. Philosophy of Language.
183. Logic and Language.
202. Seminar in Theories of Language.

PSYCHOLOGY
146. Language and Thought.
214. Psycholinguistics.
SLAVIC

196. Russian Pronunciation—Problems of theoretical and applied phonology.

197. Russian Lexicology and Phraseology—Introduction to problems of advanced grammar and usage.

201. Synchronic Morphology of Russian Conjugation and Declension.

211. Introduction to Old Church Slavonic and Early Russian Texts.

212. History of the Russian Language.

228. Divergence of Slavic Languages.

SPANISH

190. Spanish Linguistics.

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.

MATHEMATICS

Emeriti: Stefan Bergman, William A. Manning, George Polya, Gabor Szegö (Professors)

Chairman: Ralph Phillips
Vice Chairman: Paul W. Berg


Associate Professor: Mary V. Sunseri. Visiting: Yasutaka Ihara, Neil S. Trudinger

Assistant Professors: Lawrence G. Brown, Gregory Brumfiel, Paul C. Eklof, Kent B. Erickson, Howard E. Gorman, C. Denson Hill, Stephen Scheinberg, Bostwick F. Wyman, Lawrence Zalcman

Instructors: Daniel B. Kotlow, Charles W. Lamb

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, 56). 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) is offered for students who will not need detailed technical knowledge of calculus. Students may change from one series to another only by special arrangement.

Honors sequence Mathematics 52, 53, and 54, 55, 56 is an honors course in calculus. These courses cover the material contained in Mathematics 42, 43, and 44, 45, 46 in a more mathematically systematic way, and explore some of the more interesting consequences of calculus in mathematics and science. Prerequisites: 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: Mathematics (either forms AB or BC) 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 at
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 M. 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, 56). 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. (See “4” below.)

2. Three quarters of Algebra (113, 114, 120); two quarters of Differential Equations (130, 131); two quarters of Fundamental Concepts of Analysis (115, 116) (see description of course 54 below); one quarter of Introduction to Functions of a Complex Variable (106) or of Theory of Functions of a Complex Variable (206A); 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 2.0.

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 52, or Russian 52 or, in the case of students attending Stanford-in-Italy, Italian 23.

5. One of the following:
   a. Physics 51, 53, 55, 57 (total, 15 units).
   b. Any four quarters of Physics lecture courses, chosen from those numbered 51 or above.
   c. A series of courses, within which mathematics is applied in a significant manner. The student choosing this option must have his plan approved by the Undergraduate Affairs Committee of the Department of Mathematics.

**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 Mathematics 198 or 199. Independent work (199) requires 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 work or seminar work 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 Mathematics 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.

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 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**

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 will ordinarily include Mathematics 205A, B, C, 206A, B, C, 210A, B, C. 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 display sufficient breadth in mathematics outside the student's field of specialization. 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 Academic Secretary of the Department.

**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 course numbered 100 or above, and in addition, 1
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, 56 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 twenty 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. (Attention is called to the fact that this course cannot be taken in partial fulfillment of the distribution requirement in Natural Science, Mathematics, and Technology.)

4 units, Aut (——) MTWThF 8, 9, 10 or 2:15
Win (——) MTWThF 10

9. Freshman Mathematics for Advanced Placement Students—This course is recommended for freshmen receiving advanced placement in mathematics. It is designed as a transition between the student’s high school calculus course and his university mathematics courses and should also help him decide whether or not to try for the honors calculus sequence. Topics treated in the course will be chosen from those not encountered in the calculus series, such as introductory modern algebra, number theory and the foundations of mathematics. Although intended primarily for students with advanced placement in mathematics, the course is also open to any freshman having a good background in mathematics and the consent of the instructor. Prerequisites: advanced placement in mathematics or consent of instructor.

3 units, Aut (de Leeuw) MWF 1:15

10. Analytic Geometry and Calculus — Function, tangent to a curve, rate of change, derivatives of polynomials, chain rule, derivatives of products and quotients, implicit functions, higher order derivatives, antiderivatives, areas, fundamental theorem, vectors, scalar product, analytic geometry of the straight line, circle, parabola, ellipse, hyperbola. 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, 9, 10, or 2:15
Win (——) MWF 8, 10, 12, or 2:15


3 units, Win (——) MWF 8, 10, or 2:15
Spr (——) MWF 8, 10, 12, or 2:15
21. Analytic Geometry and Calculus — Continuation of 11: Technique of integration, Simpson's rule, more rigorous treatment of limits, continuity, mean value theorem, existence of the definite integral, fundamental theorem, applied maximum and minimum and rate problems. Prerequisite: 11.

3 units, Aut (McC) MWF 8 or 3:15
Spr (McC) MWF 8, 10, or 2:15

22. Analytic Geometry and Calculus — Continuation of 21: Differentials, parametric representation, arc length, curvature, hydrostatic force, work, center of gravity, moment of inertia, l'Hospital's rule, improper integrals, curves in polar coordinates, tangents, areas, arc length, and curvature in polar coordinates. Prerequisite: 21.

3 units, Aut (McC) MWF 9, 11, or 1:15
Win (McC) MWF 8 or 3:15


3 units, Aut (McC) MWF 12
Win (McC) MWF 9 or 11
Spr (McC) 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 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 (McC) MWF 11

32. Introduction to Mathematics—Continuation of 31.

3 units, Win (McC) MWF 11

33. Introduction to Mathematics—Continuation of 32.

3 units, Spr (McC) 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; (Lamb) MTWThF 10
Win (Ornstein) 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 or 10
Spr (Gilbarg) MTWThF 10

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 co-
ordinates, 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, linear), special second order differential equations, l'Hospital's rule. Prerequisite: 42.

5 units, Aut (Gorman) MTWThF 10
Spr (Sunseri) MTWThF 8;
(Bacon) MTWThF 9 or 10

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 8, 9, 11, or 1:15
Win (———) MWF 12
Spr (———) MWF 9

45. Advanced Calculus II — Vectors and curves in the plane. Functions of two variables, directional derivatives, gradient, line integrals, double integrals. Plane mappings, vector fields, Green's theorem. Prerequisite: 44 or concurrent registration in 44.

3 units, Aut (———) MWF 9
Win (———) MWF 9 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 2:15

52. Honors Calculus—52 and 53 constitute an honors sequence in calculus. The material covered is that of 41, 42, 43, and 44, 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 (Schiffer) MTWThF 9

53. Honors Calculus—Continuation of 52.

5 units, Spr (Schiffer) MTWThF 9

54. Honors Calculus — 54, 55, and 56 constitute an honors sequence in advanced calculus. The material covered is a more general version of 44, 45, 46, 115, 116, and 117. Students majoring in mathematics who complete this sequence may be permitted to substitute six elective units for the requirement of 115, 116. Prerequisites: 53 and 113 (or concurrent registration in 113), and consent of the instructor.

3 units, Aut (Scheinberg) MWF 10

55. Honors Calculus—Continuation of 54.

3 units, Win (Scheinberg) MWF 10

56. Honors Calculus — Continuation of 55.

3 units, Spr (Scheinberg) MWF 10

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

Prerequisites for the courses below may be waived with the consent of the instructor.

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 or 1:15
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, 10, or 1:15
Win (———) MWF 10 or 1:15
Sum (———)

113H. Linear Algebra and Matrix Theory (Honors).

3 units, Aut (Brown) MWF 11

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 elemen-
tary divisors; vector spaces over arbitrary fields; inner products; Hermitian and unitary matrices; multilinear algebra.

3 units, Win (——) MWF 9 or 1:15
Spr (——) MWF 10

114H. Linear Algebra and Matrix Theory (Honors).
3 units, Win (Brown) MWF 11

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. Prerequisite: 45.

3 units, Aut (——) MWF 11 or 2:15
Win (——) MWF 11 or 2:15


3 units, Win (——) MWF 11 or 2:15
Spr (——) MWF 11


3 units, Spr (——) MWF 11

120. Modern Algebra — Integral domains, fields, polynomials, divisibility theory, groups. Prerequisite: 113.

3 units, Win (Brown) MWF 2:15
Spr (——) MWF 1:15

121. Modern Algebra—Continuation of 120.
3 units, Spr (Brown) MWF 2:15

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. Prerequisite: 44.

3 units, Win (Lamb) MWF 11

124. Introduction to Stochastic Processes—The discussion will include types of Markov chains, branching and queuing processes, applications to order statistics, and an introduction to Brownian motion. Prerequisite: 123.

3 units, Spr (Lamb) 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. Prerequisite: 44 or concurrent registration in 44.

3 units, Aut (——) MWF 8, 11, or 2:15
Win (——) MWF 11 or 2:15
Spr (——) MWF 10 or 11

130H. Ordinary Differential Equations (Honors).
3 units, Aut (Kotlow) MWF 11


3 units, Win (——) MWF 8, 11, or 2:15
Spr (——) MWF 10 or 11

131H. Partial Differential Equations (Honors).
3 units, Win (Kotlow) MWF 11


3 units, Spr (——) MWF 8 or 11

134. Difference and Integral Equations —An introduction to the theory of linear functional equations of the difference and integral types, with analytical techniques for their resolution and numerous illustrative examples of historical or technical interest

3 units, Spr (Levine) MWF 1:15

136. Introduction to Computing — (Enroll in Computer Science 106.)
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 1971-72
143A. **Topics in Geometry** — Discussion of the various geometries and the axiom systems which characterize them: the concept of betweenness and the axiom of Pasch; Desargues’s theorem and the introduction of coordinates; consequences of the metric axioms; elliptic, Euclidean, and hyperbolic planes. Prerequisites: 120 and 142, or consent of the instructor.

3 units, Spr, alternate years, given 1971–72

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 (Gorman) MWF 2:15

157. **Non-Euclidean Geometry** — Hyperbolic, elliptic plane geometry, trigonometry.

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 (Scheinberg) MWF 9

160A,B. **Symbolic Logic** — (Enroll in Philosophy 160A,B.) Thorough treatment of validity, provability, consistency, completeness, definability and decision problems for logical calculi, and axiomatic theories.

161. **Introduction to Set Theory** — (Enroll in Philosophy 161.) 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.

162. **Theory of Automata** — (Enroll in Philosophy 162.) An introduction to finite automata. Comparison of different notions of computability. Relationship to programming languages and theories of grammars.

197. **Undergraduate Seminars** — These seminars are intended to supplement the standard curriculum, and especially to provide an opportunity for any student, through active involvement, to share in the excitement of discovery in Mathematics. The seminars will be designed for the average student, rather than the honors mathematics major.

The program will be under the direction of Professor deLeeuw; individual seminars will be conducted by graduate students in the department. A list of seminar offerings each quarter will be available from the academic secretary of the department.

1 to 3 units, Aut, Win, Spr, by arrangement

198. **Honors Seminar** — This seminar will provide an opportunity for the members of the honors program to work together and also for a number of faculty members to become acquainted with the honors majors in a seminar setting. The seminar will be given each quarter, the subject matter depending on the interests of the students and of the faculty member in charge, and may be taken any number of times. The seminar is also open to those who are considering applying for admission to the honors program.

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

199. **Independent Work** — This course provides an opportunity for any undergraduate to pursue a reading program on a topic of his choice under the direction of a faculty member of the Department of Mathematics. Students having a topic they wish to investigate but who need help in finding a faculty member to direct their reading should see Professor deLeeuw.

(Staff) by arrangement

**COURSES INTENDED PRIMARILY FOR GRADUATE STUDENTS**


205A. 3 units, Aut (Osserman) MWF 10

205B. 3 units, Win (Cohen) MWF 10

205C. 3 units, Spr (Cohen) MWF 10

206A,B,C. **Theory of Functions of a Com-
plex 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 (Berg) MWF 11
206B. 3 units, Win (Berg) MWF 11
206C. 3 units, Spr (Berg) 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 (Gorman) MWF 1:15
210B. 3 units, Win (Gorman) MWF 1:15
210C. 3 units, Spr (Gorman) 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. Prerequisite: 130 or equivalent.

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 (Gilbarg) TTh 11:00–12:15
220B. 3 units, Win (Gilbarg) TTh 11:00–12:15
220C. 3 units, Spr (Gilbarg) TTh 11:00–12:15

221A. Calculus of Variations — Euler-Lagrange equations, sufficient conditions; applications to eigenvalue and scattering problems; direct methods, Dirichlet's principle. 3 units, Win (Levine) MWF 1:15


230A,B. 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.

230A. 3 units, Win (Ornstein) MWF 2:15
230B. 3 units, Spr (Ornstein) MWF 2:15

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

253A,B,C. Selected Topics in Analysis.

253A. 3 units, Aut (Katznelson) by arrangement
253B. 3 units, Win (Katznelson) by arrangement
253C. 3 units, Spr (Katznelson) by arrangement

254A,B. Ordinary Differential Equations—Fundamental existence theorems, stability and asymptotic behavior of nonlinear systems, Poincaré-Bendixon 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 1971–72


256A. 3 units, Aut (Finn) TTh 11:00–12:15
256B. 3 units, Win (Finn) TTh 11:00–12:15
256C. 3 units, Spr (Trudinger) TTh 11:00–12:15

259A,B. Scattering Theory — The central theme will be the Lax-Phillips theory of scattering and applications to hyperbolic partial differential equations. The time de-
pendent Kato theory and the Kato-Kuroda stationary theory will also be considered along with applications to the Schrödinger wave equation.

259A. 3 units, Aut (Phillips) TTh 11:00–12:15
259B. 3 units, Win (Phillips) TTh 11:00–12:15


261A. 3 units, Aut (McGregor) MWF 10
261B. 3 units, Win (McGregor) MWF 10
261C. 3 units, Spr (McGregor) MWF 10


263A. 3 units, Win (Samelson) MWF 11
263B. 3 units, Spr (Samelson) MWF 11

277A,B. Mathematical Theory of Relativity—Ricci calculus; variational principles and covariance properties; differential geometry of space-time; Cauchy's problem for the differential equations of gravitation and electromagnetism; relativistic hydrodynamics; unified field theories.

277A. 3 units, Win (Schiffer) MWF 11
277B. 3 units, Spr (Schiffer) MWF 11


281A. 3 units, Aut (Brumfiel) MWF 9
281B. 3 units, Win (Brumfiel) MWF 9
281C. 3 units, Spr (Brumfiel) MWF 9

292A. 3 units, Aut (Feferman)  
TTh 1:15–2:30

292B. 3 units, Win (——) by arrangement

293A, B. Topics in Proof Theory — Selected principally from: Gentzen's theory of formal rules for finite and infinitary languages; analysis of formal proof trees by use of ordinal functions, constructive functionals of higher type. Prerequisite: 290 or equivalent.

Alternate years, given 1971–72

294A, B. Topics in Set Theory — Selected principally from: Forcing and generic sets, Boolean valued models and independence results; mathematical consequences of large cardinal assumptions. Prerequisite: 290 or equivalent.

Alternate years, given 1971–72

295. Advanced Automata Theory—(Enroll in Electrical Engineering 484.)

350. Directed Reading.

Any quarter (Staff) by arrangement

360. Advanced Reading and Research.

Any quarter (Staff) by arrangement


By arrangement

381. Seminar in Analysis.

By arrangement

385. Seminar in Abstract Analysis.

By arrangement

386. Seminar in Geometry and Topology.

By arrangement

387. Seminar in Function Theory.

By arrangement


By arrangement

389. Seminar in Mathematical Biology.

By arrangement

391. Seminar in Foundations of Mathematics.

By arrangement

MILITARY SCIENCE

Chairman: Stanley M. Ramey (Colonel, Armor)

Professor: Stanley M. Ramey (Colonel, Armor)

Assistant Professors: John W. Burberry, Jr. (Major, Artillery), Thomas E. Casey (Captain, Artillery)

Lecturers: Clinton L. Anderson (Captain, Field Artillery) Edward K. Eckt (Lieutenant, Military Intelligence)

GENERAL

The Military Science Department, through the Reserve Officer Training Corps Program (ROTC), affords the opportunity for qualified male students to receive instruction in essential military subjects which, when combined with a baccalaureate degree earned through undergraduate work in fields of their own choice, will qualify them for a Regular Army or a reserve commission in the U.S. Army. The objectives of the Military Science Department are as follows:

1. To prepare the participating student for commissioning in the U.S. Army.

2. To develop in each student the following:
   a) Behavioral patterns of self-discipline, integrity, and a sense of responsibility.
   b) An appreciation of the role of a participating citizen in matters dealing with national security.
   c) The ability to evaluate situations, to make decisions, to understand personal and group behavioral patterns and to practice those attributes considered essential in a leader.

PROGRAMS OF STUDY

The curriculum consists of a two-year basic course and a two-year advanced course which includes a six-week summer camp. In addition to the academic instruction, leadership laboratory is required during each year. This laboratory supplements the academic instruction. It provides opportunity for each student to develop his ability to communicate with and lead effectively a group of his fellow students. The development of personal confidence and an appreciation for the fundamentals of group dynamics, staff and command procedures is engendered.

Extracurricular activities on a voluntary basis are sponsored to broaden cadet interests and to provide opportunity to apply principles of leadership, management, and staff procedures.

Several awards are made each year to those who excel in the program.
Enrollment in ROTC

Enrollment in the ROTC program is 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. 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 (PMS) and his assistants. Interested candidates desiring further information should communicate with the Professor of Military Science.

Advanced Military Science

Students for enrollment in Advanced Course Army ROTC are selected during spring quarter of the sophomore year from among applicants in the second year Basic Course by the Professor of Military Science. Advanced Course students are enlisted in the Army Enlisted Reserve and receive an allowance of $50 per month during the last two years. Prerequisites: successful completion of the Basic Military Science course or for those students entering under the Two-Year Program, the successful completion of a six-week summer camp; and acceptance by the Professor of Military Science.

Two-Year ROTC Program

A limited number of students may enroll in ROTC without having completed the Basic Course.

The two-year Army ROTC students are normally selected 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 camp training session prior to enrollment in the Advanced Military Science program. Two-year Army ROTC students receive an allowance of $50 per month. Applications are accepted by the Professor of Military Science between January 1 and March 1.

Commissioning

Upon successful completion of the entire sequence of required courses in Military Science, together with the University requirements for a baccalaureate degree, Army ROTC students are appointed Second Lieutenants in their selected branch and serve on active duty with the Army as commissioned officers.

Scholarship Programs

Four-Year

The Army Four-Year ROTC scholarship student is chosen in nationwide competition and attends the University under Army sponsorship. In addition to payment for tuition and a book and laboratory fee of $100, the scholarship student draws a subsistence of $50 per month. Application for this must be completed in the senior year of high school.

Three-Year

The Army ROTC Three-Year scholarship student is chosen in regional competition. The PMS selects outstanding applicants in the first year Basic Course and submits recommendations to Regional Army Headquarters for final selections. The Three-Year scholarship student receives complete tuition, a book and laboratory fee of $100, and an allowance of $50 per month for three years.

Two-Year

Army ROTC Two-Year scholarship students are selected from among applicants in the second year Basic Course by the PMS. The Two-Year scholarship student receives complete tuition, a book and laboratory fee of $100 and an allowance of $50 per month for the two years.

One-Year

The Army ROTC One-Year scholarship student is chosen in regional competition. The PMS selects outstanding applicants in the third year Advanced Course and submits recommendation to Regional Army Headquarters for final selection. The One-Year scholarship student receives complete
tuition, a book and laboratory fee of $100, and an allowance of $50 per month.

**Military Science Laboratory**

The study and practice of principles of leadership and staff and command organization and procedures. This laboratory is required during each year. It provides supplemental learning experiences in the area of military group dynamics and leadership.

**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.

**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. Under exceptional circumstances attendance at summer camp may be deferred until after graduation when this deferment is shown to be essential.

**Courses**

*Note*: The question of academic credit for the following courses is under active consideration and may be subject to some change.

**First-Year**

11. World Military History—Study of the forces which historically have produced armed conflict; historical development of basic concepts of war and their application to current national security problems; perspective of the history of warfare. Consult *Time Schedule* for days and hours course is given.

   1 unit, Aut (Anderson)

12. World Military History—Continuation of 11.

   1 unit, Win (Anderson)


   1 unit, Spr (Anderson)

**Second-Year**

21. Foundations of National Power—Study of the capacity of a nation to produce the elements of power; effectiveness of national power in solving international problems with emphasis on the role of military power and national security. Consult *Time Schedule* for days and hours course is given.

   1 unit, Aut (Eckert)


   1 unit, Win (Eckert)


   1 unit, Spr (Eckert)

**Third-Year**

131. Leadership and Management—Study in leadership and management. Delegation of authority and responsibility, span of control, planning, coordinating, and decision-making. Development of the student’s ability to express himself clearly and accurately with emphasis on analysis of military problems, evaluation and preparation and delivery of logical solutions. Analysis of the leader’s role in small unit problems, to include military geography, weapons systems, communication systems and intelligence gathering capabilities. Consult *Time Schedule* for days and hours course is given.

   1 unit, Aut (Burbery)

132. Leadership and Management—Continuation of 131.

   1 unit, Win (Burbery)

133. Leadership and Management—Continuation of 132.

   1 unit, Spr (Burbery)

**Fourth-Year**

141. Seminar in Leadership and Management—Analysis of leadership and manag
ment problems selected from both within and without the military structure with a view to developing principles which are applicable to military leadership and management. Consult Time Schedule for days and hours course is given.

1 unit, Aut (Burberry)

142. Seminar in Leadership and Management—Continuation of 141.

1 unit, Win (Burberry)

143. Seminar in Leadership and Management—Continuation of 142.

1 unit, Spr (Burberry)

199. Command and Staff Procedures—Theory, practice in developing staff studies and military programs. Prerequisites: completion of basic course and consent of PMS.

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

MODERN THOUGHT AND LITERATURE

Committee in Charge: Albert J. Guerard (English), Chairman, Marc Bertrand (French), Margot Drekmeier (History), David Halliburton (English), Herbert Lindenberger (Comparative Literature and English), Robert R. Sears (Psychology), Walter Sokel (German), Irvin Yalom (Psychiatry)

The Committee offers several new interdisciplinary courses open to any qualified student. It also sponsors a program leading to a new degree, the Ph.D. in Modern Thought and Literature. This degree is designed for students intending to teach modern literature in one of the established departments or in interdisciplinary programs. It assumes serious interest in one or more areas of modern thought: history, philosophy, anthropology, linguistics, political and social thought, religious studies, the several arts, contemporary culture generally. The term modern is construed to mean, roughly, from the Enlightenment to the present. Thus a student would specialize in modern English and American (or modern French, German, Russian, etc.) literature from the Enlightenment to the present, and in addition would pursue an individual program of interdisciplinary studies involving part of the same period. He would, that is, acquire an extensive knowledge of the literature in one language for approximately the last two hundred years. But no attempt would necessarily be made to cover aspects of non-literary thought for the full modern period.

In 1970-71 the new degree program will be limited to a few advanced graduate students already at Stanford. Regular admission of a limited number of new students will begin with the autumn quarter of 1971. These will presumably be students intending to teach in English departments or in interdisciplinary programs. In later years arrangements will be made for students specializing in other modern literatures.

PROGRAMS OF STUDY

MASTER OF ARTS

Only candidates for the Ph.D. will be admitted. But students in the Ph.D. program who satisfy the committee of their progress, and who complete satisfactorily 36 units of work, may apply for an A.M. in Modern Thought and Literature.

DOCTOR OF PHILOSOPHY

University regulations regarding this degree are discussed in the section “Degrees” in this bulletin. The following Committee requirements are in addition to the basic ones established by the University.

A candidate for the Ph.D. degree in Modern Thought and Literature must complete three years (nine quarters) of full-time work, or their equivalent, in graduate study beyond the A.B. He will be expected to offer at least 72 units of graduate work in addition to his dissertation. At least three consecutive quarters of graduate work must be taken at Stanford. Normally, students will spend one year of graduate study abroad.

Each student will plan his program with specified advisers. The exact distribution of time, between the literature of specialization and the interdisciplinary work in modern thought and literature, will depend on the nature of the undergraduate preparation. Candidates with an inadequate preparation in earlier literature may be asked to take appropriate courses.

The Committee believes that creative writing or other artistic activity contributes
to the development of the teacher of modern literature. A reasonable amount of creative work (the amount to be approved by each student's advisers) may be counted among the 72 units required.

Normally, the requirements for the Ph.D. in Modern Thought and Literature would be distributed as follows:

1. An introductory seminar, Modern Thought and Literature 361 (4 units).
2. Approximately 36 units of advanced work in "modern" literature of one language, including at least two seminars in the appropriate department.
3. Approximately 32 units of advanced work in a coherent and individually arranged interdisciplinary program, including at least one further seminar. The program may include courses and reading in various areas of modern thought and culture, and individual creative work.
4. Assessment of Progress. A full assessment will be made of progress both in the modern literature of specialization and in the chosen area of interdisciplinary work. This assessment may take the form, at the discretion of the student's advisers, of
   (a) written or oral examinations;
   (b) a series of monographs covering the work done;
   (c) some combination of examinations, monographs, and (for certain areas) public lectures and discussions. The nature of the field precludes any single system or time schedule for assessment. New combinations of subject-matter may involve new methods of assessment.
5. A university oral examination, normally to be taken in the third year of graduate study. Those who spend the third year of study abroad may arrange to take this examination shortly after their return. The examination will normally cover: a) the field of intensive concentration (as defined by the student and his advisory committee) and b) plans for the dissertation.
6. Dissertation. A substantial and original contribution acceptable to the Committee on Modern Thought and Literature. The subject may be drawn from the literature of specialization, from the area of non-literary studies, or from a combination of the two.

Language Requirement — Students specializing in modern English and American literature must demonstrate a reading knowledge of one foreign language comparable to that required by the Department of English and an advanced reading knowledge of one other foreign language. An "advanced" reading knowledge assumes the ability to make a genuine scholarly use of the language; that is, to read prose of ordinary difficulty at sight, or with only occasional recourse to a dictionary.

The language requirements for students specializing in a foreign literature are to be determined by appropriate advisory committees.

At the termination of his work for the degree each student will prepare a detailed statement of the advanced work he has done outside the literature of specialization. This statement, to be approved by the student's advisers, will be certified by the Committee on Modern Thought and Literature.

Courses

The following seminars are open to qualified graduate students from any department and, where space permits, to unusually well-prepared undergraduates. Consent should be obtained in advance from individual instructors.

361. The Modern Tradition—(Same as English 361.) Introduction to the interdisciplinary study of modern thought and literature. No prerequisite. Limited to 15.
   4 units, Aut (Guerard) TTh 4:15-6:05

   4 units, Spr (Sears) TTh 2:15-4:05

   4 units, Win (Yalom) MW 2:15-4:05

364. Structuralism—An examination of contemporary structuralist theory, including such authors as Levi-Strauss, Sebag, Foucault, Derrida, Lacan, Ecol, and Trias. Prerequisite: reading knowledge of French or consent of instructor.
   4 units, Win (Mancall) evenings by arrangement
365. Alienation and Detachment—Two traditions of social philosophy depicting man’s relation to the social and natural world as a problem of estrangement and reification. No prerequisite. Limited enrollment.

4 units, Spr (C. Drekmeier) evenings by arrangement

366. Psychoanalysis and History — The relation of basic psychic mechanisms to social structures; the internalization of cultural contradictions as a factor in social change; conceptions of human nature in modern ideologies. No prerequisite. Limited enrollment.

4 units, Win (M. Drekmeier) evenings by arrangement

367. Literature and Psychology. (Formerly English 385.)

4 units (Guerard) given alternate years

RELATED COURSES

Students of Modern Thought and Literature are referred to the offerings of the several literature departments and of Comparative Literature. A few courses of special interdisciplinary interest are listed below. Consent of the instructor is required for most of these.

ANTHROPOLOGY

121. Cultural Evolution.
143. Anthropological Approaches to Religion.
167. Language and Culture.
245. Advanced Political Anthropology.
255. Psychological Anthropology.
256. Cultural Transmission.

ART

221A. Studies in Modern Painting from 1900–1920.

COMMUNICATION

101. Film Aesthetics.
141. History of Film.


COMPARATIVE LITERATURE

300. Existential and Visionary Literature.

ENGLISH

262. Melville and Marx.
279. Science Fiction.
304A. Modern Anglo-American Criticism.
304B. Modern Continental Criticism.
341D. Literature and Society in the Eighteenth Century.
382. Utopian and Anti-Utopian Literature.
383. The Existential Hero in Modern Literature.
386. Comparative Literature Seminar: The Enlightenment and Its Traditions.

FRENCH

365. La Formation du Siècle des Lumières.

GERMAN

378. Lessing, Wieland und die Aufklärung.
380. Herder und der Sturm und Drang.
400. Seminar: Heideggers Existenzphilosophie und die Literatur.

HISTORY

337. Graduate Colloquium: Modern European Intellectual History.
443. Graduate Seminar: Britain, 1890–1914.

HUMANITIES

305. The Early Modern Period.

LAW

293. Selected Problems in International Law and Organizations.
323. The Legal Systems of Western Europe and Latin America.
LINGUISTICS
301. Seminar: The Structure of Linguistic Theory.
372. Sociolinguistics.

PHILOSOPHY
103. Philosophy in the Nineteenth and Early Twentieth Centuries.
178. Phenomenology and Its Background.
181. Philosophy of Language.
183. Logic and Language.
199. Seminar in Recent Philosophical Literature.

POLITICAL SCIENCE
160 (260). "Modernisms."
186. The Politics of Race.
263A,B,C. Political Theory, Private and Public.

PSYCHOLOGY
121. Social Psychology.
131. Abnormal Personality.
132. Personality.
146. Language and Thought.
172. Psychology of Mental Phenomena.
212. Advanced Social Psychology.
214. Psycholinguistics.

RELIGIOUS STUDIES
(See Humanities Special Programs.)
23 Christian Theology since the Enlightenment.
165. Modern Catholic Theologians.
233. Graduate Research in Nineteenth and Twentieth Century Religious Thought.

SOCIOLOGY
100. Introduction to Sociological Research.
102. Basic Social Institutions.
123. Political Institutions and Behavior.
250. Basic Problems in Sociological Theory.

MUSIC
Emeritus: Putnam C. Aldrich (Professor)
Chairman: William L. Crosten
Associate Professors: Imogene Horsley, George L. Houle
Assistant Professor: John M. Chowning
Senior Lecturers: Arthur P. Barnes (Director of Bands), Marie Gibson (Voice)
Visiting Lecturer: George H. Kyme, University of California (Music Education)
Lecturers: Adolph Baller, Earle Blew, Naomi Sparrow (Piano), Stuart Canin, Kenneth Goldsmith (Violin), Pamela Goldsmith (Viola), Margaret Rowell, Laszlo Varga (Violoncello), Lloyd E. Gowen (Flute), Raymond H. Duste (Oboe), Donald O'Brien (Clarinet), ....... (Bassoon), Charles R. Bubb (Trumpet), Robert Szabo (Trombone), Herman Dorfman (French Horn), Marjorie Chauvel (Harp), Stanley Buetens (Lute), Martha Blackman (Viola da Gamba), Margaret Fabrizio (Harpsichord).

Music Librarian: Edward E. Colby
Director of Men's Glee Club: Robert R. MacKinnon

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 (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 four-part chorale harmonizations as well as playing two prepared pieces on the level of Bartok's Mikrokosmos, Book 3. 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.

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 University Distribution Requirements may be fulfilled so as to permit substantial work in music during the Freshman and Sophomore years. Note the inclusion of foreign language study which is strongly recommended for all music majors and especially for those expecting to continue into graduate work.

RECOMMENDED SCHEDULE FOR FIRST TWO YEARS OF A MUSIC MAJOR PROGRAM

First Year

<table>
<thead>
<tr>
<th>Courses</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
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</thead>
<tbody>
<tr>
<td>English * (two quarters writing)</td>
<td>3</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Foreign Language (through 23)</td>
<td>3-4</td>
<td>3-4</td>
<td>3-4</td>
</tr>
<tr>
<td>Music 11A, B</td>
<td>—</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Music 21*, 22, 23</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Music 100</td>
<td>—</td>
<td>—</td>
<td>5*</td>
</tr>
<tr>
<td>Individual Instruction and/or ensemble</td>
<td>1-4</td>
<td>1-4</td>
<td>1-4</td>
</tr>
</tbody>
</table>

* (English or Music 21 may begin Winter Quarter. If Music 21, 22 are taken in winter and spring quarters of first year, Music 23 should be taken in autumn of second year.)

** (Music 100 may be taken Spring Quarter of second year)

Second Year

<table>
<thead>
<tr>
<th>Courses</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign Language (through 23)</td>
<td>3</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>University Distribution Requirement in Science or Social Science</td>
<td>3-5</td>
<td>3-5</td>
<td>3-5</td>
</tr>
<tr>
<td>Music 101, 102, 103</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Individual Instruction and/or ensemble</td>
<td>1-4</td>
<td>1-4</td>
<td>1-4</td>
</tr>
</tbody>
</table>

During the third and fourth year the music major may continue in his chosen concentration and, at the same time, elect such courses in or out of the department as his interest dictates.

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 65A, B, C. Voice and instrumental classes (3 to 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 arrange to take the Graduate Record Examination, including the Advanced Music sections. Prior to his initial registration, the student should be prepared: (a) to demonstrate proficiency in piano equal to that specified in the A.B. program; and (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.

Teaching assistantships—It is the policy of the Department to appoint each Doctoral candidate to a teaching assistantship for at least one quarter.

MASTER OF ARTS

Residence—A minimum of three quarters of full-time study in residence is required.

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; and (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 including Music 200, 201, ensemble performance (3 quarters), Master of Arts Project (1 or 2 quarters). No more than 6 of these 42 units may be earned in ensemble. Depending on the concentration, the Master of Arts Project will be an investigative essay, a composition, or a demonstration of performance supported by a written commentary. In any case it should be completed during the last quarter of residence.

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 entrance tests, an applicant will be asked to submit evidence of accomplishment in his proposed field of concentration. Applicant 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. At least three of the quarters in residence must be consecutive.

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; and (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—(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; and (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 knowledge of the common musical terms in French, German, and Italian, and, with possible exception at discretion of the adviser for concentrators in music education, a reading knowledge of one of the above languages. Concentrators in conducting and performance practice are further required by the end of their first year of doctoral study to demonstrate reading ability in a second language chosen from the three listed above.

Departmental examinations—(1) An advisory examination to be taken toward the end of the student’s second quarter 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.

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 entrance tests, 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 culminating in 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 second quarter in residence, to determine whether he will be recommended to continue work for the degree; (2) a qualifying examination to be taken prior to enrolling in dissertation work.

COURSES

FOR THE GENERAL STUDENT

Any of the following courses may be used in partial fulfillment of the University’s distribution requirement in the Humanities:

1. Introduction to Music — Musical expression, style, structure explained, illustrated for the listener.
   3 units, any quarter (Staff)

   3 units (Houle)

   3 units (Houle and Salgo)

   3 units (Salgo)

8. New Music — Instrumental, vocal and electronic music since 1950. New forms and performing media in relation to contemporary aesthetics.
   3 units (Chowning)

    3 units (Nanney)

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.
    11A. 3 units, Win (Staff)
    11B. 3 units, Spr (Staff)

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 musical composition. No prerequisite for 21 except ability to read music.

21. 4 units, Aut (Staff)
    Win (Staff)

22. 4 units, Win (Staff)
    Spr (Staff)

23. Tonal Harmony.
    4 units, Aut (Staff)
    Spr (Staff)

100. Music History and Theory (I)—Music in the system of ecclesiastical modes. Prerequisites: 11A,B,C, 21, 22.
    5 units, Spr (Horsley)

    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: consent of instructor.
    3 units, Aut, Win, Spr (Smith)

126. Counterpoint — Prerequisite: 102 or 128.
    3 units (——)

127. Orchestration — Prerequisite: 22 or equivalent.
    3 units (Chowning)

    128. 4 units, Aut (Horsley)
    228A. 4 units, Win (Horsley)
    228B. 4 units, Spr (Horsley)

    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. Prerequisite: experience in musical composition or consent of instructor.
    4 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.

4 units, Win (Chowning)

220C. Music IV Program — Detailed study of an all-Fortran sound-generating and composing program which can be operated at most university computer installations.

4 units, Spr (Chowning)

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)

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 (Horsley, Houle)


4 units (Horsley, Houle)


142A. String Quartets of Beethoven.

4 units (Ratner)

142B. Operas of Mozart.

4 units (Crosten)


4 units (Crosten)

144. Studies in Modern Music — Prerequisite: 103.

144A. Twelve-Tone and Serial Music.

4 units (Smith)

150. History of Musical Instruments.

4 units (Houle)

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)

65A. Stringed Instruments Class—For Credential candidates.

1 unit, Aut, Win, Spr (Kuhn, K. Goldsmith)

65B. Wind Instruments Class—For credential candidates.

1 unit, Aut, Win, Spr (Barnes)

65C. Voice Class—Section 1. For Credential candidates. Section 2. For music majors and non-majors who are members of departmental performing organizations.

1 unit, Aut, Win, Spr (Gibson)

73, 74, 75, 76, 77. Small Group Instruction—A special fee of $25 per quarter is charged for enrollment in any of these groups.

1 unit, Aut, Win, Spr (Staff)

73. Voice Class.

(Staff)

74A. Stringed Instruments Classes.

(Staff)

74B. Viola da Gamba Class.

(Blackman)

74C. Lute and Classical Guitar Class.

(Buetens)

75A. Wind Instruments Classes.

(Staff)

75B. Renaissance Wind Instruments Class.

(Staff)

76. Brass Instruments Classes.

(Staff)

77. Percussion Class.

(Chowning)

172, 173, 174, 175, 176, 177, 272, 273, 274, 275, 276, 277. Individual Vocal and Instrumental Instruction—A special fee of $50 per quarter for majors and $100 for non-majors is charged for enrollment in any of these courses.

3 units, Aut, Win, Spr
172A, 272A. Piano.
   (Blew, Baller, Sparrow)
172B, 272B. Organ.
   (Nanney)
172C, 272C. Harpsichord.
   (Fabrizio)
   (Gibson)
174, 274. Stringed Instruments.
174A, 274A. Violin.
   (Canin, K. Goldsmith)
174B, 274B. Viola.
   (P. Goldsmith)
174C, 274C. Violoncello.
   (Rowell, Varga)
174D, 274D. Contrabass.
   (____)
174E, 274E. Viola da Gamba.
   (Blackman)
   (Buetens)
   (Chauvel)
175, 275. Woodwind Instruments.
175A, 275A. Flute.
   (Gowen)
175B, 275B. Oboe.
   (Duste)
175C, 275C. Bassoon.
   (____)
175D, 275D. Renaissance Wind Instruments.
   (Houle and Staff)
176, 276. Brass Instruments.
176A, 276A. French Horn.
   (Dorfman)
176B, 276B. Trumpet.
   (Babb)
176C, 276C. Trombone.
   (Szabo)
176D, 276D. Tuba.
   (____)
177, 277. Percussion.
   (Chowning)
130. Orchestral Conducting—Prerequisite: 127.
130A. 3 units, Win (Salgo) given 1971–72
130B. 3 units, Spr (Salgo) given 1971–72
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. 4 units, Aut (Schmidt)
231B. 4 units, Win (Schmidt)
251. Choral Repertory (1500–1750).
   4 units, Aut (Schmidt)
252. Choral Repertory (1750 to Present).
   4 units, Aut (Schmidt) given 1971–72
269. Studies in Performance Practice—Performance studied in the light of musical resources, aesthetic attitudes, and theoretical principles of the various historical periods. Lectures, individual research, and practice sessions leading to concert performances. May be repeated for credit.
269A. Renaissance.
   4 units, Aut (Houle)
269B. Baroque.
   4 units, Win (Houle)
269C. Medieval.
   4 units, Spr (Houle)
269D. Modern.
   4 units (Chowning, Smith)
   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 unit, 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 unit, Aut (Barnes) MWF
  4:15-5:30
  1 unit, Win, Spr (Barnes) by arrangement

162. University Chorus.
  1 unit, 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 and special occasions in the Church calendar. Eight members chosen by audition may receive an honorarium for performing duties other than those required of the regular Choir.
  2 units, any quarter (Schmidt) T 4:15-5:30 and Th 7:00-8:30 p.m. and Sunday 10–12

  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 unit, 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

168A. University Wind Ensemble.
  1 unit, Aut, Win, Spr (Barnes)
  MTh 12 and W 7:30

168B. Brass Choir.
  1 unit, Aut, Win, Spr (Barnes)
  T 4:15 and Th 12

171. Chamber Music—Open to any student with sufficient technical ability to play in small combinations for strings, winds, and keyboard instruments.
  1 unit, Aut, Win, Spr (Staff)

271. Performance Special — For students who take part in performances organized in Music 269 or 273 while not enrolled in either of those classes.
  1 unit, Aut, Win, Spr (Staff)

MUSIC EDUCATION

  265A. 3 units, Sum (——) MTWTh 3:15
  265B. 1 unit, Aut (Kyme) T 4:15–6:05
  265C. 1 unit, Win (Kyme) T 4:15–6:05
  265D. 1 unit, Spr (Kyme) T 4:15–6:05

280. Seminar in Music Education.
  4 units, Aut (Kyme)

281. Administration and Supervision of Public School Music.
  4 units, Spr (Kuhn) given 1971–72

GRADUATE RESEARCH AND SPECIAL STUDIES

200. Music Bibliography — Use of bibliographical materials in graduate study; introduction to methods of research.
  3 units, Win (Colby)

201. Master of Arts Seminar in Music History and Analysis.
  4 units, Aut (Staff)

299. Master of Arts Project.
  4 units, any quarter (Staff)

300. Seminar in Musical Notation.
  300A. 4 units, Aut (Horsley)
  300B. 4 units, Win (Horsley)
  300C. 4 units, Spr (Horsley)

301. Seminar in Music History and Analysis.
  301A. 4 units, Aut (Crosten)
  301B. 4 units, Win (Horsley)
  301C. 4 units, Spr (Smith)

302. Research in Musicology.
  Aut, Win, Spr (Crosten, Horsley, Ratner) by arrangement

303. Research in Music Education.
  any quarter (Kyme) 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 (Horsley)
304B. 4 units (Horsley)

321. Readings in Music Theory.
   3 units (Horsley, 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, any quarter (Kyme)

399. D.M.A. Final Project.
   Any quarter (Staff) by arrangement

NAVAL SCIENCE

Chairman: 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)
Assistant Professors: Richard S. Varney (Major, USMC), Jack B. Bowman, Jr. (Lieutenant Commander, USN), Christopher M. Clark (Lieutenant, USN)

OFFERINGS AND FACILITIES

The Naval Science Program 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.

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 cruise normally during their last summer.

All Stanford students are eligible for enrollment in Naval Science courses with the consent of the instructor.

PROGRAMS OF STUDY

ACADEMIC MAJOR

To qualify for commissioning in the U.S. Naval Service, students must satisfy all requirements leading toward a baccalaureate degree. No restriction is placed on the individual's selection of a major other than requiring the Navy scholarship student to pursue a field of study of interest to the Naval Service. Satisfactory programs include, but are not restricted to, Arts, Business, Chemistry, Economics, Education, Engineering, Humanities, Mathematics, Physical Science, and Physics.

SPECIFIED COURSES

Additionally students must satisfactorily complete the following courses offered by other departments of the University.

1. A Mathematics series (one of the below)
   Math 10, 11, 21
   Math 21, 22, 23
   Math 31, 32, 33
   Math 41, 42
   Math 10, 11, and Statistics 50
Statistics 7, 50
Statistics 50H

2. A Science series (one of the below)
Physics 21, 23, 29 including lab
Physics 51, 53, 55 including lab
Chemistry 1, 2, 3
Chemistry 4, 5
General Biology 4, 5
Physical Science 1, 2, 3
An approved Earth Science sequence

3. Computer Science 105 or 106

4. Industrial Engineering 100 or other selected management courses.

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.

111. Principles of Naval Organization and Management—An introduction to the structure and principles of naval organization and management. Naval organization and management practices and the concepts that lie behind them are examined within the context of American social and industrial organization and practice. Introduction to lines of command and control, organization for logistics, service and support, functions and services of major components of the Navy and Marine Corps, and shipboard organization.

2 units, Aut (Bowman) WF 8 or 12; lab. Th 8 or 12

113. Introduction to Naval Ships Systems—Types, structure, and purpose of Naval ships. Ship compartmentation, propulsion systems, auxiliary power systems, interior communications, and ship control are included. Elements of ship design to achieve safe operations, and ship stability characteristics are examined.

3 units, Spr (Bowman) MWF 8 or 12; lab. Th 8 or 12

211. American Military Affairs—An introductory survey of military affairs in the United States from the American Revolution to the present. The transformation from the limited wars of the eighteenth century to the total wars of this century, and the brushfire wars of the last two decades is described using as a framework the American military experience, chronologically arranged.

4 units, Aut, Win (Varney, Ramsdell) MW 9 or 1:15; lab. Th 9 or 1:15

213. National Security Policy—The formulation and implementation of American security policy. American military history is analyzed briefly to determine the factors bearing on the development of the defense structure of the United States. The elements of national power are reviewed.

3 units, Spr (Varney, Ramsdell) MWF 9 or 1:15; lab. Th 9 or 1:15


3 units, Aut (Clark) MWF 10 or 12; lab. Th 10 or 12

311A. Evolution of Warfare—Development of the art of warfare through consideration of historical examples of evolutionary and technical trends in strategy and tactics.

4 units, Aut, Win (Staff) MW 10 or 2:15; Th 10 or 2:15


3 units, Win (Clark) MWF 10 or 12; lab. Th 10 or 12

313. Naval Operations Analysis—Application of elementary operations research and systems analysis methodology to solution of military and military-related problems.

3 units, Spr (Clark) MWF 10 or 12; lab. Th 10 or 12

411. Introduction to Naval Weapons Systems—Discussion of the concept of weapons systems. Introduction to techniques of linear analysis of ballistics and weapons.

3 units, Aut (Miller) MWF 11 or 1:15; lab. Th 11 or 1:15


3 units, Win (Miller) MWF 11 or 1:15; lab. Th 11 or 1:15
413. Survey of Naval Weapons Systems—A descriptive course of naval weapons systems now in use.
3 units, Spr (Miller) MWF 11 or 1:15; lab. Th 11 or 1:15

3 units, Spr (Miller) by arrangement; 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. Sophomores attend a seminar in Sea Power and Maritime Affairs.

PHILOSOPHY

Chairman: David S. Nivison
Director of Graduate Study: Joseph D. Sneed
Director of Undergraduate Study: John D. Goheen


Associate Professors: Harvey Friedman (on leave 1970–71), Joseph D. Sneed

Assistant Professors: Robert Howell, Thomas Schwartz, Michael Tooley, Leonard Waks

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, 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.

Both the graduate students and the undergraduate majors in philosophy have associations for discussion of philosophical issues and reading of papers by students, faculty and visitors. The Hume Society, the graduate philosophical group, takes an active part in the Department’s activities and decisions, and frequently invites visiting speakers to the campus.

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 areas: (1) logic, philosophy of science, philosophy of language; (2) ethics, aesthetics, social philosophy; (3) epistemology, metaphysics; (4) history of philosophy. Majors who do not take senior tutorial will select, in consultation with their Departmental advisers, a program of courses emphasizing one of these major areas of philosophy. 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.

Majors in Philosophy must maintain a
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 Chairman 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 Chairman of each of the departments concerned.

**Honors Program in Humanities**

The Department of Philosophy participates in the Graduate Program in Humanities leading to the joint Ph.D. degree in Philosophy and Humanities. For description of that program, see the section "Humanities Special Programs" in this Bulletin.

**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 required to take, in their senior year or later, the Graduate Record Aptitude Test.

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**

**Proficiency Requirements**

1. Every student is expected to satisfy a proficiency requirement in each of the following areas:
   a) History of Philosophy
   b) Logic and Philosophy of Science
   c) Epistemology and Metaphysics
   d) Value Theory

2. Written preliminary examinations, four hours in duration, will be given in each of these areas during the second week in March. The scope of each examination is described below:
   a) Three sections:
      i) Plato, Aristotle
      ii) Berkeley, Locke, Hume, Descartes
      iii) Spinoza, Leibniz, Kant, some major 19th century philosophers
   Those examined will answer questions on one philosopher from each section.
   b) Three sections:
      i) elementary logic (157A,B level)
      ii) advanced logic
      iii) philosophy of science
   Those examined must answer questions in section i) and in at least one other section.
   c) Four sections:
      i) epistemology
      ii) metaphysics
      iii) philosophy of language
      iv) philosophy of religion
   Those examined must answer questions in at least two sections.
   d) Five sections:
      i) ethics
      ii) social and political philosophy
      iii) aesthetics
      iv) philosophy of law
      v) philosophy of education
   Those examined must answer questions in section i) and at least one other section.

3. Every student must take at least one preliminary examination during his first year of graduate study.

4. Every student must have passed at least two preliminary examinations by the end of his second year of graduate study.

5. Students may satisfy the remainder of the proficiency requirements in any one of the following ways:
   a) passing two additional preliminary examinations before the end of the second year;
   b) passing one additional preliminary examination before the end of the second year and fulfilling the course requirement in the area in which an examination has not been taken (see 7. below for a description of course requirements);
   c) passing one additional preliminary examination before the end of the second year, passing a specialized examination (see 8. below) in some area in which he has previously passed a preliminary examination, and fulfilling the special course requirement in the area in which an examination has not been taken;
   d) fulfilling the course requirement in one of the two areas in which an examination has not been taken, passing a specialized examination in some area in which he has previously passed a preliminary examination, and fulfilling a special course requirement in the remaining area.

6. In addition to these programs a student may substitute a research paper for no more than one preliminary examination (excluding specialized examinations) or course requirement in any of the above options subject to the following conditions:
   a) the student submits a written request for this substitution, including a detailed sketch of the proposed paper, to the faculty committee responsible for the preliminary examination in the relevant area no later than the second week of the autumn quarter of the student’s second year of graduate study;
   b) the faculty committee unanimously approves the request;
   c) the final draft of the paper is submitted to the faculty committee no later than Friday of the second week in March of the student’s second year of graduate study;
   d) the faculty committee passes the paper.

7. Course requirements, general and special, in the areas are as follows:
   a) History of Philosophy
      i) general: four courses from the following: 100–104, 120, 122, 136, 137, 142, 144, 145, 146, 147, 178, 232, 236, 237 (at most one course in the group 100–104, 120, 122 may be included);
      ii) special: two courses from the above list (neither survey courses nor seminar courses may be chosen to satisfy this requirement).
b) Logic and Philosophy of Science  
   i) general: at least one of the following courses: 157A, 157B, 160A, 160B, and three additional courses chosen from the following: 161, 162, 163A, 163B, 164A, 164B, 165, 166, 188, 201, 205, 206, 207, 242A, 242B, 242C. An advanced course in theoretical science or mathematics may be substituted for at most one of these three additional courses, subject to approval by the Director of Graduate Study;  
   ii) special: 157A and 157B.  

   c) Epistemology and Metaphysics  
   i) general: 184 plus three additional courses from the following: 169, 178, 180, 181, 182, 189, 201, 202, 220;  
   ii) special: 184 plus one additional course from the above list.  

d) Value Theory  
   i) general: 170 or 171 plus three additional courses from the following list: 170, 171, 174, 175, 177, 179, 188, 193, 203, 204, 215;  
   ii) special: 170, 171 or 172, plus one additional course from the above list.  

   A grade of B, or better, must be obtained in a course if it is to count toward fulfilling a course requirement. Course requirements need not be completed during the second year of graduate study but must be completed before the student is admitted to candidacy for the Ph.D. Under no circumstances will courses taken at another university count toward fulfilling a course requirement.  

   8. At the request of individual students pursuing a program under 5.c) or 5.d) above, the faculty committee preparing the preliminary examination in a given area will administer a specialized examination in this area during the third week in March. This specialized examination will focus intensively on one or more of the sections of the regular examination and may be tailored to the student's special interests. The examination may be written, oral, or both written and oral, at the discretion of the committee.  

   9. First-year students should inform the department secretary, no later than the first Monday in February, of the preliminary examinations they propose to take during that year. Second-year students should inform the secretary, by this same date of the program (see 5. and 6. above) they have chosen to satisfy the proficiency requirements.  

   10. Normally (to continue as a student in the Department) one is expected to have passed all examination (preliminary and special) and research paper requirements in his chosen program by the end of the second year. Exceptions to this rule are the following:  
   a) Students in interdepartmental degree programs may be permitted to postpone attempting to satisfy these requirements until the third year. Students must submit to the Director of Graduate Study a written request for such permission. In no case will permission be granted to postpone the preliminary examination taken during the first year.  
   b) In special circumstances, determined by the Department, students who attempt and fail to satisfy these requirements by the end of the second year may be allowed an additional year in which to satisfy them.  

   Language Requirements—There is no departmental language requirement, but a student's dissertation committee may require him to demonstrate competence in one or more languages if his dissertation research makes this requirement appropriate.  

   Dissertation—Upon passing the preliminary examinations the candidate will submit a brief written statement of his dissertation plans to the Department, and a committee will be appointed to direct the research for and writing of the dissertation. Departmental approval of the dissertation proposal is required for formal admission to candidacy for the doctoral degree.  

   The dissertation requirement may be fulfilled either by one work of monographic character or by two or more separate articles whose appropriate length, number, and topical and methodological unity or diversity are to be decided in consultation with the dissertation committee.  

   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 reinstate 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 dis-
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 second year.

Courses—All students in these programs are required to take 160A,B (Symbolic Logic), 161 (Introduction to Set Theory), 164A, B (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, value theory, and social philosophy (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 Departmental 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 students must pass the preliminary examination in logic and philosophy of science given to students in the general graduate program (see above).
2. All second-year students must pass a special written examination, four hours in duration, containing three sections, given during the second week in March:
   i) logic
   ii) philosophy of science
   iii) philosophy of language
Questions from at least two sections must be answered.
3. All third-year students must pass an examination in the area in which they propose to write a dissertation. This examination will be tailored to the student’s special interests. It may be written, oral, or a combination of both, at the discretion of the examining committee. This examination will be given no later than the third week in March.
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 an 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

The Department endeavors to provide financial support, when needed, to anyone admitted as a graduate student and maintaining a satisfactory level of graduate work. Fellowships provided by the Locke and Weiss funds are reserved for students in philosophy. Application forms for fellowships may be secured by writing the office of Financial Aids.

The Department of Philosophy no longer offers separate teaching assistantships as part of its support program. Normally each student, whatever his financial status or form of support, will be expected to handle no more than four quarter sections as part of his graduate experience. Ordinarily two of these will be in the second year of study at Stanford and two in the third year. In any term in which he is teaching a section, the student may register for 239, “Teaching Methods in Philosophy.” Members of the Philosophy faculty will provide the student with individual guidance during this teaching experience. Whenever possible, the student’s teaching experience will be in courses he chooses.

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, utilitarian
ism, 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 (Schwartz) MTWTh 1:15 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 will consist of one lecture, plus four sessions a week on computer-based terminals. Enrollment limited to 40 students per quarter.

5 units, Aut (Suppes) Lec T 1:15 plus four hours at terminals
Win (Suppes) Lec T 1:15 plus four hours at terminals
Spr (Suppes) Lec T 1:15 plus four hours at terminals
Sum (———) Lec 11 plus four hours at terminals

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) MTWTh 10 and Th or F section
Spr (Moravcsik) MTWTh 9 and Th or F section
Sum (Moravcsik) MTWThF 9 and Th or F section

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. 4 units, Win (Rhinelander) MWF 10
6B. 4 units, Spr (Rhinelander) MWF 10, given 1971-72


4 units, Aut (Smith) MTWF 9, given 1971-72

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) possible relationships between religion and morality; (4) the relevance of evidence to religious belief; (5) the distinction between theology and philosophy of religion. There will be two separate sections; enrollment in each will be limited to 20.

4 units, Aut (Tooley) T 4:15–6:05 or W 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 (Schwartz) Th 3:15–5:05

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, alternate years, given 1971–72
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, or 6A.

4 units, Aut (Goheen) MTWTh 11


4 units, Win (Goheen) MTWTh 11


4 or 5 units, Spr (Moravcsik) 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. Recommended: 102.

4 or 5 units, Win (Moravcsik) MTWTh 11

104. Contemporary Philosophy — Some principal developments in contemporary philosophical thinking. Prerequisite: a total of two philosophy courses.

4 units, Spr (Goheen) MTWTh 9

106. Introduction to Philosophy — For graduate students. Lectures same as 5.

4 units, Aut (Mothershead) MTWTh 10 and Th or F section
Spr (Moravcsik) MTWTh 9 and Th or F section
Sum (Moravcsik) MTWThF 9 and Th or F section

I. COURSES IN THE PHILOSOPHY OF A PERIOD AND IN INDIVIDUAL PHILOSOPHERS

The following courses will be offered in 1970–71 or 1971–72. Others will be announced in subsequent years or announced from quarter to quarter depending on the interests of students and instructors. Prerequisite: consent of instructor.

136. Philosophy of Plato.

4 units, Win (Moravcsik) MTWTh 10

137. Philosophy of Aristotle — Prerequisite: 100 or equivalent.

4 units, Spr (Moravcsik) MTWTh 10, given 1971–72

142. Seminar in the Philosophy of Descartes — Prerequisite: 102 or equivalent.

3 units, Aut (Howell) T 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, alternate years, given 1971–72

145. Seminar in the Philosophy of David Hume — Prerequisite: 102 or equivalent.

3 units, Win (Howell) T 4:15–6:05, given 1971–72
146. British Empiricism — Epistemology and metaphysics in the principal works of Locke, Berkeley, and Hume.
4 units, Win (Houwell) TTh 2:15–4:05

147. The Philosophy of Kant—A selection of representative problems in Kant’s philosophy is discussed in the light of recent developments.
3 units, Spr (Hintikka) M 4:15–6:05, given 1971–72

III. SYSTEMATIC PHILOSOPHY

Unless otherwise specified the prerequisite for the following courses is one course in philosophy or consent of the instructor.

156. Introduction to Ethics—For graduate students. Lectures same as Philosophy 2. Special section for graduate students.
4 units, Win (Schwartz) MTWTh 1:15 and Th or F section

157A. Introduction to Logic—For graduate students without prior preparation. Four sessions per week on computer-based terminals. Tuesday lecture optional.
5 units, Aut (Suppes) Lec T 1:15 plus four hours at terminals
Win (Suppes) Lec T 1:15 plus four hours at terminals
Spr (Suppes) Lec T 1:15 plus four hours at terminals
Sum (——) Lec 11 plus four hours at terminals

157B. Intermediate Logic—Continuation of 157A: The main purpose of this course is to give the student experience with some elementary mathematical theories, and the proofs of theorems in these theories. The theories selected for study have conceptual importance in various parts of philosophy. Main emphasis will be on the elementary algebra of the real numbers, Boolean algebra, and elementary probability theory. Three sessions at computer-based terminals plus one section meeting.
3 units, Win (Suppes) Th or F section by arrangement
3 units, Spr (Suppes) Th or F section by arrangement

160A. 3 units, Win (——) TTh 11:00–12:15
160B. 3 units, Spr (——) 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, Aut (——) 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 (Suppes) MWF 2:15 and one hour by arrangement

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, Aut (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, Win (——) MW 3:15

164A, B. Philosophy of Science — 164A is an introduction to philosophy of science with emphasis on the foundations of probability. 164B is the continuation of 164A; detailed analysis of the structure and methods of empirical science with emphasis on set-theoretical models, causality, and the testing of theories.
164A. 4 units, Win (Sneed) MWF 2:15 and one hour by arrangement
164B. 4 units, Spr (Suppes) MW 1:15 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 ver-
sus 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, Win (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.

4 units, Spr (Hintikka) MTWTh 3:15, given 1971–72

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

169. Philosophy of Religion: A Critical Survey—An examination of a number of central problems in the philosophy of religion, with emphasis upon their relations to the issue of belief versus unbelief. 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. Fact and Value—A discussion of some of the main problems connected with the nature of values and value judgments, especially as they arise in the twentieth century literature value theory and “meta-ethics.” Specific topics include the Naturalistic Fallacy, non-cognitivism, intrinsic and extrinsic value, the derivability of an “ought” from an “is,” and the nature of ethical disagreement.

4 units, Win (Waks) MTWTh 1:15

171. Moral Obligation—A critical examination of the most prominent theories of moral obligation and a discussion of the problems an adequate theory must solve. Attention will be focused on the relation of duty to interest, the question whether moral obligations are essentially other-regarding, the connection between rectitude and goodness, the question, “Why shouldn’t I be moral?”, and the generalizability of ethical judgments. In the forefront of the entire discussion will be the question, “What does ‘What does moral obligation mean?’ mean?”

4 units, Aut (Schwartz) MTWTh 1:15

172. Psychology of Mental Phenomena—(Enroll in Psychology 172.)

174. Aesthetics—Some central problems in philosophy of art: the nature of a work of art, modern and traditional definitions and theories of art, aesthetic experience, objectivity and non-relativity in criticism, possibility of standards of taste or of evaluation, special topics concerning aesthetic perception and the notion of aesthetic sensibility.

4 units, Aut (Howell) MTWTh 9, given 1971–72

175. Freedom and Authority—An analysis of the grounds on which political authority can be justified and individual liberty justifiably limited. Classic theories of the state will be assessed with an eye toward elucidating the relation between authority and consent, collective and individual interest, power and freedom, liberal and totalitarian democracy, and moral and legal duty. Emphasis will be placed on the ethics of revolution, tyranny and other forms of civil disobedience.

3 units, Win (Schwartz) MWF 11,
given 1971–72

176. Philosophy of Education — (Same as Education 204.)

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) TTh 2:15–4:05


3 units, Sum (Føllesdal) MWF 10

179. Philosophy of Law — The nature and
function of law, the relation of law to ethics, and the judicial process.

3 units, Aut (Rhinelander) MWF 10, given 1971-72

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) MTWF 9, given 1971-72

181. Philosophy of Language—A study of the concepts and techniques required for the syntactic and semantic analysis of natural languages, including elements of formal semantics and transformational grammar. Prerequisites: two courses in philosophy or linguistics.

4 units, Aut (Moravcsik) MTWTh 10

182. Metaphysics—Traditional and current interrelated metaphysical distinctions and concepts: ontological dependence relations and priorities; theories of the nature and function of categories; individuation, space, and time; the universal-particular, abstract-concrete, type-token, substance-attribute, and other distinctions; boundaries between science and metaphysics.

4 units, Win (Howell) MTWTh 10

183. Logic and Language—A discussion of some of the main problems in the logical analysis of language—problems bordering on logic, the philosophy of language and ontology and often discussed under rubrics like "philosophy of logic" and "philosophical logic." Sample topics: (1) Singular terms and definite descriptions; (2) Ontic commitment; (3) Intentionality, with special emphasis on referential opacity and quantification into intensional contexts; (4) The logical form of statements involving adverbs and attributes; (5) Time and tense; (6) The logical form of statements with non-designating accusatives; (7) Abstract reference and the abstract/concrete distinction. Attention will also be given to the nature of logical form, to the rationale behind the logical analysis of language, and to the criteria for successful analyses. Prerequisite: 3 or 157A.

3 units, Spr (Schwartz) TTh 11:00-12:15

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—A discussion of the concepts of action and behavior; belief, desire, sensation, and perception; and of the logical relations in which concepts of the former group may stand to those of the latter group.

4 units, Spr (Howell) MTWTh 11


4 units, any quarter (Tooley) by arrangement

193. Formal Aspects of Social Decision Making — The following topics to be discussed: relation between individual values and social policy; criticism 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 consent of the instructor.

3 units, Spr (Schwartz) MW 11:00-12:15

196. Tutorial—Senior year.

5 units, any quarter (Staff) by arrangement

197. Individual Work for Undergraduates.

Any quarter (Staff) by arrangement

199. Seminar in Recent Philosophical Literature—Open to junior and senior students with consent of instructor.

Topic: Aesthetics—Topics to be considered include representation and expression, varieties of nonliteral language, symbolism, appreciation, and the concept of taste.

3 units, Aut (Howell) W 4:15-6:05

Topic: To be announced.

3 units, Win (______)

Topic: Philosophy of Religion.

3 units, Spr (Tooley) T 4:15-6:05

COURSES INTENDED PRIMARILY FOR GRADUATE STUDENTS

201. Mathematical Linguistics — The relationship between various types of automata
and grammars will be developed in some detail. Construction of categorical grammars as well as phrase-structure grammars. Introduction to probabilistic grammars. Discussion of semantics of natural languages. Recommended: 162 but not required.

3 units, Win (Suppes) MW 1:15


3 units, Win (Moravcsik) M 4:15–6:05

203. Seminar in Ethical Theory—Analyses of texts by Moore, Ross, Stevenson, Hare, Dewey, and a selection of recent papers in ethical theory will serve as the basis for discussion. One term paper or several short papers. Prerequisite: 2 or consent of the instructor.

3 units, Spr (Mothershead) T 2:15–4:05

204. Seminar in Moral and Political Obligation—A “formal models” approach to explicating the grounds of moral and political obligation.

3 units, Win (Schwartz) Th 4:15–6:05

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 multi-valued logic. Various axiomatic formulations of classical quantum mechanics will also be discussed.

3 units, Spr (Sneed) MW 3:15

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, given 1971–72

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, given 1971–72

210A,B,C. Seminar in the Mathematical Models of Learning and Instruction—(Same as Education 483.)

210A. 1 to 3 units, Aut (Suppes) T 4:15–6:05

210B. 1 to 3 units, Win (Suppes) T 4:15–6:05

210C. 1 to 3 units, Spr (Suppes) T 4:15–6:05

215. Philosophy, Education and Society—(Same as Education 405.)

4 units, Win (Waks), given 1971–72

220. Epistemology—A survey of the central problems of epistemology emphasizing the uses of modern techniques in clarifying classical epistemological issues.

4 units, Win (Hintikka) MTWTh 3:15, given in 1971–72


3 units, Spr (Howell) T 2:15–4:05

236. Seminar in the Philosophy of Plato—A study of metaphysical and epistemological themes in the later Platonic dialogues.

3 units, Spr (Goheen) M 4:15–6:05

237. Seminar in the Philosophy of Aristotle —A study of some of Aristotle’s metaphysical writings.

3 units, Aut (Moravcsik) T 4:15–6:05

239. Teaching Methods in Philosophy.

1 to 3 units, any quarter (Staff) by arrangement

240. Individual Work for Graduates.

Any quarter (Staff) by arrangement

241A,B,C. Seminar in the Philosophy of Language—This is a continuing seminar that is organized to cover the most important contemporary literature in the philosophy of language. It is understood that students involved will play an important role in organizing the work of the seminar.

1 to 6 units, Aut (Moravcsik, Suppes) W 4:15–6:05

1 to 6 units, Win (Moravcsik, Suppes) W 4:15–6:05
1 to 6 units, Spr (Moravcsik, Suppes) W 4:15–6:05

242A,B,C. Seminar in the Philosophy of Science.

242A. 3 units, Aut (——) T 4:15–6:05
242B. 3 units, Win (——) T 4:15–6:05
242C. 3 units, Spr (——) M 4:15–6:05

243A. Berkeley-Stanford Seminar in the Philosophy of Science — This seminar meets every two weeks alternating between Berkeley and Stanford. The tentative subject for the autumn quarter is, “The Philosophical Foundations of Quantum Mechanics.” More specific information about the organization and topics of the seminar will be available in late summer, together with a reading list.

1 to 3 units, Aut (Suppes) M 4:15–6:05

244. Seminar in Metaphysics.

3 units, Win (Howell) T 4:15–6:05

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) M 4:15–6:05


Any quarter (Staff) by arrangement

290A,B,C. Mathematical Logic—(Enroll in Mathematics 290A,B,C.)

291A,B. Topics in Model Theory—(Enroll in Mathematics 291A,B.)

292A,B. Topics in Recursion Theory—(Enroll in Mathematics 292A,B.)

293A,B. Topics in Proof Theory—(Enroll in Mathematics 293A,B.) Alternate years, given 1971–72

294A,B. Topics in Set Theory — (Enroll in Mathematics 294A,B.) Alternate years, given 1971–72

295. Advanced Automata Theory—(Enroll in Electrical Engineering 484.)

299. Advanced Seminar in Recent Philosophical Literature.

Topic: The Abstract and the Concrete.
3 units, Aut (Schwartz) Th 4:15–6:05

Topic: Referential Opacity.
3 units, Spr (Moravcsik) M 4:15–6:05

Topic: Philosophy of Language.
3 units, Sum (Follesdal) M 3:15–5:05


391A. Aut (——) T 4:15–6:05, units by arrangement
391B. Win (——) T 4:15–6:05, units by arrangement
391C. Spr (Feferman) 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. Compston, 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.

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. 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, laboratory work in astronomy, chemistry, physics, geology, to give a concept of the general field 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 (Ripley) TTh 8; lab. by arrangement
3. 3 units, Spr (Ripley) TTh 8; lab. by arrangement

5, 6, 7. Physical Science — Survey of physical sciences as an expanding field of knowledge. Similar to 1, 2, 3, but no laboratory work and no Geology. Lectures emphasize history and philosophy 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

150. Philosophical Problems in the Physical Sciences — Current issues and problems in the philosophy of science in the context of modern scientific and mathematical developments. Topics to be discussed will include: the meaning and verification of scientific theories and models; the nature, function, and interpretation of postulate systems; the role of explanation and prediction; problems of "causation," "probability," and "reality" in the light of quantum physics and relativity theory. Emphasis and selection of topics will be determined on the basis of student background and interest. Prerequisites: restricted to a maximum of 20 students of junior or senior standing, who have completed a minimum of 6 credit hours in a course in one of the physical sciences (chemistry, physics, geology, etc.) on the university level, and who have completed the equivalent of college algebra. Exceptions only with the consent of the instructor.

3 units, Spr (Ripley) TTh 11:00–12:15


Any quarter (Staff)

**PHYSICS**

Emeriti: Paul H. Kirkpatrick, David L. Webster (Professors)

Chairman: Walter E. Meyerhof


Assistant Professors: William A. Bardeen, Jerome L. Finkelstein, John J. Schwartz
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. The facilities include several accelerators up to 1.2 Bev in size. Separated from this group is the Stanford Linear Accelerator Center (SLAC), a separate very high-energy physics laboratory which has as its principal tool a two-mile-long 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, 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 Department, Biophysics Program, 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, 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 Department and in the Biophysics Program. The number of graduate students admitted to the Physics Department is strictly limited. Students should complete application by January 15, 1971, 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. The Department strongly advises the study of Chemistry 4 and 5 and also the study of a modern language.

The mean grade for all courses taken in physics 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 and permission of the Physics Department Undergraduate Study Committee.

A second advanced sequence, Physics 59 and 60, is available to students with at least a year of high school physics and some calculus. Incoming students should apply directly to the Department before entering Stanford for permission to take 59 and 60. For these students the first year would be Physics 59, 60 and 61.

Sample programs in physics and mathe-
mathematics under the two sequences are shown below. Students should consult their advisers about the course distribution requirements in other areas. The sequence of courses during the first two years is relatively inflexible, but considerable freedom exists during the upper-class years. 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†**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 51-53</td>
<td>Mechanics, Electricity</td>
</tr>
<tr>
<td>Physics 54</td>
<td>Electricity Laboratory</td>
</tr>
<tr>
<td>Math. 41, 42, 43</td>
<td>Analytic Geometry and Calculus</td>
</tr>
</tbody>
</table>

**Second Year†**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 55, 57, 61</td>
<td>Light and Heat, Atomic Physics, Optics and Wave Motion</td>
</tr>
<tr>
<td>Physics 56, 58</td>
<td>Light and Heat, and Atomic Physics Laboratory</td>
</tr>
<tr>
<td>Physics 110, 111</td>
<td>Intermediate Mechanics</td>
</tr>
<tr>
<td>Math. 44, 45, 46</td>
<td>Advanced Calculus</td>
</tr>
<tr>
<td>Math. 130, 131, 132</td>
<td>Ordinary Differential Equations, Partial Differential Equations</td>
</tr>
</tbody>
</table>

**Third Year†**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 105, 100</td>
<td>Introductory Electronics, Intermediate Physics Laboratory</td>
</tr>
<tr>
<td>Physics 120, 121, 122</td>
<td>Intermediate Electricity and Magnetism</td>
</tr>
<tr>
<td>Physics 130, 131, 132</td>
<td>Atomic and Nuclear Structure</td>
</tr>
<tr>
<td>Math. 113, 114 or 120</td>
<td>Linear Algebra and Matrix Theory, or Modern Algebra</td>
</tr>
</tbody>
</table>

* Not required for degree in physics.
† Additional elective units must be added to bring the total number of units to 180 as required by the University. Students should consult their advisers about the course distribution requirements in areas outside of the sciences.

**Fourth Year†**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 170, 171, 172</td>
<td>Thermodynamics, Kinetic Theory and Introduction to Statistical Mechanics, Physics of Solids</td>
</tr>
<tr>
<td>Physics 200, 201, 202</td>
<td>Advanced Physics Laboratory</td>
</tr>
<tr>
<td>Physics 210, 211, 212</td>
<td>Introductory Theoretical Physics</td>
</tr>
<tr>
<td>Math. 106</td>
<td>Complex Variable</td>
</tr>
</tbody>
</table>

**ACCELERATED SEQUENCE**

**First Year†**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 51, 53</td>
<td>Mechanics, Electricity</td>
</tr>
<tr>
<td>Physics 54</td>
<td>Electricity Laboratory</td>
</tr>
<tr>
<td>Math. 43, 44</td>
<td>Analytic Geometry, Calculus, and Advanced Calculus</td>
</tr>
</tbody>
</table>

**Second Year†**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 55, 57, 61</td>
<td>Light and Heat, Atomic Physics, Optics and Wave Motion</td>
</tr>
<tr>
<td>Physics 100, 101, 105</td>
<td>Introductory Electronics, Intermediate Physics Laboratory</td>
</tr>
<tr>
<td>Physics 120, 121, 122</td>
<td>Intermediate Electricity and Magnetism</td>
</tr>
<tr>
<td>Math. 45, 46</td>
<td>Advanced Calculus</td>
</tr>
<tr>
<td>Math. 130, 131, 132</td>
<td>Ordinary Differential Equations, Partial Differential Equations</td>
</tr>
</tbody>
</table>

**Third Year†**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 130, 131, 132</td>
<td>Atomic and Nuclear Structure</td>
</tr>
<tr>
<td>Physics 170, 171, 172</td>
<td>Thermodynamics, Kinetic Theory and Introduction to Statistical Mechanics, Physics of Solids</td>
</tr>
<tr>
<td>Physics 210, 211, 212</td>
<td>Introductory Theoretical Physics</td>
</tr>
<tr>
<td>Math. 113, 114, or 120</td>
<td>Linear Algebra and Matrix Theory or Modern Algebra</td>
</tr>
</tbody>
</table>

**Fourth Year†**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 200, 201, 202</td>
<td>Advanced Physics Laboratory</td>
</tr>
<tr>
<td>Physics 220, 221, 222</td>
<td>Classical Electrodynamics</td>
</tr>
<tr>
<td>Physics 230, 231, 232</td>
<td>Quantum Mechanics</td>
</tr>
<tr>
<td>Math. 106</td>
<td>Complex Variable</td>
</tr>
</tbody>
</table>

* Not required for degree in physics.
† Additional elective units must be added to bring the total number of units to 180 as required by the University. Students should consult their advisers about the course distribution requirements in areas outside of the sciences.
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, 172, 202, 210, 211, and, if no thesis is submitted, at least 9 additional units of course work above the 200 level (not including 290, 389, or 390).

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, one quarter of Advanced Laboratory (202, 203), 210, 211, 220, 221, 222, 230, 231, 232, 260, 261, 262, 270, 330, and at least two quarters of any of the following courses: 240, 241, 250, 251, 331, 332, 334, 370, 371. 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. After completion of the thesis he must take the University oral examination (defense of thesis). The Physics faculty believes that it is valuable for a scientist to have facility with a foreign language for cultural reasons and in order to establish better contact at meetings in foreign countries.

The Physics Department does not require a minor, but students are advised that the following mathematics courses have been found useful for graduate study in physics, especially for theoretical work: 206, 210, 220, 254, 256.

All prospective Ph.D. candidates in physics, regardless of their source of financial support, will be expected to gain teaching experience as an integral part of their graduate training.

The student interested in applied physics and biophysics research should also be aware of the Ph.D. granted independently by the Applied Physics Department and by the Biophysics Program. See elsewhere in this bulletin.

Minors in physics must take either Physics 210, 211, and one other course above 100, 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 and research. Applications for fellowships, scholarships, and assistantships are made to the Financial Aids Office; they must be completed by January 15, 1971.

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, 58) 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: undergraduate courses (1), first- and second-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), high energy physics (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 Department and the Biophysics Program.

10. Special Topics in Physics — This course proposes to familiarize the general student with the methodology of physics. At the option of the instructor, either general principles of physics or one particular area of physics will be discussed. In 1970-71 the latter format will be chosen, the subject being The Development of Nuclear Physics. Starting with a historical review of the concept of an atom, the discovery of X-rays, of radioactivity, and of the neutron will be considered. A general discussion of nuclear structure and nuclear reactions leads into a review of stellar processes, fission and applications of nuclear physics. The relevance of nuclear physics in modern society will be emphasized. The course is open only to students not majoring in the physical sciences or engineering. No prerequisites, but junior or senior standing is advised. One term paper will be required.

2 units, Win (Meyerhof) M 2:15-4:05

19. An Introduction to Physics — A presentation from non-technical, non-mathematical viewpoints of the aims, methods (experimental and theoretical) and achievements in the attempts to understand the basic principles governing the physical world. Each topic is usually introduced through the historical background, but the emphasis is on present knowledge and current problems. The choice of subject matter and the style and depth of presentation are strongly determined by the interests and preparation of the students. Likely topics: molecules, atoms, nuclei, elementary particles, radiation, relativity, electricity, gravitation. No prerequisites.

3 units, Sum (——) tentative


4 units, Aut (Hofstadter) 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 (Little) lec. and lab.

29. Modern Physics — Basis of modern atomic theory, structure and properties of atoms, the nucleus, radioactivity. Prerequisite: 23.

4 units, Spr (Fairbank) 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 continua-
tion in Mathematics 42, or consent of instructor.
4 units, Win (Schwettman) lec. and discussions

53. Electricity — Electric charges and currents, magnetism, induced currents, electric oscillations, electromagnetic waves. Prerequisites: 51 and Mathematics 42 or 21, or consent of instructor.
4 units, Spr (Meyerhof) lec.; (—) discussions

54. Electricity Laboratory — Concurrent registration in 53 is required.
1 unit, Spr (—)

55. Light and Heat — Reflection and refraction of light, lens systems; light and electromagnetic waves; temperature, properties of matter, introduction to kinetic theory of matter. Prerequisites: 53 and Mathematics 43 or 23, or consent of instructor.
4 units, Aut (Ritson) lec.; (—) discussions

56. Light and Heat Laboratory—Concurrent registration in 55 is required.
1 unit, Aut (—)

57. Atomic Physics — Experimental basis of quantum theory; atoms, atomic structure, X-rays, nuclei, radioactivity. Prerequisite: 55.
3 units, Win (J. Schwartz) TTh 11:00-12:15
3 units, Sum (—) tentative

58. Atomic Physics Laboratory — Concurrent or prior registration in 57 is required.
1 unit, Win (Yearian)

59. 60. Advanced Freshman Physics—This course deals mainly with the subjects of mechanics and electricity at the level of the Berkeley physics course (McGraw-Hill, 1968) and the Feynman Lectures in Physics (Addison-Wesley, 1963 and 1964). A considerable amount of outside reading and homework will be required. A discussion period or fourth lecture may be added to the regular lectures, as needed. Students who complete the two quarters of the course will be excused from the entire Physics Fifty Series and can take Physics 61 in the spring quarter. Prerequisites: advanced placement in mathematics and in the Physics Fifty Series. Concurrent registration in Mathematics 43. Consent of the instructor required.
59. 4 units, Aut (Yearian) MWF 10 and one hour by arrangement
60. 4 units, Win (Yearian) MWF 10 and one hour by arrangement

61. Optics and Wave Motion — Theory of wave motions from point of view of Huygens’ principle, superposition; interference, diffraction phenomena. Prerequisites: 55 or 60 or admission to Accelerated Sequence, Mathematics 42, and concurrent or prior registration in 43 or 59 and 60.
3 units, Spr (—) 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 (—) by arrangement
101. 2 units, Spr (—) by arrangement

105. Introductory Electronics — Practical electronics for the research physicist with the emphasis on circuits, covering both vacuum tubes and transistors as black-box elements. 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. Recommended: concurrent or prior registration in 120.
3 units, Aut (—) TTh 2:15-3:30

110, 111. Intermediate Mechanics—Matrices, vector, gradient; Newton's law, particle motion; conservation theorems, collisions; special relativity; gravity, potential; harmonic motion, Hamilton's principle, Lagrange's equations, central forces, non-inertial reference systems; rigid body dynamics, inertia tensor. Prerequisites: 51 and Mathematics 130.
110. 3 units, Win (—) MWF 11
111. 3 units, Spr (—) MWF 11

120, 121, 122. Intermediate Electricity and Magnetism — Vector analysis, electrostatic
fields, including multipole expansion; dielectrics, static magnetic induction, magnetic materials, Maxwell's equations. Application of Maxwell's equations to plane-wave problems (free space, wave guides, dielectric boundaries), dipole and quadrupole radiation; special relativity and transformations between electric and magnetic fields. Prerequisites: 53 and prior or concurrent registration in 110. Concurrent or prior registration in Mathematics 130 and 131 with Physics 120 and 121, respectively, is required.

120. 3 units, Aut (M. Schwartz) MWF 10
121. 3 units, Win (M. Schwartz) MWF 10
122. 3 units, Spr (M. Schwartz) MWF 10

130, 131. Atomic Structure—Origin of quantum theory, Bohr theory of H atom, including elliptic orbits, Schrödinger equation, one electron atom. First order perturbation theory (time independent and time dependent), magnetic moment and spin, Helium atom, many-electron atom, molecular spectra, X-ray spectra. Prerequisites: 57 or admission to Accelerated Sequence, 61, and 111. Concurrent or prior registration in 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


3 units, Spr (Wojcicki) MWF 11

170. Thermodynamics—Derivation of laws of thermodynamics from basic postulates. Temperature, equations of state, heat, internal energy, entropy, reversibility, applications to various properties of matter, absolute zero and low temperature phenomena. Prerequisites: 55 or admission to Accelerated Sequence and Mathematics 130.

3 units, Aut (——) TTh 11:00-12:15


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. Applications to semiconductors, retification, superconductors, para- and ferromagnetism, magnetic resonance. Prerequisites: 171, or 57 and Electrical Engineering 328A.

3 units, Spr (——) 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

191. Senior Seminar — Special topics in physics of interest to senior students.

1 unit, offered occasionally (Staff)

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 (——) by arrangement
202. 3 units, Aut, Win, Spr (——) by arrangement
203. 3 units, Aut, Win, Spr (——) by arrangement

210. Advanced Mechanics — Elementary principles of mechanics (D'Alembert's principle, Lagrange's equations), variational principles, two-body central force problem,
rigid body kinematics and dynamics, Hamilton's equations, canonical transformations, Hamilton-Jacobi theory. Prerequisites: 111 and Mathematics 131.

3 units, Aut (——) MWF 10


3 units, Win (——) MWF 10

220, 221, 222. Classical Electrodynamics — Electrostatics (multipole expansion, Helmholtz's theorem), Maxwell's equations (scalar and vector potential), static electrical and magnetic properties of matter, wave equation. Lienard-Wiechert potential, virtual photons, covariant formulation of Maxwell's equations, relativistic electrodynamics (stress, energy, momentum, angular momentum tensors). Radiation theory (multipole fields), dynamic properties of materials, dispersion relations. Special topics, such as magnetohydrodynamics and plasma physics. Prerequisites: 122 or the equivalent, Mathematics 106 and 132, or concurrent registration in Physics 210 and 211.

220. 3 units, Aut (——) MWF 9
221. 3 units, Win (——) MWF 9
222. 3 units, Spr (——) MWF 9

300, 321, 322. Quantum Mechanics — The first quarter develops the Schrödinger equation: the formalism of state vectors is employed. The eigenvalues and eigenfunctions are found for simple systems such as the harmonic oscillator and the hydrogen atom. The properties of angular momentum are presented from a group theoretical point of view. In the second quarter variational techniques and perturbation theory are introduced to treat the more complicated systems of many-electron atoms and molecules. The interaction of such systems with radiation is also analyzed using time-dependent perturbation theory. The third quarter deals with scattering theory. The concepts of the scattering matrix, phase shifts, complex potentials, and dispersion relations are developed. The technique of second quantization is also introduced. Prerequisites: 132 and 211 and Mathematics 106 and 132, and preferably Physics 222.

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, 241. Nuclear Physics — Nuclear force; properties of nuclei; nuclear models. Interaction of nuclear radiations with matter; alpha, beta and gamma decays; nuclear reactions. Prerequisite: 132 and 231, or equivalent.

240. 3 units, Aut (Hanna) MWF 11
241. 3 units, Win (Hanna) MWF 11

250, 251. High Energy Physics—Transition probabilities; relativistic treatment of kinematics, spin, phase space; particles and conservation laws (parity, isospin, hypercharge, etc.); quantum numbers of the baryons and mesons; scattering of strongly interacting particles. Unitary symmetry, weak interactions (muon decay and properties), Regge poles, dispersion relations, nuclear-nucleon interactions. Prerequisites: 240 and 330; concurrent registration in 331, 332 is recommended.

250. 3 units, Win (Hofstadter) MWF 10
251. 3 units, Spr (——) MWF 10

260, 261, 262. Research Activities at Stanford—Review of research activities in the Department of Physics at a level suitable for entering graduate students. Each research group will give a presentation of its work for approximately one-half quarter. The research groups have been divided as follows: Nuclear physics, High energy and elementary particle physics, Elementary particle physics, Low temperature physics, Quantum electronics, Theoretical physics.

260. 3 units, Aut (Hanna, Meyerhof, Hofstadter, Yearian, and others) MWF 1:15
261. 3 units, Win (Fairbank, Little, Ritson, M. Schwartz, Schwettman, Wojcicki, and others) MWF 1:15
262. 3 units, Spr (Bloch, Schiff, Walecka, and others) MWF 1:15

270. Statistical Mechanics—Liouville theorem, Canonical Distribution, Thermodynamic Functions, Specific Heat, Magnetism, Quantum Statistics, Einstein-Bose and Fermi-Dirac distribution. Prerequisite: 171. Con-
current or prior enrollment in 232 and Mathematics 106 is required.

3 units, Spr (Bloch) MWF 10

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 consent of instructor.

Any quarter (Staff) by arrangement

330, 331, 332. Advanced Quantum Mechanics—Review of quantum mechanics and relativity, relativistic single particle equations (Klein-Gordon and Dirac), second quantization, canonical field theory, relativistic scattering theory. Quantum electrodynamics: applications, radiative corrections, renormalization theory, the Lamb shift. Symmetry principles, phenomenological field theories, special topics in field theory. Prerequisites: 222 and 232.

330. 3 units, Aut (Bardeen) TTh 9–11
331. 3 units, Win (Bardeen) TTh 9–11
332. 3 units, Spr (Bardeen) TTh 9–11


3 units, Win (Schawlow) MWF 11, alternate years, given 1971–72

336. Advanced Topics in Theoretical Physics—Discussion of selected topics of current interest in theoretical physics. Prerequisite: 330.

3 units, Spr (——) by arrangement


3 units, Aut (Walecka) MWF 9

341, 342. Nuclear and Elementary Particle Theory—Nuclear matter, theory of angular momentum, group theory and nuclear spectroscopy. Nuclear models. Weak interactions, nuclear reactions, and special topics in elementary particle theory. Prerequisites: 222, 241, 251, 340, concurrent or prior registration in 331, 332 is recommended.

341. 3 units, Win (Walecka) alternate years, given 1971–72
342. 3 units, Spr (Walecka) alternate years, given 1971–72


370. 3 units, Win (——) TTh 1:15–3:05, alternate years, given 1970–71
371. 3 units, Spr (——) TTh 1:15–3:05, alternate years, given 1970–71

389. Research Orientation—The purpose of this course is to allow students to become familiar with the activities of one or more research groups, within the Department or outside. Registration is limited to one quarter per research group with an overall limitation of two quarters. Consent of the student's adviser is required for registration.

Any quarter (Staff) by arrangement

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)

Chairman: Heinz Eulau

Professors: Gabriel A. Almond, Frank Bonilla, Richard A. Brody (on leave 1970–71),

Associate Professor: Yosal Rogat

Lecturers: Robert M. Rosenzweig, Eric Voegelin

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) An advanced course or seminar (numbered 100 or above) in at least three of the following fields: public administration, comparative politics, international relations, political theory, American politics, public law.
   b) At least one seminar, which may be counted toward fulfillment of a), above.

(No more than ten units of directed reading may be counted as credit toward the major, except in cases where such units were taken before spring quarter 1969.)

HONORS PROGRAM IN POLITICAL SCIENCE

The Honors Program provides well qualified students with an opportunity to write a thesis on a subject of individual interest, for which up to 15 units of credit will be given in the honors candidate’s senior year.

Application for admission to the Honors Program should be made in the Spring quarter of the junior year. Applicants must have at least a 3.0 grade point average in all University work and at least a 3.3 average in political science courses; and must have secured the agreement of a regular faculty member to be their thesis adviser. Students admitted to the program will be so advised before the end of Spring quarter.

Graduation with Honors in Political Science will require: 1) completion of all requirements for a major in political science; 2) at least a 3.0 average in all University work; 3) at least a 3.3 average in political science; 4) 55 units of political science, including up to 15 units of Political Science 199 (honors thesis); 5) submission of an acceptable honors thesis. Students who successfully complete the program will graduate “with Honors in Political Science.” Interested students should consult the adviser of the Honors Program in their Junior 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. The normal quota of students to be admitted is filled from those who have completed their applications by January 15. Only in the most exceptional circumstances will students applying after that date be admitted. Applications completed after June 1 will not be considered. 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.

Graduate applicants over the age of 40 will not be considered.

MASTER OF ARTS

Applications from students who plan to terminate their graduate study at the Master’s level are not accepted except in joint
degree programs with certain other professional schools within Stanford University.

The Master's degree may be awarded to Doctoral candidates who have completed the following requirements:

The faculty of the Department recommends a candidate for the Master's 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 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 offer three of the following fields of political science: American politics, comparative politics, international relations, political analysis, political theory, public administration, and public law. The student will prepare and submit himself to written examinations in two of these seven fields of political science. The requirement for the third field may be satisfied either by taking a written examination in that field or by offering a minimum of ten units with a grade of B or better in the third field from among the formal graduate level courses in the Department.

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 the following:

1. competence in a foreign language; and/or
2. competence in statistics and/or related skills such as scale analysis, content analysis, mathematics for social science, or computer science.

The language and/or skill alternatives shall be those most likely to be useful in connection with the student's dissertation research. Level of competence needed for successful completion of the research shall be determined by the student's adviser and program committee. In consultation with his adviser and program committee, the student shall propose a relevant program of preparation in a language and/or statistics. This program shall be mandatory unless the student can demonstrate, through an examination in a language or statistics, that he has mastered the necessary skills. In many cases, it may be necessary for the student to show competence in both a language and statistics.

d. 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.

e. 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 which he is offering, (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.

f. 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. Up
on successful completion of the written examinations a date for the University oral examination is set by his dissertation committee in consultation with the student.

g. 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.

h. As part of the Ph.D. program, the candidate will normally be appointed a teaching or research assistant for two quarters.

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.

ASSISTANTSHIPS, SCHOLARSHIPS, AND PRIZES

The Department has teaching assistantships in Political Science 1, 10, 15, 20, 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.

   5 units, Aut (Marshall) MTWThF 10
   Win (Marshall) MTWThF 11

10. American Government — Political participation, voting, and public opinion (emphasized by Mr. Wolfinger); the Constitution, the Supreme Court, and judicial review (emphasized by Mr. Horn); Congress, the President, political parties, and pressure groups; the process of policy formation in the federal government.

   5 units, Aut (Wolfinger) MTWThF 11
   Spr (Horn) MTWThF 11

15B. Introduction to Political Science — Comparative analysis of the formation and development of political systems; special attention to participation, state-building, and resource allocation in Western and non-Western countries.

   5 units, Aut (Abernethy, Staff) lec. MW 10 and section

15C. Introduction to Political Science — The international system.

   5 units, Spr (North) lec. MW 11 and 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*

107. Seminar in Government and Natural Resources—Political, economic, administrative 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. Recommended: Economics 1. (Graduate students register for 207.)

*5 units, Win (Marshall) M 2:15–4:05*

108. Seminar in Administrative Responsibility—Conflicting loyalties, accountability of administrative officials in decision-making processes; responsibility to public at large, pressure groups, chief executive, legislature, profession. Case study method used. Prerequisite: 10. (Graduate students register for 208.)

*5 units, Aut (Marshall) M 2:15–4:05*

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. (Graduate students register for 210.)

*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.

*4 to 5 units, Aut (Almond) MWTh 11*

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; processes of political socialization. Desirable prerequisite: 15B, or 20, and reading knowledge of German.

*4 to 5 units, Spr (Weiler) MTWThF 10*

111C. European Politics: The Austrian Political System—The development of the Austrian political system; the demographic, economic, and institutional framework of politics; political culture; and the performance of political functions in contemporary Austria. Desirable prerequisite: 15B or 20.

*4 to 5 units, Spr (Steiner) given 1971–72*

112. Government and Politics in Asia—Survey of governmental institutions and the political process in Asian countries. Desirable prerequisite: 20, or equivalent, or previous study of the area.

*4 to 5 units, Aut (Ike) MTWThF 1:15*

113A, B. Latin American Politics.

113A. Topics in contemporary Latin American politics: social, economic, and cultural context; political institutions; decision-making; political parties; the military; other groups and movements. 15B, 20, or History 177 desirable but not required. May be taken separately or together with 113B.

*4 to 5 units, Win (Packenham) MWF 1:15*

113B. Continuation of 113A. Focusses on specific countries and U.S. foreign policy as a factor in contemporary Latin American politics. May be taken separately or together with 113A.

*4 to 5 units, Spr (Packenham) MWF 1:15*

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: 15B, or 20, or 112.

4 to 5 units, Win (Ike) 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 prerequisite: 20 or equivalent or 112; History 190, 191, 192, or 193; or Anthropology 117.

4 to 5 units, Win (Oksenberg) MTWThF 9

116. Comparative Politics of Communist Parties — Examination of selected non-ruling communist parties (Italian, Japanese, Venezuelan, Israeli, Finnish, 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. Desirable prerequisite: 20 or 126.

4 to 5 units, Spr (Triska) MWF 2:15–4:05

117. Government and Politics of Africa South of the Sahara—Focuses on the colonial situation, the growth of nationalism, the one-party state, the role of the military, and such current issues as tribalism and regionalism, administrative weakness, neo-colonialism, and race relations in plural societies.

4 to 5 units, Win (Abernethy) MTWThF 10

120. Introductory Seminar in Comparative Politics. Prerequisite: 15B, or 20.

5 units, Aut (Steiner) T 4:15–6:05

120A. Seminar in Comparative Politics: Japan — (Graduate students register for 220A.)

5 units, Spr (Steiner) Th 4:15–6:05

121. Seminar in Comparative Politics: Party Systems.

5 units, Win (Steiner) T 4:15–6:05

121A. Undergraduate Seminar on Social Science and Public Policy — Utilities and limitations of social science for public policy, mainly in the United States. (Graduate students register for 221A.)

4 to 5 units, Aut (Packenham) Th 2:15–4:05

122. Seminar in Comparative Politics: Patterns of Politics in Non-Western Countries. Prerequisite: 112.

5 units, Spr (Ike) T 2:15–4:05

122A. Seminar in Comparative Politics: Democracy and Modernization in Asia—Modernization and democratic political culture and institutions in Japan, Philippines, and India.

5 units, Win (Ike) W 2:15–4:05

123B. Seminar in Comparative Politics: Cuba — By consent of instructor. Reading knowledge of Spanish strongly recommend.

5 units, Aut (Fagen) given 1971–72

124. Seminar in Comparative Politics: Local Government—Survey of 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, Aut (Steiner) T 4:15–6:05

125. Seminar in Comparative Politics: China—Focus on domestic problems. (Graduate students register for 225.) Consent of instructor required.

5 units, Aut (Lewis) Th 2:15–4:05

125A. Seminar in Comparative Politics: Vietnam.

5 units, Spr (Lewis) Th 2:15–4:05

126. Comparative Politics in Eastern Europe and the USSR — Systematic examination of the USSR and the eight East European systems in terms of their historical development, the policy-making processes, and their system maintenance and adaptation. Desirable prerequisite: 15B or 20.

4 to 5 units, Win (Triska) MWF 2:15–4:05

126A. Comparative Political Ideologies.

5 units, Aut (Bonilla) MW 2:15–3:30


127A. Seminar in Comparative Politics: West Germany—Case studies and analyses of data on voting behavior, political attitudes, political socialization. Reading knowledge of German desirable. (Graduate students register for 227A.)

5 units, Aut (Weiler) W 2:15–4:05

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. Education and political socialization. Desirable prerequisite: reading knowledge of a European language other than English.

5 units, Spr (Weiler) W 2:15-4:05

128. Comparative National Priorities — Comparative and historical study of the priorities of governments, as seen through development plans, budgets, and other official documents. Special attention to role of government in the economy, allocations to defense, social services, directly productive activities. U. S. will be included in the analysis.

5 units, Spr (Abernethy) MTWThF 9

128A. Revolutionary and Post-Revolutionary Societies—See 228A.

129. Directed Reading in Comparative Politics — Advanced individual study in comparative politics. Prerequisites: 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) given 1971-72

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) given 1971-72

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, Aut (Watkins) MTWThF 10

133. Seminar in the Politics of Development: Eastern Europe — A comparative study of the social pressures and consequences which economic development and modernization produce on the nature and structure of political authority in the East European political systems. Three pilot survey research studies on Soviet participation (Czechoslovakia, Hungary, and Yugoslavia) will be available for the seminar participants. Desirable prerequisite: reading knowledge of at least one East European language and 126. (Graduate students register for 233.)

5 units, Win (Triska) Th 2:15-4:05


4 to 5 units, Aut (Weiler) given 1971-72

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

135C. How Nations Deal With Each Other—(See History 135C.)

5 units, Aut (George, Crowl, Craig, Paret, Lederer, Meier)

136C. Conflict Development and Resolution.

5 units, Win (Noel) T 2:15-4:05; lab. by arrangement


4 to 5 units, Spr (Watkins) MTWThF 10

138A,B. Problems of Arms Control and Disarmament — General international politics; international law and relations, stressing political, legal, and technological problems of arms control. 138A is a prerequisite to 138B; the second quarter will provide for individual research.

138A. 5 units, Win (Lewis, Barton, Craig, T. Ehrlich, W. Panofsky, Paret, A. Peterson) T 2:15-4:05
138B. 5 units, Spr (Lewis, Barton, Craig, T. Ehrlich, W. Panofsky, Paret, A. Peterson) T 2:15–4:05

139. Chinese Foreign Policy — Analysis of China's goals and conduct in world affairs; consideration given to historical forces and domestic pressures which shape her policy. 4 to 5 units, Spr (Oksenberg) MTWThF 9

140. Seminar in International Relations — Prerequisite: 135 or equivalent. 5 units, Aut (Watkins) Th 2:15–4:05

140A. Seminar in History of International Relations Thought. 5 units, Win (Watkins) given 1971–72

141. International Relations: An Introductory Seminar in Scope and Method. (Graduate students register for 241.) 5 units, Win (Brody) given 1971–72

142. Seminar in Public Opinion and Foreign Policy. (Graduate students register for 242.) 5 units, Win (Brody) given 1971–72

145. Seminar in the Politics of Escalation—International environments, competitions, conflicts, arms races, and violence. (Graduate students register for 245.) 5 units, Win (North) Th 4:15–6:05

145A. Force and Diplomacy in Recent U.S. Foreign Policy — Selective examination of post-World War II crises and conflicts; lessons for theory and practice. Enrollment limited to 15 juniors and seniors with previous courses in international relations, by consent of instructor. 5 units, Spr (George) F 2:15–4:05

146. Seminar in International Law: International Treaties. (Graduate students register for 246.) 5 units, Win (Triska) given 1971–72

147. Seminar on Soviet-Chinese Relations. (Graduate students register for 247.) 5 units, Win (North) T 4:15–6:05

148. Introductory Seminar in International Organization—Prerequisite: 137 or equivalent. 5 units, Win (Watkins) T 4:15–6:05

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. Political Thought: Greek and Roman Theory—The beginnings of political speculation in preliterate societies, the ancient world, and pre-Socratic Hellas; the philosophical systems of Plato, Aristotle, and the Hellenistic schools; Roman institutions and theories of law and politics. 5 units, Aut (Drekmeier) MTWThF 11

151. Political Thought: Augustine to Hobbes — 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. 5 units, Win (Drekmeier) MTWThF 11

151A. Recent American Political Thought. 5 units, Aut (Rogat) M 2:15–4:05

152. Political Thought: Modern Ideas and Doctrines—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, Spr (Drekmeier) MTWThF 11

153. Freedom and Order in Western Political Theory—An introductory survey of political thought since the Reformation, with particular attention to varying conceptions of the nature and conditions of political and social freedom. 5 units, Aut (Drekmeier) given 1971–72

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 (Ike) 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. (Graduate students register for 255.) 4 to 5 units, Aut (North) MTWThF 2:15

157. History of Political Ideas II: Classical
Politics (Plato and Aristotle) — (Graduate students register for 257.)

5 units, Spr (Voegelin) MTW 10

158A.B. Theory, Power, and Social Science.
158A. The development of modern social science and social philosophy: discussions of value, the nature of man, human interaction, the organization of power, belief systems, social change, and related themes in the different idealist, formalist, and positivist schools of thought. No prerequisite, but 153 or a course in modern philosophy or intellectual history will be helpful. This course provides the historical and philosophical background for 158B. (Graduate students register for 258A.)

5 units, Win (Drekmeier) given 1971-72

158B. The theory of political structure and process: typology of social relationships, organization and leadership, social class and ideology, alienation and participation, etc. Political sociologies of elites, bureaucracy, and class in the writings of Marx, Tönnies, Simmel, Weber, Mannheim, Durkheim, Michels, and contemporary theorists. Psychoanalytic, phenomenological, and other conceptions of the nature of consciousness and experience will be considered in the analysis of behavioral aspects of the subject. 158A strongly recommended. (Graduate students register for 258B.)

5 units, Spr (Drekmeier) given 1971-72

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. Seminar in Power, Authority, and Disobedience. (Graduate students register for 261.)

5 units, Spr (Drekmeier) Th 4:15-6:05

163A,B,C. Political Theory: Private and Public — (Graduate Students register for 263A,B,C.)

163A. Privacy — Notions of self, individual property.
5 units, Aut (Paff) TTh 2:15-4:05

163B. Public Places (Seminar) — Author-
For graduate courses in Public Law, see Part III.

AMERICAN POLITICS

181. Attitude Formation and Voting Behavior—The determinants of opinions and political beliefs, 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 (Sniderman) MTWThF 11

183. Urban Politics—An analysis of the variety of political forms and forces operative in urban settings and how they relate to the "urban crisis." The primary focus will be upon the urban area as a conflict arena.

5 units, Spr (Greenberg) T W Th 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

186. The Politics of Race—A discussion of black political behavior in the context of political behavior research; the interrelationships of the black community and the urban political process; the causes, nature and implications of urban disorders; white responses to black political initiatives.

5 units, Win (Greenberg) T W Th 12

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) F 2:15-4:05

188A, B. Introduction to the Study of Political Behavior—This seminar is designed to provide undergraduates with a comprehensive introduction to the major areas of study and methods of analysis in the field of Political Behavior. Among the topics to be covered are the psychology of political participation, the study of leadership in small groups and legislative institutions, the linkage of public opinion and policy issues, the acquisition of social values, and personality and political belief. Time will also be devoted to an evaluation of methods of social analysis, including the uses and abuses of participant observation, survey research, and small group experiments.

188A. 5 units, Win (Sniderman)

M 2:15-4:05

188B. 5 units, Spr (Sniderman)

M 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

199. Senior Honors Thesis.

15 units maximum, any 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. Seminar in Organizational Theory.

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, Win (Almond) W 2:15-4:05

213. Seminar in Comparative Politics: Latin America—Problems in Latin American politics. Reading knowledge of Spanish or Portuguese recommended but not required.

5 units, Win (Bonilla) M 2:15-4:05

219. Seminar in Political Development
Theory: Enlightenment, Liberal, and Marxist Theories of Political Development—Contemporary approaches to development processes in political sociology and political science. Toward an empirical theory of political development.

5 units, Spr (Almond) M 2:15-4:05

220A. Seminar in Comparative Politics: Japan—See 120A.

221A. Social Science and Public Policy — See 121A.

224. Seminar in Comparative Politics: Local Government—See 124.

225. Seminar in Comparative Politics: Communist China—See 125.

227. Seminar in Comparative Politics: Africa. Open to selected undergraduates who have taken an Africa-related course.

5 units, Spr (Abernethy) M 2:15-4:05

227A. Seminar in Comparative Politics: West Germany—See 127A.


228A. Revolutionary and Post-Revolutionary Societies—(Undergraduates register for 128A.)

5 units, Aut (Oksenberg) M 2:15-4:05

229. Directed Reading in Comparative Politics.

Any quarter (Staff) by arrangement


234. Seminar in International Politics — A survey of central concepts.

5 units, Aut (——) Th 2:15-4:05

236. Seminar in 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. Desirable prerequisites: reading knowledge of Russian and 15C.

5 units, Aut (Triska) Th 2:15-4:05

241. International Relations—See 141.

242. Public Opinion and Foreign Policy—See 142.


247. Seminar on Soviet-Chinese Relations—See 147.

249. Directed Reading in International Law and Relations.

Any quarter (Staff) by arrangement


5 units, Aut (Drekmeier) Th 4:15-6:05

255. Comparative Marxist Theory — See 155.


258A,B. Theory, Power, and Social Science — See 158A, B.

260A,B. "Modernisms"—See 160A, B.

261. Seminar in Power, Authority, and Disobedience—See 161.


5 units, Aut (Paff) W 2:15-4:05

261B. Research Seminar — Contemporary political theory.

5 units, Win (Paff) W 2:15-4:05

263A,B,C. Political Theory, Private and Public—See 163A, B, C.

269. Directed Reading in Political Theory.

Any quarter (Staff) by arrangement

270. The Supreme Court and the Constitution—See 170.


5 units, Aut (Horn) T 4:15-6:05

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, Aut (Eulau) given 1971–72
281B. 5 units, Win (Eulau) given 1971–72

289. Directed Reading in Politics
Any quarter (Staff) by arrangement

300. Thesis
Any 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, Oksenberg, Skinner, Van Slyke) by arrangement

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, Aut (Almond) given 1971–72

325. Advanced Seminar in Reform and Revolution in Twentieth Century China and Japan.
5 units, Aut (Ike) given 1971–72

326. Advanced Seminar on Japanese Politics—Emphasis will be on empirical studies, leadership, voting and public opinion. Reading knowledge of Japanese required.
5 units, Aut (Ike) Th 2:15–4:05

331. Advanced Seminar in International Political Theory.
5 units, Spr (North) T 4:15–6:05

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) F 2:15–4:05
334B. Student research on historical cases and policy problems.
5 units, Spr (George) given 1971–72

336. Research Seminar in Comparative Foreign Policy: Eastern Europe—Workshop in the problems posed by comparative study of foreign policies. (Offered jointly with the Department of History.)
5 units, Spr (Triska, Lederer) Th 2:15–4:05

342A,B. Research Seminar in Public Opinion and Foreign Policy.
342A. 5 units, Win (Brody) given 1971–72
342B. 5 units, Spr (Brody) given 1971–72

380. Research Seminar on Comparative Political Sociology of the Professions.
5 units, Spr (Eulau) M 2:15–4:05

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) Th 7:30–9:30 p.m.
381B. Student research on some aspect of leadership.
5 units, Win (George) Th 7:30–9:30 p.m.

384A. 5 units, Win (Wolfinger) W 2:15–4:05
384B. 5 units, Spr (Wolfinger) W 2:15–4:05

386. Seminar on Political Behavior: Urban Community Politics—Intensive and critical reading of the literature of urban politics with an eye toward defining alternative concerns, approaches and frameworks of analysis.
5 units, Spr (Greenberg) M 2:15–4:05

387A,B. Research Seminar in American Politics: The Roots of Political Belief—Intensive review of major findings on the roots of belief and ideology. Examination of major psychological theories concerning conform-
ity and deviation, ideological coherence, etc. Students must take both quarters.

387A. 5 units, Win (Sniderman)
F 2:15–4:05

387B. 5 units, Spr (Sniderman)
F 2:15–4:05

388A,B. Research Seminar on Comparative Political Behavior.

388A. 5 units, Win (Bonilla) W 2:15–4:05

388B. 5 units, Spr (Bonilla) W 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 (—) M 2:15–4:05

PSYCHOLOGY

Emeriti: Paul R. Farnsworth, Ernest R. Hilgard, Maud Merrill James, Quinn McNe mar, Lois Meek Stolz (Professors)

Chairman: Richard C. Atkinson


Associate Professors: J. Merrill Carlsmith, Herbert H. Clark, Edith M. Dowley (Di rector, The Bing Nursery School), Leo Ganz, Leonard M. Horowitz

Assistant Professors: Cedric C. Clark, Charles R. Hamilton, George A. Kaplan, Mark R. Lepper, Keith E. Nelson, Lee Ross, Edward E. Smith

Lecturer: Norman H. Mackworth

LABORATORIES

In addition to lecture and seminar rooms, the Department maintains extensive laboratory and shop facilities. Several of the laboratories are equipped with computers, and procedures have been set up to link them with the University's Computation Center.

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, 1971.

PROGRAMS OF STUDY

BACHELOR OF ARTS

For the Bachelor's degree, 45 units of psychology are required, including courses 1 and 60. Related courses in other fields may be counted as fulfilling up to 10 of the non-laboratory units for the degree. A list is on file in the Department.

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 and 207 must be elected as well as two other courses from the content areas, one to be selected from 208, 209, 210, 214, and 215, 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 and also 152, must be completed 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. In addition to the course requirements above, the student must show competence in three additional content areas. This requirement normally should be completed during the second year of graduate study and may be met either by taking the appropriate courses selected from 208, 209, 210, 211, 212, 213, 214, and 215, or by special examination. Further course work prior to the admission to doctoral candidacy is to be arranged under the guidance of the student's adviser.

3. The candidate shall either complete a University minor, satisfactory to the minor department, or he may elect to have the minor waived by selecting 12 approved units outside the Department and additional work in general psychology.

4. The candidate shall pass the University oral examination which will cover the relevant literature to his doctoral research and a defense of the dissertation proposal.

5. The candidate shall complete 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. 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.

**Courses Open to All Students**

1. **General Psychology**—Introduction, survey.
   - 5 units, Aut (Horowitz and Staff) MWF 10
   - Win (-----) MWF 11
   - Spr (Smith) MWF 10

2. **Statistical Methods.**
   - 5 units, Aut, Sec 1 (Ross) MTWThF 10; Sec II (Calfee) TTh 10:00-11:30
   - Win (-----) MTWThF 11
   - Spr (Horowitz) MTWThF 9

3. **Experimental Psychology: Personality and Interpersonal Processes**—Prerequisites: 1 and 60.
   - 3 units, Win (Ross) MWF 11

4. **Experimental Psychology: Perception**—Prerequisites: 1 and 60.
   - 3 units, Aut (Ross) MWF 11

5. **Learning**—Prerequisites: 1 and 60.
   - 5 units, Aut (Kaplan) TTh 2:15-4:05

6. **Special Laboratory Projects**—Prerequisites: 1 and 60, and consent of instructor.
   - 3 to 6 units, any quarter (Staff) by arrangement
106. Experimental Psychology: Attention and Memory—Prerequisites: 1 and 60.
  5 units, Win (Smith) MWF 9
  and by arrangement

107. Experimental Psychology: Social Psychology—Prerequisites: 1 and 60.
  5 units, Spr (Lepper) MWF 10
  and by arrangement

  4 units, Aut (Nelson) MWF

112. Personality and Social Development—Motivation, emotion, and interpersonal action systems examined from birth into adolescence, with emphasis on child rearing and peer group influences. Prerequisite: 111 or equivalent.
  4 units, Win (Sears) MWF 11

113. Development of Cognition and Language—Intensive exploration of the child’s development of thought, memory, and language. Prerequisite: 111 or equivalent.
  4 units, Spr (Nelson) MWF 10

114. Exceptional Children—The focus will be on (a) the value assumptions, (b) the range of behavioral responses to “standard conditions,” and (c) the etiological components of behavior which lead to exceptionality. The specific case of delinquent behavior as seen in psychopathic (sociopathic) personalities will be studied. Prerequisites: familiarity with psychological theory and at least senior standing.
  4 units, Spr (Hawkinshire) MW 9-11

115. Social Behavior in Children—Prerequisite: 111 or equivalent.
  4 units, Aut (Lepper) MWF 11

117. Observation of Children—Enrollment limited to 16. Prerequisites: 111 or equivalent, and consent of instructor.
  3 to 5 units, Aut, Win, Spr (Dowley)
  Th 2:15-4:05 and by arrangement

118. Nursery School Practice—Supervised experience with the nursery school child. Prerequisites: 111, 117, and consent of instructor.
  3 to 5 units, Aut, Win, Spr (Dowley)
  T 2:15-4:05 and by arrangement

121. Social Psychology—Prerequisite: 1 or equivalent.
  4 units, Spr (Zimbardo) TTh 11:00-12:30

123. Social Psychology of Communication—Introduction to the study of human communication behavior. Emphasis is on the social-psychological determinants of message selection, transformation, and generation. Prerequisite: 1 or equivalent.
  3 units, Win (C. Clark) TTh 3:15

124. Psychological Dimensions of the Black Experience—Application of social-psychological principles to the analysis of black-white social interaction. Prerequisite: 1 or equivalent.
  3 units, Spr (C. Clark) M 2:15 and sections

131. Abnormal Personality—Theories and findings regarding the psychological causes, assessment, and therapeutic change of abnormal personality. Focuses on psychodynamic, behavioral and cognitive approaches to the origins, measurement, and modification of abnormal behavior. Prerequisites: 1 and at least second year standing.
  4 units, Aut (——) MWF 9
  Spr (Mischel) MWF 1:15

132. Personality—Personality theories and findings regarding the nature and development of personality. Prerequisites: 1 and at least second year standing.
  4 units, Win (——) MWF 1:15

141. History of Psychology—Prerequisites: three courses in psychology and junior standing.
  4 units, Spr (——) MWF 11

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 (Cronbach) TTh 3:15-5:05
  Sum (Staff) MTWTh 10 and by arrangement

146. Language and Thought—Surveys current topics of interest in language and thought, including language acquisition by children, language comprehension and production, phonological perception, biological bases of language, meaning, linguistic relativity, bilingualism, and aphasia. These topics will be treated from a cognitive point of view and will be related to other cognitive
processes such as perception and reasoning. Prerequisite: 1 or equivalent.
4 units, Aut (H. Clark) MWF 1:15

147. Comparative Psychology — Prerequisite: 1 or equivalent.
4 units, Spr (Hamilton) MWF 9

148. Physiological Psychology — Prerequisites: 1 and a course in biology or physiology.
4 units, Win (Pribram) MWF 8

151. Statistical Methodology—Prerequisite: 60 or equivalent.
4 units, Win (Horowitz) MWF 9

152. Analysis of Data—Prerequisite: 151 or permission of instructor.
4 units, Spr (Carhmith) MWF 9

155. Human Abilities—(Same as Education 255.) The nature, development, and measurement of intellectual abilities. Prerequisites: 1 and Statistics 160, or equivalent.
3 units, Spr (Snow) MWF 10

164. Mathematical Representation of Structures in Data—Theory of psychological scaling and measurement, metric and nonmetric representations in one or more dimensions, hierarchical clustering, linear and nonlinear factor analysis. Prerequisites: 1 and 60 or mathematics through calculus.
4 units, Spr (Shepard) TTh 11:00-12:20

165. Mathematical Theories of Learning and Memory I — Mathematical models of psychological processes are introduced, and their applications to learning data are illustrated. Psychological topics include: learning, reinforcement contingencies, generalization, discrimination, forgetting, and recognition. Mathematical techniques include difference equations, probability theory, Markov chains and parameter estimation. Prior familiarity with probability theory and the psychology of learning would be desirable, though not necessary. Prerequisites: 1 and 60 or equivalent.
4 units, Aut (Atkinson) given 1971-72

166. Mathematical Theories of Learning and Memory II—Continuation of 165 into further topics: development and intensive analysis of Markov models for short-term memory and verbal learning. Other topics may include models describing decision making, reaction time, and psychophysical judgments. Prerequisites: 1 and 60 or 165.
4 units, Win (Bower) given 1971-72

170. Hypnotic Phenomena—Lectures, readings, and discussions on hypnosis, with emphasis on experimental studies designed to study hypnosis as related to more familiar psychological phenomena. Limited to graduate students in psychology, and in other fields by special consent, and to senior majors in psychology.
3 units, Aut (Hilgard) W 2:15-4:05

172. Psychology of Mental Phenomena—An examination of selected investigations into perception, dreaming, hallucinations, "split" brains, artificial intelligence, and the philosophical mind-body problem; and the implications of such investigations for the nature of conscious experience. Prerequisites: 1, or equivalent, or course in philosophy.
4 units, Win (Shepard) MW 2:15-3:30

175. Brain and Choice: the Neuropsychology of Skill—Skilled behavior in adults and children starts with attention, proceeds to information selection and possibly even to a change of plan or strategy. The complete analysis of such individual behavior can now include line of sight and brain wave recordings. We therefore need to discuss the extent to which human performance and brain function are closely interrelated.
3 units, Aut (Mackworth) M 2:15-4:05

177. Introduction to Brain Theory—(Same as Electrical Engineering 204.) A slightly mathematical introduction to the use of information processing devices as metaphors to aid our understanding of brain function. The role of internal models in memory and perception. Survey of Gross neuroanatomy. Computation in neural nets. Parallel computation, interpreters, and hierarchical programs, and their relation to perception, memory, and the control of movement. (Students who continue with Psychology 230 are encouraged to undertake a project to be graded at the end of the second quarter.) Prerequisite: senior or graduate standing.
3 units, Aut (Arbib) by arrangement

182. Honors Seminar (Senior)—Limited to
seniors in the Psychology Honors Program.

185. Research Seminar in the Linguistic and Cognitive Processes in Reading—(Same as Linguistics 225.) This seminar will concentrate on the analysis of the process of reading. The seminar will consider recent experimental studies of reading in the light of various linguistic models. The discussions will try to develop experimental programs to resolve some of the crucial questions in the psychology of language.

3 units, Win (Mackworth and Wanat)

MTh 2.15

188. Reading and Special Work — Independent study. Prerequisite: consent of instructor.

1 to 3 units, any quarter (Staff)

by arrangement

190. Undergraduate Seminar in Psycholinguistics—Primarily intended for majors in psychology. Prerequisite: consent of instructor.

3 units, Win (Kaplan) by arrangement

190A. Undergraduate Seminar in Early Experience—Primarily intended for majors in psychology. Prerequisite: consent of instructor.

3 units, Win (Levine) 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: consent of instructor.

3 units, Win (Bandura) by arrangement

192. Undergraduate Seminar in Behavior Modification — (Same as Education 236.) Counseling techniques for altering client behavior in a variety of settings. Research studies, case studies, and technique demonstrations involved. Prerequisite: consent of instructor.

3 units, Aut (Thoresen) by arrangement

193. Undergraduate Seminar in Social Psychology—Primarily intended for majors in psychology. Prerequisite: consent of instructor.

3 units, Spr (——) by arrangement

194. Undergraduate Seminar on Selected Topics in Developmental Psychology—Primarily intended for majors in psychology. Prerequisite: consent of instructor.

3 units, Aut, Win, Spr (Sears, Maccoby, Nelson, Lepper) by arrangement

195. Undergraduate Seminar in Personality —Primarily intended for majors in psychology. Prerequisite: consent of instructor.

3 units, Win (——) by arrangement

196. Undergraduate Seminar in Physiological Psychology—See 268.

198. Senior Research Seminar in Hypnosis —Intended to extend experience with hypnosis for senior majors. Prerequisite: 170.

3 units, Spr (——) by arrangement

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.

3 units, Aut (Atkinson and Staff)

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, Win (Hamilton) MWF 10

209. Advanced Perception — Prerequisite: graduate standing in psychology or consent of instructor.

2 to 3 units, Aut (Ganz) TWF 9

210. Memory and Learning: An Information Processing Approach — Prerequisite: graduate standing in psychology or consent of instructor.

2 to 3 units, Spr (Bower) MWF 11

211. Advanced Developmental Psychology — Prerequisite: graduate standing in psychology or consent of instructor.

2 to 3 units, Win (Maccoby) by arrangement

212. Advanced Social Psychology — Prerequisite: graduate standing in psychology or consent of instructor.

2 to 3 units, Spr (Ross) by arrangement
213. Advanced Personality — Prerequisite: graduate standing in psychology or consent of instructor.
2 to 3 units, Aut (Mischel) M 9–12

214. Psycholinguistics — Prerequisite: graduate standing in psychology or consent of instructor.
2 to 3 units, Spr (H. Clark) by arrangement

215. Mathematical Psychology — A survey of mathematical theories of choice behavior, decision-making, psychophysical judgments, utility and motivation, learning and concept formation. Prerequisite: graduate standing in psychology or consent of instructor.
2 to 3 units, Win (Atkinson and Bower) TTh 11:00–12:15

219. Introduction to Behavior Genetics — (Same as Psychiatry 219.) Designed to provide upper undergraduates and graduates in the fields of biology, psychology, and anthropology with background in the principles and methods of behavior genetics. Prerequisite: Genetics 201 or equivalent course in genetics; at least one course in biology or psychology treating animal behavior.
2 units, Win (Kessler) TTh 1:15–2:05

221A. Organization Theory: Applications — (Enroll in Business 472.) Prerequisite: consent of instructor.
4 units, Aut (Leavitt) by arrangement

221B. Small Groups — (Enroll in Business 475.) Prerequisite: consent of instructor.
4 units, Win (Bradford) by arrangement

222. Mathematical Theories of Perception — Prerequisite: consent of instructor.
4 units, Spr (——) by arrangement

224. Models of Thought Processes — (Same as Computer Science 224.) Introductory survey of concepts and problems in artificial intelligence research; heuristic processes in problem solving, and heuristic programming; information processing models as explanations of human cognitive and affective behavior. Prerequisite: Computer Science 105 or 106, or equivalent.
3 units, Aut (——) TTh 1:15–2:30

226. Seminar in Endocrines and Behavior — Intended for graduate and undergraduate students. Prerequisite: 148 or equivalent.
3 units, Spr (Levine) by arrangement

3 units, Win (Arbib) by arrangement

235. Seminar in Cross-Cultural Communication — Examination of the social-psychological effects of mass and interpersonal communication in relation to the nature of attitudes, values, and behavior patterns characterizing people of different cultures. Prerequisite: graduate standing in psychology or communication.
3 units, Aut (C. Clark) Th 4:15–6:05

237. Experimental Psychology of Reading — (Same as Education 389.) Review of research literature on the reading process, and acquisition of reading. Emphasis on critical evaluation of process research, and on interaction of psychological, linguistic, and educational aspects of reading. Prerequisite: consent of instructor.
3 units, Spr (Calfee) TTh 10:00–11:30

242. Theories of Child Development — An intensive survey of major theories of development (cognitive, learning, action, analytic, stage). Comparison of areas for which they are useful, and evaluation in light of their contributions to research. Prerequisite: consent of instructor.
3 units, Aut (Sears and Staff) by arrangement, alternate years, given 1970–71

243. Seminar on the Development of Early Social Communication — Prerequisite: consent of instructor.
3 units, Spr (Siegel) M 2:15–4:05

244. Seminar on Theories of Socialization — (Enroll in Education 410.)
2 units, Win (Hess) by arrangement

245. Socialization of Pre-Adults in Contemporary U.S. Society — (Same as Education 311.)
3 units, Spr (Hess) by arrangement
246. Methods in Developmental Research — Prerequisite: consent of instructors.
4 units, Aut (Sears and Staff) by arrangement, alternate years, given 1970–71

247. Physical Growth and Maturation — The course will deal with the physical growth of the human and his organs from early embryonic life to post-adolescence. Emphasis will be placed on the biology of growth and environmental effects on growth and development. Some functional inter-relationships during development will be considered with special concentration on the nervous system. Prerequisites: graduate standing, or senior standing in psychology and consent of instructor.
3 units, Aut (Kretzmer) by arrangement, alternate years, given 1970–71

248. Introduction to Test Theory — (Same as Education 252.) Concepts of reliability and validity; mathematical models underlying commonly used procedures for test analysis. Test scales and norms. Prerequisite: Statistics 160 or equivalent.
3 to 4 units, Aut, alternate years, given 1971–72

249. Problems in Measurement — (Same as 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 personnel decisions. Prerequisites: 152 and 248, or Education 250B and 252, or equivalent.
3 to 4 units, Spr (Cronbach) MW 2:15–4:05, alternate years, given 1970–71

250. Psychopathology — Prerequisite: graduate standing in psychology or consent of instructor.
3 units, Win (——) by arrangement

251A. Seminar in Methods and Issues in Social Psychology I — Limited to graduate students in the Department of Psychology. Prerequisite: consent of instructor.
3 units, Aut (Zimbardo) by arrangement

251B. Seminar in Methods and Issues in Social Psychology II — Limited to graduate students in the Department of Psychology. Prerequisite: consent of instructor.
3 units, Win (Zimbardo) by arrangement

252. Special Topics in Memory — Prerequisite: consent of instructor.
3 units, Win (Horowitz) by arrangement

253. Seminar in Perception — Prerequisite: consent of instructor.
3 units, Win (Ganz) by arrangement

254. Seminar in Learning Theory — Prerequisite: consent of instructor.
3 units, Win (Bower) by arrangement

255. Seminar in Mathematical Theories of Learning and Memory — Prerequisite: consent of instructor.
3 units, Spr (Atkinson) by arrangement

256. Seminar on Selected Topics in Developmental Psychology — Prerequisite: consent of instructor.
2 to 3 units, Aut, Win, Spr (Nelson, Maccoby, Sears, and Lepper) by arrangement
267. Seminar in Person Perception — Prerequisite: consent of instructor.
3 units, Spr (Hastorf) by arrangement

268. Seminar in Physiological Psychology — Special topics. Graduate or undergraduate standing. Prerequisites: 148 or 208, and consent of instructor.
3 units, Aut (Hamilton) by arrangement

269. Seminar in Personality — Prerequisite: consent of instructor.
3 units, Win (Mischel) T 2:15-5:05

271. Seminar in Information Processing — Prerequisite: consent of instructor.
2 units, Spr (Lawrence) given 1971-72

272. Seminar in Semantics — Prerequisite: consent of instructor.
3 units, Win (H. Clark) 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

(Staff) by arrangement

303. Research Seminar in Hypnosis — Primarily for graduate students doing research in hypnosis and related areas. Prerequisite: consent of instructors.
1 to 3 units, Aut, Win, Spr (E. Hilgard, J. Hilgard) F 3:00-4:15

304. Research Seminar in Neuropsychology — Prerequisite: consent of instructor.
1 to 3 units, Aut, Win, Spr (Pribram) T 12-2

305. Research Seminar in Mathematical Psychology — Prerequisite: consent of instructors.
1 unit, Aut, Win, Spr (Atkinson, Bower, Shepard) F 3:15-4:30

The Biochemistry of Behavior — See Psychiatry 9.

311. Research Seminar in Developmental Psychology — Prerequisite: consent of instructors.
1 unit, Aut, Win, Spr (Maccoby, Sears, Nelson, Lepper) by arrangement

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**SLAVIC LANGUAGES and LITERATURES**

Emeriti: Jack A. Posin (Professor); Sarra Kliachko, Elisabeth Stenbock-Fermor (Assistant Professors)

Chairman: Joseph A. Van Campen
Professor: Edward J. Brown
Associate Professors: Lawrence L. Stahlberger, Joseph A. Van Campen
Acting Assistant Professor: Robert T. Whittaker, Jr.
Senior Lecturer: Nicholas S. Pashin
Lecturers: Elise Belenky, Victoria Emmons

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**OFFERINGS AND FACILITIES**

The Department accepts candidates for the degree of Bachelor of Arts, Master of Arts, and Doctor of Philosophy. Particular requirements for each degree are described below.

**MASTER OF ARTS IN TEACHING**

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. Detailed requirements for the degree are outlined in the School of Education section of this bulletin. The program includes 45 units of which 25 must be in the teaching field and 12 in education. Specific language requirements are established in consultation with the Department.

**JOINT PH.D. IN SLAVIC AND HUMANITIES**

The Department participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in Slavic and Humanities. For a description of that program, see the section "Humanities Special Programs" in this bulletin.

**PROGRAMS OF STUDY**

**BACHELOR OF ARTS: RUSSIAN**

Candidates must have completed the first- and second-year courses in reading, composition, and conversation (or their equivalent).
Candidates are expected to complete a minimum of 35 units, selected with the approval of their adviser, to include in any course cases numbered 111, 112, 113, 145, 146, 147, 148, 187, 188.

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

Admission to Candidacy—The requirements for admission to candidacy are:
1. A Bachelor of Arts degree (or its equivalent) from an accredited college or university.
2. A command of the Russian language sufficient to permit the student to do satisfactory graduate work in his area of specialization.
3. A familiarity with Russian literature sufficient to permit the student to perform adequately in courses at the graduate level.

The applicant's previous academic training in Russian language and literature must normally serve as a tentative indication of his competence. Accordingly, the Department will not ordinarily consider applications from students who have not had at least three years of college Russian and some undergraduate training in Russian literature of the 19th and 20th centuries.

However, before registering for the first quarter's work in the Department, all entering graduate students are required to take placement examinations in language and literature. Students who fail to perform satisfactorily on such examinations will be required to register for remedial courses in the area or areas in which they are deficient. Such remedial courses, which must normally be completed within the first three quarters of residence, will carry no credit toward either the A.M. or the Ph.D. degree.

Course Requirements

1. Non-remedial Courses:

Students may concentrate either in language and linguistics or in literature.

a) Required courses:
   1) For all students: 189, *196, **201, **211, 300
   2) For students concentrating in language or linguistics: *197, *198, **212, and two of the following: 187, 188, 193A, 193B
   3) For students concentrating in literature: 187, 188, 193A, 193B, and either *197 or *198

Courses preceded by a single asterisk may be waived on the basis of a special placement examination to be given to candidates who can show evidence of previous training in the subject matter of the course in question. If a required course cannot be offered during a given year, students will be allowed either to postpone that course until the following year or, where necessary, to do supervised reading on the appropriate material under the guidance of a faculty member.

b) Elective courses:

Since many well-prepared students may be released from one or more of the asterisked courses, the total number of required non-remedial courses will in many cases be less than the maximum possible number (ten) and, in a few cases, may fall as low as five or six. When the number of required courses is less than nine, the student should supplement required work with additional courses such that the total number of units accumulated during his first year of graduate study will not be less than thirty-nine. Although the choice of additional courses should be primarily guided by the student's needs and interests, the following should be noted.

1) No credit toward the A.M. degree will be allowed for first- or second-year courses in non-Slavic languages required for the Ph.D. degree.
2) Students taking two required courses in a given quarter should not register for more than four units of additional work. Students taking one required course should not register for more than eight units of additional work. (Since all required courses are five-unit courses, it will in most cases be possible for students to register for less than the maximum amount of additional work and still accumulate the necessary number of units per quarter.)
3) Students not enrolled in the Ph.D. program should bear in mind the areas to be covered by the final examination for the A.M. degree (see section below). Students in the Ph.D. program should attempt either to complete the thesis requirement for
the A.M. degree or, where this is not possible, to enroll in courses appropriate to their Ph.D. program.

Students with nine or more required courses should not plan to take any non-required courses during their first year of study.

2. Remedial Courses:

114, 115, 145 (+147), 146 (+148).

These courses must be taken as early in the student's career as possible. In most circumstances the completion of required course work will be delayed by one or more quarters.

Final Examination — Students not enrolled in the Ph.D. program are required to take a final examination based primarily on their required course work. Regardless of the area of specialization, the student will be required to demonstrate on a written examination (1) a command of the phonology, morphology, syntax, and lexicology of contemporary Standard Russian sufficient to allow him to teach beginning and intermediate courses at the college level; (2) an ability to read contemporary Standard Russian sufficient to permit him to be a reliable guide to students studying contemporary Russian poetry or literary prose; and (3) sufficient familiarity with Russian literature of either the 19th or the 20th century to allow him to handle successfully survey courses dealing with his chosen period.

The examination should be passed at the end of the final quarter of required course work.

Thesis — Students enrolled in the Ph.D. program are required to write a thesis. Where the scheduling of required courses permits, every effort should be made to complete the thesis by the end of the first year of study. (It should be noted that a seminar paper of outstanding quality may serve as the basis for the thesis.) In no case should the completion of the A.M. thesis be delayed more than one quarter beyond the end of required course work.

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. Students wishing to do advanced work in Polish should consider spending a year abroad under the Stanford-Warsaw exchange. In addition to courses 15, 16, 17, and 215, 216, 217, such students should arrange to do at least nine units of advanced work in Polish literature. Students considering minors in other areas, such as Asian languages, English, or comparative literature, should consult with their adviser and the chairman of the Slavic Department.

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 the Department chairman. 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. Pass written and oral Departmental general qualifying examinations covering the following areas:

a) the history and structure of the Russian language and its relationship to 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.

(One or more sections of the written and/or oral examinations will be conducted in Russian, and the evaluation of the student's performance on these sections will include an evaluation of his command of the Russian language.)

3. Pass a University Oral Examination in the defense of a dissertation proposal covering: content relevant to the area of study rationale for the proposed investigation and strategy to be employed in the research.

4. Write a dissertation that embodies such results of research as would merit publication.
Specialization:
Candidates in Slavic Languages and Literatures specialize either in language and 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. Requirements will thus vary according to the nature of the specialized program requested.

Course Work and Overall Scheduling
1. Those students not possessing the equivalent of the Stanford A.M. degree should schedule their first year of course work in accordance with the requirements for the A.M. degree. The A.M. thesis should be completed by the end of the fourth quarter of graduate study at the latest. The remainder of the second year of graduate study should be devoted to course work designed to prepare the student for the general qualifying examination and to fulfill the requirements for his minor, if any. The Departmental general qualifying examinations must be taken by the end of the first quarter of the third year of study; they may be taken during the second year if the student and his adviser feel this is appropriate. During the two quarters following the general qualifying examination the student should be primarily concerned with preparation for the University Oral Examination. (The latter should take place no later than the end of the third quarter of the third year.) However, students may, if necessary, do limited amounts of course work not directly related to the dissertation proposal.

The fourth year should be devoted to the completion of the dissertation.

2. Students possessing the equivalent of the Stanford A.M. will normally be expected to adhere to the schedule for the second, third, and fourth years of work outlined under 1. above.

Note on Non-Slavic Language Requirements:
It should be noted that no credit toward either the A.M. or the Ph.D. degrees will be granted for first- or second-year courses in non-Slavic languages. It is assumed that on entering the program the student will have a reading knowledge of both German and French or, at the very least, of one of these languages. The reading examination in one of these languages must be passed by the end of the second year of study. The second examination must be passed before the candidate takes his University Oral Examination, i.e., before the end of the third year.

General Courses (A)
When registering, students are advised to prefix the identifying letter A to the course number.

4 units, Win (Whittaker) MWF 10
146. Russian Literature of the Twentieth Century—Major emphasis on the novel. Readings in English.
4 units, Aut (Brown) MWF 11
149. Introduction to the Culture and Literature of the Slavic Peoples—No foreign language required.
4 units, Aut (Stahlberger) MWF 1:15, alternate years, given 1971-72
151. Dostoevsky—A reading of the major works in English translation. Open to all students except freshmen.
4 units, Aut (——) MWF 11, alternate years, given 1971-72
153. Leo Tolstoy—Chief works of fiction in English translation. Open to all students except freshmen.
4 units, Win (Stahlberger) MWF 11, alternate years, given 1971-72

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 (——) MTWTh 8
16. Intermediate Polish — Introduction to the reading of prose texts. Prerequisite: 15 or equivalent.
4 units, Win (——) MTWTh 8
17. **Advanced Polish** — Reading of prose texts. Prerequisite: 16 or equivalent.  
4 units, Spr (----) MTWTh 8

**RUSSIAN**

1. **First-Year Russian.**  
5 units, Aut (Van Campen and Staff)

2. **First-Year Russian—Continuation of 1.**  
5 units, Win (Van Campen and Staff)

3. **First-Year Russian—Continuation of 2.**  
5 units, Spr (Van Campen and 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 (Staff) MTWTh 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 (Staff) TTh 8

52. **Second-Year Russian.**  
5 units, Aut (Van Campen and Staff)

53. **Second-Year Russian—Continuation of 52.** Prerequisite: 52.  
5 units, Win (Van Campen and Staff)

54. **Second-Year Russian—Continuation of 53.** Prerequisite: 53.  
5 units, Spr (Van Campen and Staff)

**THIRD YEAR**

111. **Third-Year Russian** — Prerequisite: 54 or equivalent.  
5 units, Aut (Staff) MWF 9

112. **Third-Year Russian** — Continuation of 111.  
5 units, Win (Staff) MWF 9

113. **Third-Year Russian** — Continuation of 112.  
5 units, Spr (Staff) MWF 9

**FOURTH YEAR**

121. **Advanced Conversation and Composition I.**  
4 units, Aut (Staff)

122. **Advanced Conversation and Composition II.**  
4 units, Win (Staff)

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, Win (Whittaker) 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, Aut (----) by arrangement

**ADVANCED AND GRADUATE**

182. **Solzhenitsyn—Conducted in Russian.**  
4 units, Win (Pashin) TTh 3:45-5:05

183. **Conversational Russian for Graduate Students.**  
2 units, Win (Pashin) by arrangement

184. **The Russian Short Story—Conducted in Russian.** Prerequisite: 113 or equivalent.  
4 units, Aut (Pashin) TTh 3:15-5:05

185. **The Russian Novella** — Conducted in Russian. Prerequisite: 113 or equivalent.  
4 units, Win (Pashin) TTh 1:15-3:15

186. **The Russian Drama** — Conducted in Russian. Prerequisite: 113 or equivalent.  
4 units, Spr (Whittaker) by arrangement, alternate years, given 1970-71

187. **Russian Poetry of the Nineteenth Century** — A survey of the major figures and movements.  
5 units, Win (Stahlberger) MWF 1:15

188. **Russian Poetry of the Twentieth Century** — A survey of the major figures and movements.  
5 units, Spr (Stahlberger) MWF 1:15

189. **Russian Literature from the Eleventh to the Eighteenth Century.**  
5 units, Spr (Stahlberger) MWF 10

190. **Russian Literature of the Eighteenth Century.**  
4 units, Win (Stahlberger) MWF 11
192. Russian Formalism—Lectures in Russian. Written work may be in English.
3 units, Spr (Pashin) TTh 3:45-5:05

193A. 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.
5 units, Aut (Whittaker) MWF 10

193B. Studies in Russian Fiction: From Realism to Modernism — Continuation of 193A: the evolution of naturalist, symbolist and ornamentalist forms and movements in Russian prose over the last third of the nineteenth century and the first third of the twentieth, with special emphasis on stylistic and structural developments.
5 units, Win (Brown) MWF 11

196. Russian Pronunciation — Problems of theoretical and applied phonology. Prerequisite: 54 or equivalent.
5 units, Aut (Pashin) TTh 1:15-3:15

197. Russian Lexicology and Phraseology — Introduction to problems of advanced grammar and usage.
5 units, Spr (Pashin) TTh 1:15-3:15

198. Russian Syntax.
5 units, Win (——) MWF 3:15

199. Individual Work — Open to Russian majors or students working on special projects. May be repeated for credit.
1 to 5 units, any quarter (Staff) by arrangement

REMEDIAL LANGUAGE COURSES FOR GRADUATE STUDENTS

Aut (——) by arrangement

15. Development of Reading Skills.
Win (Whittaker) by arrangement

GRADUATE COURSES IN SLAVIC LINGUISTICS AND LITERATURES

211. Synchronic Morphology of Russian Conjugation and Declension.
5 units, Aut (——) MWF 3:15

212. History of the Russian Language — Prerequisite: 211.
5 units, Spr (Van Campen) MWF 2:15

215. Survey of Polish Literature I.
3 units, Aut (——) given 1970-71

216. Survey of Polish Literature II.
3 units, Win (——) given 1971-72

217. Survey of Polish Literature III.
3 units, Spr (——) given 1971-72

220. Introduction to Bibliography and Research.
3 units, Spr (Whittaker) TTh 10

228. Divergence of Slavic Languages.
4 units, Aut (Van Campen) MWF 2:15, alternate years, given 1970-71

277. Gogol.
Every three years, given 1972-73

278. Tolstoy.
3 units, Aut (Whittaker) MWF 11, every three years, given 1970-71

279. Dostoevsky.
3 units, Spr (Brown) MWF 11

250. Comparative Slavic Literature of the Medieval Period.
3 units, Aut (Stahlberger) every three years, given 1971-73

3 units, Aut (Stahlberger) alternate years, given 1970-71

299. Individual Work — Exclusively for graduate students in Slavic working on thesis or engaged in special work.
1 to 12 units, any quarter (Brown, Van Campen, Stahlberger, Whittaker, Pashin) by arrangement

300. Graduate Seminar—Subjects to be announced in Time Schedule.
5 units, Aut (Stahlberger) by arrangement
(Brown) by arrangement
Win (Brown) by arrangement
Spr (Van Campen) by arrangement
(Brown) by arrangement; topic: Problems in Literary Translation

For additional offerings in literature, see Comparative Literature.
SOCIAL SCIENCES (SPECIAL PROGRAM)

HONORS PROGRAM IN SOCIAL THOUGHT AND INSTITUTIONS

Charles Drekmeier (Chairman), Robert McA. Brown, Margot Drekmeier, John Flores, Oliver Holmes, Harold Kahn, Mark Mancall, Wilfred Stone

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 3.0 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, any quarter (——) by arrangement
Sociology

Emeriti: Richard T. LaPiere, Charles N. Reynolds (Professors)
Chairman: Bernard P. Cohen
Vice Chairman: W. Richard Scott

Associate Professor: By Courtesy: Elizabeth G. Cohen

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 — Typically, the student electing this program must take 45 units of sociology, in addition to basic University requirements.

All majors are required to enroll in the Departmental Seminar for Undergraduates, preferably during the first quarter of their junior year. This seminar is designed to introduce students to sociology as an academic discipline, to acquaint them with career opportunities in the field, and to expose them to current faculty research interests. Introduction to Sociological Research and Introduction to Sociological Theory are required of all majors.

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 in sociology and to engage in sociological research under the supervision of a member of the Department. Interested students should direct their inquiries to the undergraduate major advisers.

Honors students are not required to take a fixed number of units in sociology. However, each student must take the Departmental Seminar, Introduction to Sociological Research and a course in sociological theory. In addition, each student is required to complete one course in statistics or some other collateral field (e.g., logic, mathematics, computer science) appropriate to his specific interests or to his Honors Thesis research. Each student will plan his academic program with the help of an adviser whose approval must be obtained in the selection of a course to satisfy the collateral field requirement described above. 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 advantage of the resources of the entire University in pursuing their special interests.

Intensive work in the Honors Program begins in the second quarter of the junior year, when the student participates in Honors seminars. These seminars focus on the formulation of sociological problems and the problems of data gathering, analysis and interpretation. Ordinarily, students will gain first-hand experience with such problems working as members of a research team. 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 under the direction of a member of the Department. 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 replication of a study previously carried out or 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.
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 will not 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 at or above the 100 level offered by the Department.

At the student's option 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.

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 satisfactorily complete his Research Apprenticeship, working a minimum of two quarters in one of the research programs conducted by a faculty member and either collaborating in associated publications or preparing a written report of article length and professional quality based on his research experiences; (c) he must satisfactorily complete his Teaching Apprenticeship, working a minimum of two quarters as a teaching assistant under the supervision of a faculty member or members; (d) he 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, Sociological Applications of 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 160, Psychology 60, Statistics 50 or some equivalent must be taken in the first quarter after entering; and (e) finally, each student, in consultation with the Department's Graduate Studies Committee, must select two fields within sociology as his areas of special competence. The student must pass written examinations in these fields in order to complete requirements for admission to candidacy. Examples of such fields are Small Groups, Social Stratification, Socialization, Social Psychology, Family and Kinship, Sociology of Education, Formal Organizations, and Comparative Institutional Analysis. 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.

After being admitted to candidacy, the student must pass the University Oral Examination. Following this, 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, research assistantships, and traineeships in mental health for the support of its graduate students. Students need not apply separately to the Department to be considered for this type of support. All students who fill out University applications for financial assistance will be considered for both University and Departmental awards.

**Courses Primarily for Undergraduates**

*Note*—Sociology 1 consists of three distinct courses, each of which introduces the beginning student to the field of sociology. Each course presents the basic sociological concepts but differs in emphasis and topics examined. Students may take one, two, or three of these courses in any sequence.

1. **Introduction to Sociology.**
   5 units, Sum (______) MTWTh and sections by arrangement

1A. **Introduction to Sociology: Status, Role and Rank** — Analysis of social interaction; emergence of status and role; how status and role organize interaction; ambiguity in social interaction; how roles are learned; social control and deviance; emergence of differences in power and prestige; allocation of resources and rewards; sources of social instability and protest.
   5 units, Spr (Zelditch) MTWThF 11 and sections by arrangement

1C. **Introduction to Sociology: Social Structure, Power, and Control**—The institutional organization and definition of actors and actions in modern society. The social creation of individuals, and the regulation and integration of behavior in families, peer groups, schools, and other organizations which mediate between individuals and the institutional order. Readings in Weber, Simmel, Freud, Mead, Durkheim, and modern empirical studies.
   5 units, Win (Meyer) MTWThF 11 and sections by arrangement

1D. **Introduction to Sociology: the Social Self**—A social-psychological approach to the study of sociology, emphasizing such topics as the self, socialization, deviation and conformity, collective behavior, and statuses and ranks. The relation of the individual to large-scale organizations and institutions will also be considered.
   5 units, Aut (Dornbusch) MTWThF 11 and sections by arrangement

7. **Introduction to Statistical Methods I** (Same as Statistics 60)—Especially designed as a nonmathematical study of statistical methods used in the social sciences, biological sciences, and other disciplines. Organization of data and methods of summarization, including averages and measures of variability and association. Statistical inference based on a brief introduction to probability theory, including tests of hypotheses, estimation, and confidence intervals.
   5 units, Aut (______) MTWThF

60. **Racism and Prejudice** — An historical and comparative analysis of ethnic group relations in this and other countries. Attention is given to the social-psychological and structural sources of racism and prejudice.
   5 units, Win (Drake) MTWTh 9

61. **Racism and Prejudice**—Continuation of 60.
   5 units, Spr (Drake) MTWTh 9

80. **Departmental Seminar for Undergraduate Majors**—Designed to introduce students to sociology as an academic discipline, to acquaint them with career opportunities in the field, and to expose them to current faculty research interests. Required of all sociology majors.
   2 units, Aut (Staff) T 4:15–6:05

**Intermediate Level Courses**

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 (Olsen) MWF 11

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 (Alexander) MTWThF 1:15

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, given 1971–72

105. Organizational Behavior—An analysis of the structural characteristics of economic, political, educational and other organizations and their impact on individual participants and the functioning of society.

5 units, Aut (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, Homans's theory of social behavior as an exchange process and structural-functional analysis. Required of all sociology majors.

5 units, Win (Cohen) 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.

5 units, Aut (Simpson) MWF 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 1971–72

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 to 5 units, given 1971–72

129. Family Institutions and Behavior — Social structure of the family in Western and non-Western societies; family pathologies.

5 units, given 1971–72

130. Population Problems—(Same as Food Research 235.) 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) MTWTh 9

132. Black Communities in the United States—A description and analysis of some of the various types of black communities in this country.

5 units, given 1971–72

133. Socialization—A consideration of some of the major theoretical perspectives used to interpret socialization experiences of children and adults and a consideration of relevant empirical studies and case materials.

5 units, Aut (Mazur) T 2:15–4:05
Th 2:15–3:05

135. Social Psychology of Family Relationships — Analysis of the family as a social-psychological unit; emphasis on family roles and relations, pathology.

5 units, Win (Wallin) MWF 10

141. Science, Technology and Society—The mutual interactions between science, technology, and the social order will be described and analyzed. Special attention will be given to planned versus unplanned aspects of these institutions. Prerequisite: consent of instructor.

5 units, Win (Mazur) W 2:15–5:05

ADVANCED LEVEL COURSES—OPEN TO ADVANCED UNDERGRADUATES AND TO GRADUATES

Note: Students may obtain more detailed descriptions of many of the following courses from the Department Office on pre-registration and registration days.

131. Advanced Social Psychology — 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. Prerequisite: 103 or consent of instructor.

5 units, Win (Alexander) Th 2:15–5:05

137. Problems and Techniques in the Analysis of Organizations—Selected problems and
some of the methods employed in the study of formal organizations are explored. Prerequisite: 105 or 203.

5 units, Win (Scott) T 2:15–5:05

145. Survey Methods—Problems and techniques of survey analysis.
5 units, given 1971–72

146. Field Methods—Problems and techniques of conducting field research.
5 units, given 1971–72

148A. The Low Status Student: Race and Social Class—This course provides an attack on a problem of great contemporary interest in education from the point of view of sociological theory, research, and analysis. The relationship of research to policy formulation will be stressed. Relevant sociological theory and research will be covered from the areas of stratification, socialization, and race relations. Applications to “education for the disadvantaged” will be made. Because students must be prepared to contribute analyses and research formulations in class presentations, Education 310 or its equivalent is a prerequisite.

4 units, Aut (Cohen) TTh 3:15–5:00

148B. Interaction Processes in Education—With increased use of group work as a classroom technique and the new developments in team teaching, the educational researcher can benefit from selected theory and research by sociologists and social psychologists in the small group setting. Topics will include the social processes of evaluation, influence, and role differentiation. The student should acquire skills in selecting theory and research from a heterogenous behavioral science area that have some promise for problems in the educational setting. Methods for studying interaction in educational settings will be included. The course will involve some field work in observation and scoring of small groups in the educational setting. Because students must be prepared to contribute analyses and research formulations in class presentation, Education 310 or its equivalent is a prerequisite.

4 units, Spr (Cohen) TTh 3:15–5:00

149. Sociological Applications of Statistics—Prerequisite: 160 or consent of instructor.

5 units, Win (Hannan) MWF 1:15 and lab. by arrangement

160. Introduction to Statistical Methods, I—(Same as Statistics 160.) The lectures are those given in Statistics 60. For graduate students.

5 units, Aut (——) MTWThF

163. Comparative Institutional Analysis—Cross-cultural approach to the study of institutions and social systems. Prerequisite: 102 or consent of instructor.

5 units, Spr (Olsen) W 2:15–5:05

165. Advanced Social Stratification—Analysis of modern micro and macro theories of stratification. Emphasis will be on the economic and cultural forces shaping structures of inequality. Prerequisite: 108 or consent of instructor.

5 units, Win (Simpson) MWF 10

166. Interorganizational Relations—An examination of the effect of variations in an organization’s network of relations on its internal structural characteristics, and an exploration of the types of relationships which develop among various organizations. Prerequisite: 105 or 203.

5 units, given 1971–72

167. Advanced Political Sociology—Readings in comparative political organization and development, the organization of elites, and problems of political institutionalism and legitimacy. Prerequisite: 123 or consent of instructor.

5 units, Aut (Meyer) M 2:15–5:05

180A. Honors Seminar—Introduction to the field of sociology and current faculty research.

2 units, Win (Staff) by arrangement

180B. Honors Seminar—Introduction to the research process.

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) MW 11; labs. by arrangement

203. Fundamentals of Organization Theory
—(Same as Education 329.) Focuses on basic concepts and theories about the operation of complex organizations.
4 units, Aut (Baldridge) MTW 10

204. Field Methods in the Study of Organizations—(Same as Education 413B.) Field research on a selected organizational problem will be carried out with the student gaining experience in data collection and analysis.
4 units, Spr (Baldridge) T 7–10 p.m.

5 units, Spr (Wallin) T 2:15–5:05

230. Population Problems—(Same as Food Research 235.) For graduate students. See 130.
5 units, Win (Kirk) MTWTh 9

233. Policy Formation in Organizations—(Same as Education 413A.) Exploration of the political processes occurring within organizations which shape the formation of policy decisions.
4 units, Win (Baldridge) T 7–10 p.m.

236. The Individual and the Class System.
—An intensive analysis of selected research problems which relate individual character or personality to social structure.
5 units, Spr (Simpson) T 2:15–5:05

237. Status and Locality Systems—An exploration of status systems from the point of view of the territorial units on which they are based. It is assumed that within a given society, these units form a hierarchy ranging from small agricultural or residential communities up through the more encompassing units of the nation state. Consideration will be given to different types of resources available for exchange at each locality level and to their conversion between levels. Sociological literature concerning the relation between urbanization and changes in status systems of Western societies will be reviewed and analyses undertaken of strata formation at various levels in complex pre-industrial societies, particularly late traditional China.
5 units, Aut (Olsen) T 2:15–5:05

239. Professionals and Bureaucracies—Analysis of the somewhat conflicting trends of professionalization and bureaucratization. Examination of the conflicts and accommodations which occur between professionals and organizations.
5 units, Spr (Scott) W 2:15–5:05

240. Foundations of Sociology—An examination of some of the basic concepts and propositions of sociology with a discussion of their inter-relationships. Particular attention will be paid to the gaps and imperfections in our knowledge.
5 units, Aut (Dornbusch) M 2:15–5:05

245. Seminar on Status Problems.
5 units, Aut (Zelditch) W 2:15–5:05

250. Basic Problems in Sociological Theory—Selected sociological problems are pursued from their origins in the classical literature through to contemporary formulations. Prerequisite: consent of instructor.
5 units, Win (Zelditch) W 2:15–5:05

251. Institutionalized Status Systems—An examination of the structural significance of variations among social systems to the degree in which dimensions of stratification are institutionalized. Prerequisite: consent of instructor.
5 units, Spr (Meyer) M 2:15–5:05

253. Theory Construction — Prerequisite: consent of instructor.
5 units, given 1971–72

255. Logic of Social Research—Practice in the formulation and critical evaluation of research designs for the study of sociological problems. Prerequisites: 149 ar. I 260.
5 units, Aut (Wallin) T 2:15–5:05

260. Research Design—Prerequisite: 149.
5 units, Spr (Hannan) Th 2:15–5:05

267. Problems of Sociological Measurement—Prerequisite: 149.
5 units, given 1971–72
279. Seminar on Social Influence.
   5 units, Spr (Cohen) Th 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

308. Teaching Apprenticeship.
   (Staff) by arrangement

309. Research Apprenticeship.
   (Staff) by arrangement

   (Staff) by arrangement

SPANISH and PORTUGUESE

Emeriti: Juan B. Rael (Professor); Grace Knopp (Assistant Professor)
Chairman: Bernard Gicovate
Professors: Fernando Alegria, Aurelio M. Espinosa, Jr., Bernard Gicovate, Ronald Hilton, Isabel M. Schevill
Senior Lecturer: Phillip Petersen
Assistant Professors: Gustavo Alfaro, Joaquim F. Coelho (on leave 1970–71), Ruben A. Gamboa, John A. Kerr, Luis Ponce de Leon

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 45 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 SALAMANCA

Majors in Spanish and allied disciplines may spend two quarters in Spain as participants in the Stanford Program at the University of Salamanca. 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 Credentials Secretary, School of Education.

MASTER OF ARTS IN TEACHING SPANISH

The degree of Master of Arts in Teaching Spanish 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:

| Language Study: Spanish | 164, 165, 166, 185, 190, 201, 202 | 23 units |
| Literature: Chosen from courses in Hispanic Literature or Civilization numbered from 180 | up | 6 units |
| Language Laboratory | 215 | 2 units |
| Methods: Spanish | 210 | 2 units |
| Courses in Education | | 12 units |
| **Total** | **45 units** |
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 see the section "Humanities Special Programs" in this bulletin. Additional courses in literature of interest to graduate students in Spanish may be found in the section "Comparative Literature" in this bulletin.

Master of Arts in Spanish

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 or two seminars (Span. 250, 251; Port. 250) (6 units).
4. 6 units to be chosen from the following courses: Span. 181, 190, 204, 205, 260, 261, 263, 264, 266; Port. 185.
5. 25 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.

Doctor of Philosophy in Spanish

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 Portuguese and two other foreign languages. This knowledge must be demonstrated by examination.
2. 12 units to be chosen from the following courses: Span. 181, 190, 205, 260, 261, 263, 264, 266; Port. 185.
3. Pass the final written examinations in two of 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.
   d) Portuguese or Brazilian Literature and Civilization.
4. Write a dissertation that embodies such results of research as would merit publication.
5. Pass a final University oral examination in defense of the dissertation.
6. Satisfactory teaching experience. Teaching fellowships are available to enable candidates to fulfill this requirement, which will be waived in the case of students who have teaching experience in other institutions.
7. 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.

General Courses (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—Not open to Spanish majors.
3 units, Aut (Alfaro) MWF 11

150. Unamuno and Ortega — Present-day conflicts in literary works of Unamuno, Ortega y Gasset. Not open to Spanish majors.
3 units, Win (Schevill) W 4–6
3 units, Spr (Ponce de Leon) MWF 2:15

3 units, alternate years, given 1971-72

153. 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, alternate years, given 1971-72

156. Luso-Brazilian Literature in Translation—Analysis, discussion of representative works. Open to Spanish majors.
3 units, Spr (Staff) MWThl:15

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 to 4 units, Aut, Win, Spr (Hilton) MWF 10

SPANISH COURSES

FIRST- AND SECOND-YEAR
(Under the Direction of 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.
5 units, Aut, Win, Spr, Sum (Staff) MTWThF

2. First-Year Spanish—Continuation of 1.
5 units, Aut, Win, Spr (Staff) MTWThF

3. First-Year Spanish—Continuation of 2.
5 units, Aut, Win, Spr (Staff) MTWThF

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 Department as soon as possible.
15 units, Sum (Staff) MTWThF 8:00-9:30 and 10:30-12:00 and one hour daily in 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

22. Second-Year Spanish—Prerequisite: 3.
3 units, Aut, Win, Spr (Staff) MWF

3 units, Aut, Win, Spr (Staff) MWF

3 units, Aut, Win, Spr (Staff) MWF

9 units, Sum (Staff) MTWThF 8 and 11

52. Intensive Second-Year Spanish.
5 units, Aut (Staff) MTWThF

53. Intensive Second-Year Spanish.
5 units, Win (Staff) MTWThF

99. Individual Reading—Enrollment only by special consent. Prerequisite: 23.
1 to 4 units, am quarter (Staff) by arrangement

THIRD- AND FOURTH-YEAR

100. Advanced Spanish Conversation—May be repeated for credit. Prerequisite: 24 or equivalent.
3 units, Aut, Win, Spr (Staff) MWF 1:15

111. Third-Year Spanish—Prerequisite: 24.
3 units, Aut (Staff) MWF 9 or 11

112. Third-Year Spanish—Continuation of 111.
3 units, Win (Staff) MWF 9 or 11

113. Third-Year Spanish—Continuation of 112.
3 units, Spr (Staff) MWF 9 or 11
121. Hispanic American Cultural Readings
—Prerequisite: 23 or equivalent.
3 to 4 units, Win (Staff) MWF 3:15

125. Spanish Cultural Readings—Training
in careful reading of books with significant
 cultural content. Prerequisite: 23 or equiva-
 lent.
3 to 4 units, Aut (Staff) MWF 1:15

130. Cervantes — Reading and interpreta-
 tion of selected passages from Don Quixote.
Prerequisite: 23 or equivalent.
3 to 4 units, alternate years, given 1971–72

131. Masterworks of Spanish Literature I—
Selected readings of Golden Age authors.
Prerequisite: 23 or equivalent.
3 to 4 units, Win (Alfaro) MWF 11

132. Masterworks of Spanish Literature II
—Selected readings of modern Spanish au-
 thors. Prerequisite: 23 or equivalent.
3 to 4 units, alternate years, given 1971–72

142. The Spanish Novel of the Nineteenth
Century.
3 to 4 units, alternate years, given 1971–72

151. Masterworks of Spanish American Lit-
erature I—Prerequisite: 23 or equivalent.
3 to 4 units, Win (Gamboa) MWF 10

152. Masterworks of Spanish American Lit-
erature II—Prerequisite: 23 or equivalent.
3 to 4 units, Spr (Gamboa) MWF 10

160. Spanish Literature I—From its origins
to end of fifteenth century.
3 to 4 units, alternate years, given 1971–72

161. Spanish Literature II—Sixteenth and
early seventeenth centuries.
3 to 4 units, Spr (Alfaro) TTh 11

162. Spanish Literature III—From 1650 to
1899.
3 to 4 units, alternate years, given 1971–72

163. Spanish Literature IV—Twentieth cen-
tury.
3 to 4 units, alternate years, given 1971–72

164. Spanish Conversation — Discussion in
Spanish of present day problems. Enrollment
limited to 15. Students in the short-
term program should enroll for 164A for 2
units.
4 units, Sum (Staff) MTWThF 9

165. Spanish Conversation — Discussion in
Spanish of present-day problems. Enroll-
ment 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 pro-
gram should enroll for 166A for 2 units.
4 units, Sum (Staff) MTWThF 1:15

ADVANCED AND GRADUATE

184. Spanish Speech and Drama—Reading
and rehearsing of Spanish plays. May be re-
peated for credit. Prerequisites: 100 and 112
or consent of instructor.
3 units, Spr (Ponce de León) MWF 11

185. Spanish Phonetics.
2 to 3 units, Spr (Petersen) TTh 10
Sum (Petersen) MWF 10

186. Spanish American Literature I — Co-
lonial epoch. Open only to graduate and ad-
vanced undergraduate students.
3 to 4 units, Aut (Gamboa) MWF 11

187. Spanish American Literature II — Ro-
manticism. Open only to graduate and ad-
vanced undergraduate students.
3 to 4 units, Win (Gamboa) MWF 11

188. Spanish American Literature III —
Modernismo. Open only to graduate and ad-
vanced undergraduate students.
3 to 4 units, alternate years, given 1971–72

189. Spanish American Literature IV —
Twentieth Century. Open only to graduate
and advanced undergraduate students.
3 to 4 units, alternate years, given 1971–72

190. Spanish Linguistics—(Same as Educa-
tion 283.)
3 units, alternate years, given 1971–72

193. The Problems of Spain in the Litera-
ture of the Nineteenth and Twentieth Cen-
turies.
3 to 4 units, alternate years, given 1971–72

195. Chilean Literature of the Twentieth
Century.
3 to 4 units, alternate years, given 1971–72

195A. Argentine Literature of the Twen-
tieth Century.
3 to 4 units, alternate years, given 1971–72

195B. Mexican Literature of the Twentieth
Century.
3 to 4 units, Aut (Alegria) MW 4:15
195C. Peruvian Literature of the Twentieth Century.
3 to 4 units, Win (Alegria) MW 4:15

3 to 4 units, alternate years, given 1971–72

199. Individual Work — May be repeated for credit. Open only to majors in Spanish.
1 to 4 units, any quarter (Staff) by arrangement

GRADUATE COURSES IN SPANISH AND SPANISH AMERICAN LITERATURE

201. Advanced Grammar and Stylistics — Intensive review of structural syntax. Prerequisite: qualifying examination.
3 units, Aut (Gamboa) (I) MW 11
(Gamboa) (II) MW 3:15
Sum (Staff) 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 (Schevill) TTh 3:15
Sum (Staff) MTWF 3:15

203. Advanced Grammar and Stylistics — Prerequisite: 202 with grade of B or equivalent.
3 units, Spr (Schevill) W 7:00–9:30 p.m.

204. Modern Spanish I — The phonology of modern Spanish.
3 units, alternate years, given 1971–72

205. Modern Spanish II — The syntax of modern Spanish.
3 units, Spr (Espinosa) MWF 11

210. Methods of Teaching Spanish — (Same as Education 292.) See also Language Laboratory 215.
2 units, Aut (Petersen) TTh 10
Sum (Petersen) MTWThF 11

211. Spanish Literature from its Origins to 1500.
4 units, alternate years, given 1971–72

212. Spanish Literature of the Sixteenth Century.
4 units, Aut (Alfaro) MWF 2:15

213. Spanish Literature of the Seventeenth Century.
4 units, alternate years, given 1971–72

214. Spanish Literature from 1700 to 1850. 
4 units, alternate years, given 1971–72

215. Spanish Literature from 1850 to 1905.
4 units, alternate years, given 1971–72

216. Spanish Literature from 1905 to the Present.
4 units, Spr (Schevill) TTh 4:15–5:30

217. Spanish Theater of the Golden Age. 
3 to 4 units, Spr (Alfaro) TTh 2:15

218. Spanish Renaissance Prose.
3 units, alternate years, given 1971–72

220. Cervantes.
3 to 4 units, alternate years, given 1971–72

223. The Modern Spanish Novel.
3 to 4 units, alternate years, given 1971–72

3 units, Aut, alternate years, given 1971–72

3 units, alternate years, given 1971–72

228. Contemporary Spanish Poetry.
3 to 4 units, alternate years, given 1971–72

230. Hispanic Folklore.
3 to 4 units, every third year, given 1971–72

232. The Spanish Epic Tradition.
3 units, every third year, given 1971–72

240. Spanish Versification.
3 units, Spr (Espinosa) MWF 10

248. Proseminar: Problems and Methods of Research in Hispanic Literatures I.
3 units, Win (Gicovate) W 2:15

249. Proseminar: Problems and Methods of Research in Hispanic Literatures II.
3 units, Spr (Gicovate) W 2:15

250. Graduate Seminar in Spanish Literature — Subject to be announced in Time Schedule.
3 units, Sum (Staff) T 4:15–6:05 p.m.

251. Graduate Seminar in Spanish American Literature — The works of Pablo Neruda.
3 units, Win (Alegria) M 5:30 p.m.

255. Contemporary Novelists of Spanish America.
3 units, Aut (Alegria) M 5:30 p.m.
260. History of the Spanish Language — Readings in Old Spanish. Prerequisite: elementary knowledge of Latin and consent of instructor.

3 units, alternate years, given 1971–72

261. Old Spanish—Elements of phonology, morphology; reading of Old Spanish texts. Prerequisite: elementary knowledge of Latin and consent of instructor.

3 to 4 units, Win (Espinosa) MWF 10

263. Historical Spanish Linguistics I—Prerequisite: 260.

3 units, Win (Espinosa) MWF 11

264. Historical Spanish Linguistics II.

3 units, alternate years, given 1971–72

266. Hispanic Dialectology.

3 units, alternate years, given 1971–72

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.

5 units, Aut (Staff) MWTThF 1:15

2. First-Year Portuguese—Continuation of 1.

5 units, Win (Staff) MWTThF 1:15

3. First-Year Portuguese — Continuation of 2.

5 units, Spr (Staff) MWTThF 1:15

15. Intensive First-Year Portuguese — Equivalent to 1, 2, and 3 combined. Enrollment limited. Consent of instructor necessary.

15 units, Sum (Staff) MWTThF 8:00–9:30 and 10:30–12:00

22. Second-Year Portuguese—Prerequisite: 3.

3 units, Aut (Staff) MWF 12


3 units, Win (Staff) MWF 12

35. Intensive Portuguese — Intensive work on pronunciation and drill problems, conversation, and a minimum of composition and grammar. Prerequisite: one year of Portuguese.

12 units, Sum (Staff) MWTThF 11 and 1:15 and lab.

99. Individual Reading — Enrollment only by special permission. Prerequisite: 23.

1 to 2 units, any quarter (Staff) by arrangement

107. Conversations on Contemporary Brazil.

5 units, Sum (Staff) MWTThF 8

115. Advanced Intensive Portuguese — Intensive work on oral expression, correction of pronunciation and grammar.

12 units, Sum (Staff) MWTThF 8

131. Masterworks of Portuguese and Brazilian Literature.

3 to 4 units, alternate years, given 1971–72

ADVANCED UNDERGRADUATE AND GRADUATE

181. Advanced Portuguese.

3 units, Aut (Staff) MW 11

182. Advanced Portuguese — Continuation of 181.

3 units, Win (Staff) MW 11

183. Advanced Portuguese — Continuation of 182.

3 units, Spr (Staff) MW 11

185. Portuguese Linguistics.

3 to 4 units, Win (Petersen) TTh 11

186. Portuguese Phonetics.

3 to 4 units, alternate years, given 1971–72

191. Portuguese Literature I.

3 to 4 units, Aut (Staff) TTh 1:15

192. Portuguese Literature II.

3 to 4 units, Win (Staff) MWTThF 1:15

195. Brazilian Literature I.

3 to 4 units, alternate years, given 1971–72

196. Brazilian Literature II.

3 to 4 units, alternate years, given 1971–72

199. Individual Work—May be repeated for credit.

1 to 3 units, any quarter (Staff) by arrangement

207. Advanced Conversations on Contemporary Brazil.

5 units, Sum (Staff) MWTThF 11
250. Graduate Seminar—Subject to be announced in Time Schedule.
3 units, Spr (Staff)

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); Naomi Wrage (Assistant Professor)

Chairman: Michael Barry

Professors: Michael Barry, Wendell Cole, Eleanor Prosser, H. Donald Winbigler.
Visiting: Laurence Kitchin


Lecturers: Wolfgang Baba, Evelyn Draper, Mary S. Geldard, Jean Hartman, Thomas O. Robinson

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.

1. The minimum program required of all majors:
   a) Development of Drama. 90, 91, 92
   b) Theatre Practice. 160 (Acting) (2 units minimum)
   c) Fundamentals of Acting I. 164A, 164B
   d) Movement. 164L (to be taken concurrently with 164A and 164B)
   e) Fundamentals of Staging. 166
   f) Theatrical Makeup. 173A
   g) Introduction to Design and Technical Production. 174A, 174B, 174C
   h) Theatre Criticism. 195
   i) Visual Arts for Theatre or Art History. (6 units to be chosen from 170A, 170B, 170C, or Art and Architecture courses)

2. Two years of a foreign language at college level or the equivalent. In special circumstances, by petition, a program of related studies may be substituted for the language requirement.

3. A grade average of C must be maintained in all course work in major field.

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. Fundamentals of Acting I
164L. Movement (concurrent with 164A, 164B)
166. Fundamentals of Staging
90, 91, 92. Dramatic Literature
Six units to be chosen from Speech and Drama 170A, 170B, 170C or Art History
Electives in theatre 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, 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 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 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 theatre arts.

The M.F.A. is designed as a terminal degree, and M.F.A. candidates must maintain a grade average of B in all course work.

For further details please write to the Chairman, Department of Speech and Drama.

Note—Certain of the following course sequence requirements can be fulfilled by special examination given early in autumn quarter. Students are urged to prepare for examinations in areas in which they are proficient.

COSTUME DESIGN MAJOR

Candidates for the M.F.A. degree in Costume Design are required to complete 65 units of course work beyond the Bachelor's degree. The course requirements are as follows:

<table>
<thead>
<tr>
<th>First Year</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>271A, 271B, 271C. Costume I</td>
<td>6</td>
</tr>
<tr>
<td>297, 298. Theatre History</td>
<td>4</td>
</tr>
<tr>
<td>170A, 170B, 170C. Visual Arts for the Theatre</td>
<td>6</td>
</tr>
<tr>
<td>281A, 281B, 281C. Stage Design I</td>
<td>6</td>
</tr>
<tr>
<td>Elective</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>272A, 272B, 273C. Costume II</td>
<td>6</td>
</tr>
<tr>
<td>290A, 290B, 290C. Theatre Study</td>
<td>6</td>
</tr>
<tr>
<td>251A, 251B, 251C. Lighting I</td>
<td>6</td>
</tr>
<tr>
<td>173A, 173B. &quot;Theatrical Makeup</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Third Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electives (must include courses in Art and Architecture)</td>
<td>9-12</td>
</tr>
<tr>
<td>Dramatic Literature or Elective (one quarter dramatic literature required)</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>21-24</td>
</tr>
</tbody>
</table>

SCENE DESIGN MAJOR

Candidates for the M.F.A. degree in Scene Design are required to complete 69 units of course work beyond the Bachelor's degree. The course requirements are as follows:

<table>
<thead>
<tr>
<th>First Year</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>281A, 281B, 281C. Scene Design I</td>
<td>6</td>
</tr>
<tr>
<td>297, 298. Theatre History</td>
<td>4</td>
</tr>
<tr>
<td>241A, 241B, 241C. Technical Production I</td>
<td>6</td>
</tr>
<tr>
<td>170A, 170B, 170C. Visual Art for the Theatre</td>
<td>6</td>
</tr>
<tr>
<td>Elective</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>282A, 282B, 282C. Scene Design II</td>
<td>6</td>
</tr>
<tr>
<td>271A, 271B, 271C. Costume I</td>
<td>6</td>
</tr>
<tr>
<td>290A, 290B, 290C. Theatre Study</td>
<td>6</td>
</tr>
<tr>
<td>251A, 251B, 251C. Lighting I</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Third Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>283A, 283B, 283C. Scene Design III Thesis</td>
<td>3</td>
</tr>
<tr>
<td>Dramatic Literature or Project (one quarter dramatic literature required)</td>
<td>9</td>
</tr>
<tr>
<td>Electives (courses in Art)</td>
<td>9-12</td>
</tr>
<tr>
<td>Total</td>
<td>21-24</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 101 units of course work beyond the Bachelor's degree. The course requirements are as follows:

First Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>251A, 251B, 251C. Lighting I</td>
<td>6</td>
</tr>
<tr>
<td>297, 298. Theatre History</td>
<td>4</td>
</tr>
<tr>
<td>170A, 170B, 170C. Visual Art for the Theatre</td>
<td>6</td>
</tr>
<tr>
<td>214A, 241B, 241C. Technical Production I</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22</strong></td>
</tr>
</tbody>
</table>

Second Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>252A, 252B, 252C. Lighting II</td>
<td>6</td>
</tr>
<tr>
<td>242A, 242B, 242C. Technical Production II</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

Third Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>246A, 246B, 246C. Technical Production III</td>
<td>6</td>
</tr>
<tr>
<td>Thesis or Lighting III Thesis</td>
<td>3</td>
</tr>
<tr>
<td>243A, 243B, 243C. Theatre Engineering</td>
<td>3</td>
</tr>
<tr>
<td>271A, 271B, 271C. Costume I</td>
<td>6</td>
</tr>
<tr>
<td>Electives</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21</strong></td>
</tr>
</tbody>
</table>

ACTING MAJOR

The candidate for the M.F.A. in Acting is required to complete 48 units of course work.

First Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>51A, 261B, 261C. Acting I</td>
<td>9</td>
</tr>
<tr>
<td>271A, 272B, 272C. Costume Design I</td>
<td>3</td>
</tr>
<tr>
<td>233A, 263B, 263C. Voice</td>
<td>3</td>
</tr>
<tr>
<td>265A, 265B, 265C. Movement</td>
<td>3</td>
</tr>
<tr>
<td>290A, 290B, 290C. Theatre Study</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

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. Theatre History or Dramatic Literature</td>
<td>9</td>
</tr>
<tr>
<td>233A, 263B, 263C. Voice</td>
<td>3</td>
</tr>
<tr>
<td>265A, 265B, 265C. Movement</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24</strong></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 support of the degree 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. Theatre Arts requirement. During the first year of residence, the candidate will select one aspect of theatre arts as an area of concentration: acting, directing, costume design, scene design, lighting design, or technical production. In consultation with the faculty, he will elect a year of courses from the M.F.A. curriculum to further his understanding of his chosen area. (The candidate who enters the program with minimal background in theatre arts may find it necessary to take introductory courses on the undergraduate level before entering the professional graduate courses.) Before scheduling his comprehensive examinations, the candidate will demonstrate his general understanding of all the theatre arts by submitting a directorial analysis of one play of his choice.

4. Examinations. When course work is completed, the candidate takes written comprehensive examinations in his four fields of concentration (see below). Upon successful
5. Dissertation. Either immediately preceding or after 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: Classical Drama, Medieval Drama, Renaissance Drama, European Drama in the Eighteenth Century, Modern Drama from 1870 to 1918, etc.)

2. One major playwright.

3. One national drama. (To be chosen from English, American, French, Italian, Spanish, German, Russian.)

4. One area of theory to be defined by the candidate. (Examples: one aspect of dramatic theory, one critical method, Tragedy, Directing, Costume Design, etc.) The examination will be based on application of the given theory to a comprehensive list of plays, covering all periods, to be submitted by the candidate.

Only two areas of study in a candidate's program are permitted to overlap significantly. (Examples: French Drama and Molière; Renaissance Drama and Shakespeare.) At least one area of study must be before 1700. A candidate will be responsible for the theatre history in all areas of specialization.

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. Completed application forms for fellowships should be filed before January 15 at the Office of Financial Aid at the same time as completed 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

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.

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. May be repeated for credit.

80A. Debate.

80B. Debate and Forensics.

80C. Symposium.
Independent Study.  
1 to 4 units, any quarter (Staff) by arrangement

Exposition—Focuses on the individual as he experiences the process of communication in an interacting group.  
3 units, Aut, Win (Schrader, Staff) MWF 11 or 1:15

Argumentation—Reasoning processes and their use in analysis and persuasion.  
3 units, Aut, Win, Spr (Hastings) MWF 10

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

Advanced Public Speaking—Preparation and delivery of speeches designed to modify audience behavior and the study of current speakers for style, content, and rhetorical technique. Prerequisite: 20 or equivalent.  
3 units, Spr (Mosier) MTW 2:15

Persuasion Process—Processes of persuasion—personal, interpersonal, and social dimensions.  
4 units, Aut, Win (Hastings) MW 2:15–4:05

Group Communication—Decisions, conflict, and communication in small groups. Prerequisite: 120A or 120C.  
4 units, Spr (Schrader) TTh 2:15–4:05

Language and Communication—Verbal and non-verbal language in the process of communication.  
4 units, Spr (Hastings) MW 2:15–4:05

Contemporary Issues—The role of American spokesmen in contemporary social controversies.  
4 units, Win (Wrage) TTh 2:15–4:05

THEATRE AND DRAMA

Introduction to the Contemporary Theatre—Survey of the arts of the theatre; lectures and discussion of readings in contemporary drama. May not be offered in support of the major.  
3 units, Spr (Prosser) MWF 9

Development of Drama (Classical to Renaissance)—Survey of the western drama and theatre from origins in Greece to the Renaissance.  
4 units, Aut (Chioles, Cole) MTWTh 1:15

Development of Drama (Baroque to Romantic)—Survey of the western drama and theatre from the late Renaissance through the early 19th century.  
4 units, Win (Prosser, Cole) MW 1:15

Development of Drama (Modern)—Survey of the western drama and theatre from Ibsen to the present.  
4 units, Spr (Kitchin, Cole) MTWTh 1:15

Theatre Practice (Acting)—Credit for participation by undergraduates in departmental productions. Thirty hours of rehearsal per unit will be required to pass the course. May be repeated. No more than 10 units, however, may be counted by drama majors toward graduation requirements of 180 units. Prerequisite: consent of instructor.  
1 to 3 units, any quarter (Staff) by arrangement

Theatre Practice (Crew)—Credit for participation by undergraduates in departmental productions. Thirty hours of work per unit will be required to pass the course. May be repeated. Prerequisite: consent of instructor.  
1 to 3 units, any quarter (Staff) by arrangement

Fundamentals of Acting I—An introduction to the elements of self-awareness, characterization, and theatrical expression for the beginning actor. Prerequisite: sophomore standing. To be taken concurrently with 164L.  
164A. 4 units, Aut (Geldard) TTh 10–12; lab. Th 1–3 or F 1–3  
164B. 4 units, Win (Geldard) TTh 10–12; lab. Th 1–3 or F 1–3  
164C. 4 units, Spr (Geldard) TTh 10–12; lab. Th 1–3 or F 1–3

Movement—To be taken concurrently with 164A,B,C.  
1 unit, Aut, Win, Spr (Dodg) T 3:15–5:05

Fundamentals of Acting II—Prerequisites: by audition.  
165A. 3 units, Aut (Geldard) TTh 1–3  
165B. 3 units, Win (Geldard) TTh 1–3  
165C. 3 units, Spr (Geldard) by arrangement
166. Fundamentals of Theatre Staging—An approach to the problem of presenting a play in performance. An introduction to the first principles of design, text, casting, rehearsals, blocking. Prerequisites: 164A and 164B.

3 units, Spr (——) TTh 1–3

170A,B,C. Visual Art for the Theatre—Survey of painting, sculpture, as it affects theater style.

170A. 2–3 units, Aut (Robinson) MWF 1:15
170B. 2–3 units, Win (Robinson) MWF 1:15
170C. 2–3 units, Spr (Robinson) MWF 1:15

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 (Hartman)
   Section 1, T 1–3
   Section 2, by arrangement

173B. 1 unit, Win (Hartman) T 1–3

174A,B,C. Introduction to Design and Technical Production—A lecture-lab course that introduces the undergraduate (and graduates with no previous technical theatre background) to the theatrical arts and crafts of costume, stage design, lighting design, and technical production.

174A. 4 units, Aut (Baba, Hartman, Robinson) MWF 9; lab. F 2–4 and crew by arrangement
174B. 4 units, Win (Baba, Hartman, Robinson) MWF 9; lab. F 2–4 and crew by arrangement
174C. 4 units, Spr (Baba, Hartman, Robinson) MWF 9; lab. F 2–4 and crew by arrangement

190. Modes of Acting (Classical)—Prerequisites: 164A and 164B, or consent of instructor.

3 units, Aut (——) TTh 10–12

191. Modes of Acting (Renaissance and Baroque)—Prerequisites: 164A and 164B, or consent of instructor.

3 units, Win (——) TTh 10–12

192. Modes of Acting (Romantic and Modern)—Prerequisites: 164A and 164B, or consent of instructor.

3 units, Spr (——) 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 theatre arts.

1 to 4 units, any quarter (Staff) by arrangement

195. Theatre Criticism—Readings in contemporary techniques. Papers based on performances attended in the area.

3 units, Spr (Chioles) MW 10:00–11:15


3 units, Spr (Cole) MWF 11


3 to 4 units, Win (Kitchin)

GRADUATE COURSES FOR M.F.A.

Open by permission to unusually qualified undergraduate and graduate 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 scenic techniques.

241A. 2–3 units, Aut (Hunt) T 9, Th 9–11 and F 10–12
241B. 2–3 units, Win (Hunt) T 9, Th 9–11 and F 10–12
241C. 2–3 units, Spr (Hunt) T 9, Th 9–11 and F 10–12


242A. 2 units, Aut (Hunt) F 9–11 and 12–2
242B. 2 units, Win (Hunt) F 9–11 and 12–2
242C. 2 units, Spr (Hunt) F 9–11 and 12–2


243A. 1 unit, Aut (Hunt) by arrangement
243B. 1 unit, Win (Hunt) by arrangement
243C. 1 unit, Spr (Hunt) by arrangement
244A,B. Survey of Scene Design, Stage Lighting, and Technical Production.

244A. Survey of Scene Design and Technical Production.

2 to 3 units, Win (Eddelman and Hunt) MW 9

244B. Survey of Stage Lighting.

2 to 3 units, Spr (Hunt) MW 9


246A. 1 unit, Aut (Staff) by arrangement

246B. 1 unit, Win (Staff) by arrangement

246C. 1 unit, Spr (Staff) by arrangement

251A,B,C. Lighting I—Introduction to stage lighting.

251A. 2-3 units, Aut (Landry) MTh 12

251B. 2-3 units, Win (Landry) MTh 12

251C. 2-3 units, Spr (Landry) MTh 12

252A,B,C. Lighting II — Advanced stage lighting.

252A. 3 units, Aut (Hunt) M 12 and Th 11

252B. 3 units, Win (Hunt) M 12 and Th 11

252C. 3 units, Spr (Hunt) M 12 and Th 11


253A. 1 unit, Aut (Landry) by arrangement

253B. 1 unit, Win (Landry) by arrangement

253C. 1 unit, Spr (Landry) by arrangement

254A,B,C. Theatre Engineering — A study of the use of electrical and mechanical devices for theatre equipment, theatre planning, and facilitated theatrical production.

254A. 1 unit, Aut (Landry) by arrangement

254B. 1 unit, Win (Landry) by arrangement

254C. 1 unit, Spr (Landry) by arrangement

261A,B,C. Acting I.

261A. 3 units, Aut (——) MWF 9:30–12:00

261B. 3 units, Win (——) MWF 9:30–12:00

261C. 3 units, Spr (——) MWF 9:30–12:00

262A,B,C. Acting II.

262A. 3 units, Aut (Geldard) MWF 9:30–12:00

262B. 3 units, Win (Geldard) MWF 9:30–12:00

262C. 3 units, Spr (Geldard) MWF 9:30–12:00

263A,B,C. Voice — Open to M.F.A. Actors only.

263A. 1 unit, Aut (Draper) by arrangement

263B. 1 unit, Win (Draper) by arrangement

263C. 1 unit, Spr (Draper) by arrangement

265A,B,C. Movement.

265A. 1 unit, Aut (Dodge) MWF 12:30–2:00

265B. 1 unit, Win (Dodge) MWF 12:30–2:00

265C. 1 unit, Spr (Dodge) MWF 12:30–2:00

271A,B,C. Costume I — Introduction to costume history, design and construction. Two-hour drawing laboratory in the handling of various media.

271A. 1–2 units, Aut (Robinson) T 9 and Th 9–11; lab. by arrangement

271B. 1–2 units, Win (Robinson) T 9 and Th 9–11; lab. by arrangement

271C. 1–2 units, Spr (Robinson) T 9 and Th 9–11; lab. by arrangement

272A,B,C. Costume II — Projects in costume design.

272A. 2 units, Aut (Eddelman) T 1:15

272B. 2 units, Win (Eddelman) T 1:15

272C. 2 units, Spr (Eddelman) T 1:15


273A. 1 unit, Aut (Eddelman) by arrangement

273B. 1 unit, Win (Eddelman) by arrangement

273C. 1 unit, Spr (Eddelman) by arrangement

281A,B,C. Scene Design I — Principles of design and practice. Two-hour drawing laboratory in the handling of various media.

281A. 2 units, Aut (Robinson) M 10–12 and W 10; lab. by arrangement

281B. 2 units, Win (Robinson) M 10–12 and W 10; lab. by arrangement
281C. 2 units, Spr (Robinson) M 10-12 and W 10; lab. by arrangement

282A,B,C. Scene Design II—Projects in design.
282A. 2 units, Aut (Eddelman) W 11-1
282B. 2 units, Win (Eddelman) W 11-1
282C. 2 units, Spr (Eddelman) W 11-1

283A. 1 unit, Aut (Eddelman) by arrangement
283B. 1 unit, Win (Eddelman) by arrangement
283C. 1 unit, Spr (Eddelman) by arrangement

290A,B,C. Theatre Studies — An approach to the staging of drama. The initial problems and alternatives facing the director, actor, and designer are shared and developed in laboratory work.
290A. 2 units, Aut
290B. 2 units, Win
290C. 2 units, Spr

297. Theatres and Staging I (Classical) — Survey of theatres, staging methods, styles of theatrical production from the Greeks through the Neo-Classical.
2-3 units, Aut (Cole) MWF 9

298. Theatres and Staging II (Modern) — Survey of theatres, staging methods, styles of theatrical production from Neo-Classical to Modern.
2-3 units, Win (Cole) MWF 9

PH.D. COURSES

Seminar topics will vary. See Time Schedule for specific title.

301. Seminar in Classical Drama (Greek and Roman).
3 to 4 units, given 1971-72

302. Seminar in Medieval Drama.
3 to 4 units, Win (Prosser)

303. Seminar in Renaissance Drama (1550-1640).
3 to 4 units, given 1971-72

304. Seminar in Baroque Drama (1660-1775).
Seminar in Molière.
3 to 4 units, Spr (Chioles)

305. Seminar in Romantic Drama (1780-1880).
3 to 4 units, Win, given 1971-72

306. Seminar in Modern Drama (1880 to present).
Seminar in Shaw.
3 to 4 units, Aut (Barry)
Seminar in Chekhov.
3 to 4 units, Win (Kitchin)

3 to 4 units, Spr (Prosser) given 1971-72

308. Seminar in Comedy.
3 to 4 units, Aut (Kitchin)

309. Seminar in Early American Drama.
3 to 4 units, Spr (Cole)

310. Seminar in Contemporary American Drama.
3 to 4 units, Spr (Cole) given 1971-72

360A. Research Methods.
4 units, Aut (Prosser)

360B. History of Dramatic Criticism.
4 units, Win (Chioles)

360C. Contemporary Critical Techniques.
4 units, Spr (Kitchin)

390. Special Research in Drama and Theater History.
1 to 4 units, any quarter (Staff) by arrangement

391. Special Projects in Theater Arts.
1 to 4 units, any quarter (Staff) by arrangement

392. Tutorial Study.
4 units, any quarter (Staff) by arrangement

400. Dissertation Research.
Any quarter (Staff) by arrangement

STATISTICS

Emeritus: Quinn McNemar (Professor)
Chairman: Rupert G. Miller, Jr.

Offerings and Facilities

The Department’s goals 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.

Introductory courses for general students with an interest in the problems of statistical inference are: Statistics 40, 41; Statistics 50; Statistics 60, 61, 62. Statistics 40, 41 covers discrete probability theory and its applications in statistics. Statistics 50 studies the theory of making decisions in the face of uncertainty. The sequence 60, 61, 62 emphasizes mainly the techniques and methods of statistical inference. These courses do not require any knowledge of calculus; the higher-numbered courses in the catalog all have some calculus prerequisite. 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, 217, and 218 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, Computer Science, Operations Research, 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 106.
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 requirement for, at most, 1 of the following courses: Statistics 40, 41, 50, 60, 61, 62, 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, 217, 218, 219, 220 (or the Honors sections of these courses).
2. Mathematics 113; and Computer Science 106 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 mathematic
SCHOOL OF HUMANITIES AND SCIENCES

cal 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, 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 250, 251, 252, 255, and 257 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 expected to complete Statistics 116, 217, 218, 219, and 220 with a B average grade. In addition, he will be expected to satisfactorily complete five other courses chosen from Statistics Department offerings or from authorized courses in other departments.

**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 08540.

**COURSES**

40, 41. Introduction to Probability and its Applications — Basic probability theory, combinatorial problems, random variables, laws of large numbers, random walks, Markov chains, with applications drawn from decision theory, statistical inference, and games of chance. Statistics 40 may be taken without Statistics 41, but not vice versa.
STATISTICS

40. 3 units, Aut (Switzer) MWF 2:15
41. 3 units, Win (Switzer) 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, Win (Chernoff) MTWThF 2:15
4 units, Sum (———) MTWThF 10

50. Introduction to Statistical Methods, I. (Previously denoted as Statistics 7.)—Especially designed as a nonmathematical study of statistical methods used in the social sciences, biological sciences, and other disciplines. Organization of data and methods of summarization, including averages and measures of variability and association. Statistical inference based on a brief introduction to probability theory, including tests of hypotheses, estimation, and confidence intervals.
5 units, Aut (Anderson) MTWThF 3:15

51, 62. Introduction to Statistical Methods, II, III. (Previously denoted as Statistics 161, 162.)—This two-quarter sequence is planned as a continuation of Statistics 60 and will treat in detail the rationale and application of the most useful statistical methods, tests of significance, estimation of parameters, and analysis of data. Chi-square tests, the analysis of variance, least squares methods in regression, correlation, nonparametric methods, sample surveys, elementary design of experiments. Prerequisite: Statistics 60 or consent of instructor.
61. 3 units, Win (Solomon) TTh 11:00–12:15
62. 3 units, Spr (Solomon) TTh 11:00–12:15

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 3:15

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 (Lieberman) TTh 10 and MW 4:15
Spr (Lieberman) MTWF 9
Sum (———) MTWThF 9

4 units, Aut (Stein) MTWThF 11
Spr (Johns) MTWF 2:15
Sum (———) MTWThF 11

116E. Theory of Probability—A course similar to 116 for engineering students. Prerequisite: Mathematics 45.
3 units, Aut (Chernoff) MWF 11

4 units, Aut (Olshen) MTWThF 11

119. Elementary Statistical Inference—Review of probability; distribution theory; sampling, sampling distributions; univariate, bivariate normal distribution; correlation, regression. Prerequisite: 116.
4 units, Win (Solomon) MWF 10
4 units, Sum (Haley) MTWThF 8:00–9:50

119H. Elementary Statistical Inference—Honors version of 119. Prerequisites: grade of A in 116 or B in 116H; Mathematics 45.
4 units, Win (Olkin) MWF 10

120. Statistical Inference — Point estimation; interval estimation; tests of hypothesis; linear hypothesis; distribution free methods; sequential analysis. Prerequisite: 119.
4 units, Spr (Solomon) MWF 10
4 units, Sum (Haley) MTWThF 8:00–9:50

120H. Statistical Inference — Honors version of 120.
4 units, Spr (Anderson) MWF 10

136. Introduction to the Theory of Games — Two person-zero sum games; strategy; minimax solutions; infinite games. Pre- or Corequisites: 116 and Mathematics 113.
3 units, Aut (Cover) MWF 2:15

140, 141. Introduction to Probability and its Applications — For graduate students. Lectures same as 40, 41.
140. 3 units, Aut (Switzer) MWF 2:15
141. 3 units, Win (Switzer) MWF 2:15

150. Elementary Statistics — For graduate students. Lectures same as 50.
4 units, Win (Chernoff) MTWThF 2:15
3 units, Sum (———) MTWThF
152. Introduction to Operations Research I
—(Enroll in Operations Research 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 (Cottle) MW 4:15–5:30

153. Introduction to Operations Research II

3 units, Spr (Hillier) MW 4:15–5:30

160. Introduction to Statistical Methods, I
—For graduate students. Lectures same as 60.

4 units, Aut (Anderson) MTWThF 3:15

161, 162. Introduction to Statistical Methods, II, III — For graduate students. Lectures same as 61, 62.

161. 3 units, Win (Solomon) TTh 11:00–12:15
162. 3 units, Spr (Solomon) TTh 11:00–12:15

199. Independent Study — For undergraduates.

(Staff) by arrangement

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, given 1971–72

206. Mathematical Models in Behavioral Sciences: Measurement and Utility Theory —(Enroll in Philosophy 206.) 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) given 1971–72

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) given 1971–72

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, given 1971–72


3 units, given 1971–72

216. Statistical Techniques for Industrial Problems—Review of principles of lot-by-lot acceptance inspection; variables inspection; recent results in use of economic cost and Bayesian statistical methods; general principles of sequential sampling plans sampling plans for continuous production life testing. Prerequisite: 120 or equivalent.

3 units, given 1971–72

217, 218. 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.

217. 3 units, Win (——) MWF 3:15
218. 3 units, Spr (——) MWF 3:15
217, 218. 6 units, Sum (——) MTWTh 10:00–11:50

217H, 218H. Introduction to Stochastic Processes—Honors version of 217, 218, with emphasis on theory. Prerequisite: grade of A in 116 or B in 116H.

217H. 3 units, Win (Olshen) MWF 3:15
218H. 3 units, Spr (Olshen) MWF 3:15
219. Elementary Statistical Inference—For graduate students. Lectures same as 119.
   3 units, Win (Solomon) MWF 10
   3 units, Sum (Haley) MWFThF 8:00–9:50

   3 units, Win (Olkin) MWF 10

220. Statistical Inference—For graduate students. Lectures same as 120.
   3 units, Spr (Solomon) MWF 10
   3 units, Sum (Haley) MWFThF 8:00–9:50

220H. Statistical Inference—Honors version of 220.
   3 units, Spr (Anderson) MWF 9

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 (Miller) MWF 11

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, Spr (Moses) MWF 8

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.
   3 units, Aut (Stein) MWF 1:15
   3 units, Win (Stein) MWF 1:15
   3 units, Spr (Stein) MWF 1:15

236A,B,C. Mathematical Statistics—A survey of classical and modern statistics from an advanced mathematical point of view. Probability, games and decision theory, estimation, testing hypotheses, 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 (Johns) TTh 11:00–12:15
   3 units, Win (Johns) TTh 11:00–12:15
   3 units, Spr (Johns) TTh 11:00–12:15

242A,B. 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: 217 and 219.
   3 units, given 1971–72
   3 units, given 1971–72

   3 units, Win (Hillier) TTh 4:15–5:30

   3 units, Spr (Lieberman) MW 4:15–5:30

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 parametric programming. Students will solve a linear programming problem on computer. Corequisite: Mathematics 113.
   3 units, Aut (Hillier) TTh 1:15–2:45

257. Data Processing in Operations Research—(Enroll in Operations Research 257.) Seminar in selected topics in the application of electronic computers to operations research activities. Emphasis on the
use of simulation techniques. Prerequisites: Computer Science 136 and at least two courses in Operations Research.

3 units, Win (——-) MW 4:15-5:30

260A,B,C. Workshop in Biostatistics—Techniques useful in biological applications including bioassay, quantal response, epidemiology. Informal training in medical science by medical school faculty. Open to doctoral students in Statistics.

260A. 2 to 5 units, Aut (Brown, Miller) Th 1:15-3:05 and by arrangement

260B. 2 to 5 units, Win (Brown, Miller) Th 1:15-3:05 and by arrangement

260C. 2 to 5 units, Spr (Brown, Miller) Th 1:15-3:05 and by arrangement

261A,B,C. Workshop in Behavioral Science Statistics—Practicum in consulting on behavioral science problems, emphasizing both the theoretical and practical aspects of the problem. Open to doctoral students. Prerequisite: consent of instructor.

261A. 2-3 units, Aut (Olkin) by arrangement

261B. 2-3 units, Win (Olkin) by arrangement

261C. 2-3 units, Spr (Olkin) by arrangement

299. Literature of Statistics—Intensive study of literature of any special topic, usually culminating in the preparation and presentation of reports upon topics studied.

Any quarter (Staff) by arrangement

Note—Registration in courses numbered 300 and above generally requires completion of Statistics 236A,B,C (or concurrent registration, with the consent of the instructor).

324A,B. Multivariate Analysis—The multivariate normal distribution and related distributions such as the Wishart distribution and Hotelling’s $T^2$. Statistical inference for the multivariate normal distribution. Multiple regression, canonical correlations, multivariate analysis of variance, classification problems. Application of group theory to multivariate analysis.

324A. 3 units, given 1971-72

324B. 3 units, given 1971-72

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: 217 and 220.

3 units, Aut (Chernoff) MWF 9

326B. Sequential Analysis—General theory of optimal stopping with applications to sequential statistical decision problems.

3 units, Win (Chernoff) MWF 9

328A,B. 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.

328A. 3 units, given 1971-72

328B. 3 units, given 1971-72


332A. 3 units, given 1971-72

332B. 3 units, given 1971-72

336A,B. 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.

336A. 3 units, given 1971-72

336B. 3 units, given 1971-72

341. Stationary Processes—Topics will be selected from: ergodic theorems and their applications, stationary processes as mixtures of ergodic processes, central limit problem for stationary processes, entropy.

3 units, Aut (Olshen) MWF 2:15

343A,B. Foundations of Time Series Analysis—Hilbert space and function space methods of studying the probabilistic structure and statistical theory of time series. Prerequisite: 230B.
343A. 3 units, given 1971–72
343B. 3 units, given 1971–72
351A, B. 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.
351A. 3 units, given 1971–72
351B. 3 units, given 1971–72
3 units, Spr (Cover)

371. Combinatorial Analysis—Combinatorial problems in the design of experiments and in graph theory.
3 units, Win (Shrikhande) MWF 3:15

384. Special Topics in Multivariate Analysis: Matrix Analysis and Inequalities—Consideration will be given to special topics in matrix theory and inequalities: inequalities for characteristic roots, order preserving transformation, probabilistic inequalities. Applications in statistics will be stressed. Prerequisites: Mathematics 113 and 114. Recommended: 220.
3 units, Aut (Olkin) MWF 11:00–12:30

399. Research—Research work as distinguished from independent study of nonresearch character listed in 199 and 299.
Any quarter (Staff) by arrangement
SCHOOL of LAW

Dean: Bayless Manning
Professors: Thomas Ehrlich, Marc A. Franklin, John Kaplan, John Henry Merryman, Carl Bernhardt Spaeth
Assistant Professor: John H. Barton
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 professional degree in law (J.D.) constitutes an adequate preparation for the practice of law in any English-speaking jurisdiction. Graduate work leading to the degrees of Master of the Science of Law and Doctor of the Science of Law is also offered. (For full Law School Curriculum and Faculty see the School of Law Programs of Study.) The Law School is on a two-term academic calendar. Registration for the Autumn Term will be held on September 9, 1970, and classes for Spring Term will terminate on June 7, 1971.

COURSES

GRADUATE

The following courses are open to qualified graduate students of other departments of the University upon permission of the instructor:

293. 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 (Spaeth)

323. The Legal Systems of Western Europe and Latin America—The purpose of this course is to examine the traditions, attitudes, institutions and processes that are shared by the legal systems of major Western European and Latin American nations—the so-called civil law nations—and to understand some of the more important ways in which they differ from the Anglo-American common law.

3 term units, Aut (Merryman)

341. 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 (Torzsay-Biber)

NONPROFESSIONAL

The following nonprofessional courses, 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. Courts and The Legal Process—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 primary 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 units, Spr (Franklin) MTW 8:35–9:50
107. The Criminal Law and the Criminal System—Exploration of the nature and effects of public behavior control through punishment, with emphasis on its purposes, the actual operation of the system, and the application of theory to contemporary problems. Topics will include marijuana, civil disobedience, and crime rates.

3 units, Spr (Kaplan)

138A,B. Problems of Arms Control and Disarmament—New two-quarter, interdisciplinary offering. See description in Political Science 138A,B.

Win, Spr (T. Ehrlich, Barton, Craig, Lewis, W. Panofsky, Paret, A. Peterson)
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, 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 to apply that knowledge to problems of illness and health.

The curriculum offered students in the M.D. Program of the School of Medicine is an outgrowth of the Stanford Plan of Medical Education that was implemented at the time the Medical School moved from San Francisco to the University campus near Palo Alto. The goals of the Stanford Plan are:

1. To bring medical education into the University environment as a continuation of general education and to relate knowledge of the medical sciences to other fields of knowledge.
2. To provide all students with fundamental knowledge of the medical sciences, while simultaneously encouraging each student to develop as an individual in line with his abilities and interests.
3. To emphasize the unity of the medical sciences.
4. To promote in students awareness of the place of medicine in society, and of the patient and physician as members of society.
5. To produce practitioners of medicine whose approach to problems in clinical medicine is that of a scientist.
6. To encourage interested students toward academic medicine as a career.
7. To foster a graduate approach to medical education.

The School believes that the goals of the Stanford Plan of Medical Education are best achieved if each student can plan his curriculum within a flexible educational system in which the diversity of students' career goals and educational backgrounds is recognized. Accordingly, in 1968, curricular changes were introduced which emphasize the development of individualized study plans for each student. Medical students no longer take a group of specified courses nor are they required to meet specific course requirements. Rather, each student, in consultation with a faculty advisory team, develops a study plan from among the course offerings of the School of Medicine.

Such study plans are reviewed by the Advisor Teams and the Medical School's Committee on Courses and Curriculum to determine their acceptability toward fulfilling the requirements for the M.D. degree. Students are encouraged to develop study plans that will enable them to take full advantage of the resources of the Medical School and University and to pursue study of one of the medical disciplines in depth. When appropriate, students can engage in courses of study in sub-specialty areas in the clinical disciplines or in basic science or clinical research.

Students interested in combined M.D.-Ph.D. programs must first apply for admission to the M.D. Program. Selected students accepted into the M.D. Program, upon invitation by the faculty, are eligible for appointment as predoctoral fellows in the Medical Scientist Training Program in the School of Medicine. Students interested in medical research should consult the Medical School Bulletin for details of this Program.

Students are encouraged to prepare for medical school with a thorough exposure to the basic natural sciences. This includes basic courses in organic chemistry and biol-
ogy. The Medical School does not require specific courses of instruction for admission but acceptance is contingent upon the student demonstrating ability to understand basic scientific concepts. Because of its importance to an understanding of medicine, course work in mathematics is highly recommended. The general requirements for admission are in the Medical School Bulletin. For application materials write to: Chairman, Committee on Admission, M105, Stanford University School of Medicine, Stanford, California 94305.

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

Emeritus: Sarah Semans (Associate Professor)
Director: Lucille Daniels
Associate Professors: Lucille Daniels. Clinical: Herbert T. Browne, Catharine Graham

OFFERINGS AND FACILITIES

The Division of Physical Therapy in the Stanford University School of Medicine offers a Master's degree curriculum for students entering the field of physical therapy. The program encompasses two academic years of three quarters each and includes the basic courses required for state registration and advanced courses in patient care, administration, teaching, and research. The curriculum is approved by the Council on Medical Education of the American Medical Association in collaboration with the American Physical Therapy Association.

Classes are held at the Stanford Medical Center, which houses physical therapy lecture, laboratory, seminar and research rooms, a library, and a clinic, which are adjacent to the physical therapy service department. Following initial directed clinical experience in the Medical Center during the first year of the program, students have assignments to affiliated health care facilities 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 which provide part or full tuition and a stipend; 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, and a number of private agencies offer special scholarships for physical therapy students.

The Western States (including Hawaii and Alaska) without a physical therapy program provide part of the tuition of legal residents through WICHE (Western Interstate Commission for Higher Education).

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, anatomy, human physiology and psychology. Physics and sta-
tistics 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 and physiology that are offered by the respective departments in the Medical School. Electives related to the field of health may be selected.

**COURSES**

<table>
<thead>
<tr>
<th>COURSE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td><strong>Introduction to Physical Therapy</strong> — 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.</td>
</tr>
<tr>
<td>2 or 3 units, Aut (Daniels)</td>
<td>T 3:15–5:05</td>
</tr>
<tr>
<td>220</td>
<td><strong>Human Motion and Therapeutic Procedures I</strong> — Functional anatomy; biomechanics and neuroanatomy related to body motion; organization and development of movement; analysis and practice of related therapeutic exercise procedures.</td>
</tr>
<tr>
<td>5 units, Aut (Staff)</td>
<td>MWF 10–12 and open labs. by arrangement</td>
</tr>
<tr>
<td>221</td>
<td><strong>Human Motion and Therapeutic Procedures II</strong> — Continuation of 220.</td>
</tr>
<tr>
<td>5 units, Win (Staff)</td>
<td>MWF 10–12 and open labs. by arrangement</td>
</tr>
<tr>
<td>222</td>
<td><strong>Human Motion and Therapeutic Procedures III</strong> — Continuation of 221.</td>
</tr>
<tr>
<td>5 units, Spr (Staff)</td>
<td>MWF 10–12 and open labs. by arrangement</td>
</tr>
<tr>
<td>225</td>
<td><strong>Evaluative Procedures I</strong> — The use of electromyography, goniometry, dynamometry, and manual muscle tests.</td>
</tr>
<tr>
<td>3 units, Aut (Staff)</td>
<td>WF 8–10 and open labs. by arrangement</td>
</tr>
<tr>
<td>226</td>
<td><strong>Evaluative Procedures II</strong> — Continuation of 225.</td>
</tr>
<tr>
<td>3 units, Win (Staff)</td>
<td>WF 8–10 and open labs. by arrangement</td>
</tr>
<tr>
<td>230</td>
<td><strong>Physical Agents</strong> — Analysis of the principles underlying the use of electrotherapy, massage, and hydrotherapy; practice of essential techniques.</td>
</tr>
<tr>
<td>3 units, Aut or Win (Houser, Robertson)</td>
<td>TTh 10–12 and open labs. by arrangement</td>
</tr>
<tr>
<td>240</td>
<td><strong>Clinical Medicine I</strong> — Basic medical lectures in pathology, medicine, surgery, and specialty areas; discussion of problems in patient care.</td>
</tr>
<tr>
<td>2 units, Aut (Special Lecturers)</td>
<td>W 9 and Th 1:15–3:05</td>
</tr>
<tr>
<td>241</td>
<td><strong>Clinical Medicine II</strong> — Continuation of 240.</td>
</tr>
<tr>
<td>2 units, Win (Special Lecturers)</td>
<td>M 9 and Th 1:15–3:05</td>
</tr>
<tr>
<td>242</td>
<td><strong>Clinical Medicine III</strong> — Continuation of 241.</td>
</tr>
<tr>
<td>2 or 3 units, Spr (Special Lecturers)</td>
<td>Th 1:15–3:05</td>
</tr>
<tr>
<td>250</td>
<td><strong>Social and Psychological Aspects of Illness and Disability</strong> — Special problems of handicapped individuals related to reactions to illness and disability, patient-therapist relationships; emphasis on total rehabilitation of the patient.</td>
</tr>
<tr>
<td>2 to 3 units, Spr (Forward, Staff)</td>
<td>by arrangement</td>
</tr>
<tr>
<td>255</td>
<td><strong>Directed Clinical Experience in Physical Therapy</strong> — Students are assigned part-time to health care facilities.</td>
</tr>
<tr>
<td>1 to 5 units, any quarter (Kent, Staff)</td>
<td>by arrangement</td>
</tr>
<tr>
<td>256</td>
<td><strong>Internship in Physical Therapy</strong> — Students are assigned to treatment facilities for full-time supervised clinical experience.</td>
</tr>
<tr>
<td>3 to 12 units, any quarter (Kent, Staff)</td>
<td>by arrangement</td>
</tr>
<tr>
<td>257</td>
<td><strong>Case Studies and Directed Reading</strong>.</td>
</tr>
<tr>
<td>2 to 4 units, any quarter (Kent, Staff)</td>
<td>by arrangement</td>
</tr>
<tr>
<td>260</td>
<td><strong>Introduction to Administration</strong> — Administration of physical therapy facilities in hospitals, special centers, and in home care.</td>
</tr>
<tr>
<td>3 units, Win (Daniels, Staff)</td>
<td>MWF 10</td>
</tr>
<tr>
<td>261</td>
<td><strong>Seminar in Administration</strong> — Program planning; supervising and consulting techniques; interprofessional and interdepartmental relationships; field work and projects.</td>
</tr>
<tr>
<td>3 units, Spr (Daniels, Staff)</td>
<td>MWF 1:15–2:05</td>
</tr>
<tr>
<td>270</td>
<td><strong>Seminar in Therapeutic Procedures and Community Health</strong> — Individual patient evaluation and program planning; use of community resources.</td>
</tr>
<tr>
<td>5 units, Win (Blood and Staff)</td>
<td>TTh 1:15–3:05 and one hour by arrangement</td>
</tr>
<tr>
<td>280</td>
<td><strong>Curriculum Development and Instruction</strong> — Objectives, organization, content,</td>
</tr>
</tbody>
</table>
techniques in teaching courses in physical therapy; projects in selected areas of the field.

3 units, Win (Daniels) MWF 11

1 to 5 units, any quarter (Staff)

1 to 8 units, any quarter (Staff) by arrangement

290. Seminar in Research—Basic principles of research with emphasis on material applied to physical therapy.
3 to 5 units, Win (Forward and Staff) MWF 1:15-2:05

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

295. Research.
(Staff) by arrangement

ANATOMY

Emeriti: William W. Greulich, Hadley Kirkman (Professors)
Acting Chairman: Donald J. Gray
Professors: Donald J. Gray, Robert S. Turner
Associate Professors: A. Kent Christensen, Donald L. Stilwell, Jr.
Assistant Professors: Ferrell R. Campbell, Thomas E. Schroeder
Instructors: Masaka A. Baba, Myrna B. Miller, Maureen B. Sass
Clinical Lecturers: Dean T. Clark, Burt L. Davis, Jr., Mitchell S. Madison, Robert W. Meyer, Reuben Stutch, Bernard O. A. Thomas
Cooperating in the offerings of the Department of Anatomy is Shoichi Kohatsu, Assistant Professor of Surgery.

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

201. Dissection of the Human Body—Demonstrations and lectures, including a series on human embryology. A few nonmedical students may be admitted by special arrangement.
5 units, Aut (Gray, Baba, Campbell) MWF 2:15-5:05

4 units, Win (Gray, Baba, Campbell, Sass) MWF 2:15–5:05

3 units, Spr (Stilwell, Baba, Sass, Turner) TTh 8:00–10:50

204. Histology — Structural and functional organization of cells, tissues, and organs, as seen with the light and electron microscopes.
3 units, Aut (Christensen, Kirkman, Miller, Schroeder) M 3:15–4:05 and Th 2:15–5:05
205. Histology—Continuation of 204.
3 units, Win (Christensen, Kirkman, Miller, Schroeder) T 2:15–3:05 and F 2:15–5:05

206. 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 the staff.
Any quarter (Staff) by arrangement

207. Topographical Anatomy—Laboratory study of fetal, infantile, adult cadavers; dissected and specially injected specimens; reports relevant to this material. Prerequisites: 201, 202, and 203.
2 to 5 units, any quarter (Gray) by arrangement

208. Dissection of the Fetus—General introduction to fetal anatomy, or review and intensive study of selected regions. Enrollment limited. Ordinarily, prerequisites: 201 and a course in embryology.
Any quarter (Gray) by arrangement

4 units, Aut (Turner, Miller, Stilwell) MWTh 10:00–10:50

210. Hematology: Blood and Connective Tissues—Lectures and laboratory covering morphological and chemical aspects of red blood cell differentiation, elaboration of granulocytic lysosomes, and synthesis of antibody. Most laboratory time will be devoted to study of bone marrow and other organs with light microscopy and demonstrations of electron microscopic data. Prerequisite: histology.
2 units, Spr (Campbell) Th 1:15–5:05, alternate years, given 1971–72

211. Advanced Histology — This course offers an opportunity to study in detail the functional histology of any selected tissue or organ system. Consists of laboratory and library work, combined with informal discussions with the instructor.
Any quarter (Christensen, Kirkman) by arrangement

212. Biological Electron Microscopy — An introduction to routine techniques. Limited to six students, whose research may involve serious electron microscopy in the future. Prerequisite: consent of instructor.
3 units, Aut (Christensen, Campbell, Staff) S 10:00–11:50

213. Practical Anatomy — Brief survey of human body by dissection, study of anatomical preparations. Lectures, demonstrations. For students of nursing, physical therapy, hygiene, physical education, or others similarly qualified. Cannot be substituted for any part of 201.
5 units, Aut (Sass) TWTTh 1:15–4:05

214. Neuroanatomy Laboratory — A study of prepared slides and dissections of central nervous systems of man and other mammals. Prerequisite: previous or concurrent enrollment in 209.
1 unit, Aut (Turner, Miller, Stilwell) MWTh 11:00–11:50

299. Research—By individual arrangement, approved by Department faculty.
Any quarter (Staff) by arrangement

310. Advanced Dissection—Lectures, demonstrations, and dissection. Emphasis on clinical and surgical application of anatomy. Prerequisites: 201, 202, and 203, or equivalent.
Spr (Stilwell and Kohatsu) by arrangement

BIOCHEMISTRY

Acting Chairman: Paul Berg
Associate Professor: George R. Stark (on leave 1970–71)

PROGRAMS OF STUDY

The Department offers a first-year course in modern biochemistry open to medical students, 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. Remission of fees and a personal stipend are available to those students accepted. For further information, applicants should write to Dr. D. S. Hogness. 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; in the biochemistry of viral infection; in the biochemistry of the nervous system; in the biochemistry and control of developmental processes; and in the structure and function of membranes.

COURSES

200, 201. General Biochemistry — Deals with basic biochemistry, and with special biochemical aspects of the various life processes. Open to medical, graduate, and advanced undergraduate students.

200. 5 units, Aut (Staff) MTWTThF 11
201. 5 units, Win (Staff) MTWTThF 11


2 units (Stark) given 1971-72

211. Molecular Basis of Morphogenesis.

2 units (Kaiser) given 1973-74

212. Special Topics in Biochemistry.

2 units (Lehman) given 1971-72

213. The Arrangement of Information in Chromosomes — The structure of chromosomes, distribution of genes, and extraction of information from chromosomes will be considered, starting with viral chromosomes and progressing to more complex structures. Prerequisites: 200, 201 or consent of instructor.


3 units (Baldwin) given 1972-73

215. Special Topics in Biochemistry.

2 units (Berg) given 1972-73

216. Special Topics in Neurobiology — (Same as Genetics 216.)

2 units (Shooter) given 1971-72

220. Membrane Biochemistry — Composition, structure, and function of simple and complex membranes will be considered, as will related cytoplasmic and outer-cell-envelope-layer structures and functions. Emphasis will be on functional aspects such as permeation, energy transfer, and biosynthetic sequences.

2 units, Spr (Kornberg) given 1970-71

270. Seminar.

By arrangement

299. Research and Special Advanced Work.

By arrangement

GENETICS

Chairman: Joshua Lederberg*
Professors: Leonard A. Herzenberg, Joshua Lederberg, Eric M. Shooter
Associate Professor: A. T. Ganesan
Senior Scientists: 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. Interdepartmental programs leading to a Ph.D. are also available for Neurological Sciences, and are actively planned for Environmental Health.

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 sciences divisions 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, biochemical neurogenesis, the investigation of extraterrestrial life, application of new physical methods to biochemical analysis, and cell detection and sorting procedures, 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. Humanics — Special undergraduate course. 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. The course emphasizes the confrontation of new science with social policy.

3 units, Spr (Lederberg) by arrangement

201. Medical Genetics—Genetics of human populations, genetic analysis of human variability, pedigree analysis, applications to genetic diseases and some of the more important genetic polymorphisms. Nonmedical students who wish to enroll in this course must obtain special consent from the Department of Genetics.

2 units, Win (Staff) TTh 1:15-2:05

208. Human Cytogenetics and Its Clinical Applications—After a review of normal human chromosome structure and normal chromosome segregation in mitotic and meiotic divisions, abnormal patterns of chromosome segregation and abnormalities of chromosome morphology are discussed. Present knowledge of gene action and gene mapping of human chromosomes are reviewed. Human clinical syndromes related to chromosomal abnormalities of both sex chromosomes and autosomes are presented together with available information on the epidemiology of such syndromes and their patterns of inheritance. Modern experimental approaches to cytogenetic problems are discussed. Concurrent with the seminar sessions, there is opportunity for practical dem-
onstrations in the laboratory and presentation of patients with chromosomal diseases. Limited to 20 students, minimum of 5. Prerequisites: biology and basic genetics, or consent of instructor.

2 units, Spr (Luzzatti, Ganesan) by arrangement, alternate years, given 1971–72

213. Mechanism of Antibody Synthesis: Genetic, Molecular and Cellular Considerations—Structure and genetics of immunoglobulins, cellular and molecular events in antibody induction and synthesis, theories of antibody formation, genetics of the immune response. Minimum 6 students. Prerequisites: Biochemistry 200, 201, Biology 10, Medical Microbiology 200, or equivalents, or consent of instructor.

2 units, Win (Herzenberg, McDevitt) M 4:15–6:05

216. Special Topics in Neurobiology—(Same as Biochemistry 216.) Recent advances in the biochemistry of the nervous system with particular reference to developmental aspects, the basis of neurological specificity and the biochemistry of nerve cells and of their methods of communication with each other. Prerequisites: knowledge of biochemistry and consent of the instructor.

2 units (Shooter) given 1971–72

217. Computers in Medical Statistics—The course is designed to give instruction in computer use, and an understanding of the statistical methods employed in the analysis of complex data. Special attention will be paid to problems of computerized assistance to diagnosis.

3 units, Spr (Buchanan, Brown) by arrangement

249. Cytogenetics—(Same as 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 the instructor.

3 units, Aut (Ganesan) MWF 10

260. Supervised Study—Prerequisite: consent of the instructor.

Any quarter (Staff) by arrangement

270. Genetics Seminar.

Any quarter (Staff) by arrangement

271. Immunology Literature Reviews—(Same as Pathology 271.) Discussions by course participants of selected recent articles in an area of immunology. Prerequisites: a working knowledge of biochemistry, genetics, and immunology. Consent of the instructor. Limited to 12 students.

2 units, any quarter (Herzenberg, Weissman) W 8:30 p.m.

299. Individual Research.

Any quarter (Staff) by arrangement

PROGRAM IN HEARING AND SPEECH SCIENCES

Emeritus: Virgil A. Anderson (Professor)
Director: James H. Dewson III
Professors: Jon Eisenson, Earl D. Schubert
Associate Professors: Clara N. Bush (Linguistics), James H. Dewson III, Dorothy A. Huntington
Instructors: Donald M. Morehead

Clinical: Robert H. Gottsleben

OFFERINGS AND FACILITIES

The fundamental aim of the program is to make available to doctoral and postdoctoral students the material essential to a complete understanding of behavioral and physiological aspects of normal and defective processes of human communication. Students may be preparing for careers in university teaching or research, or they may have primary interests in another discipline, e.g., medicine, with a desire for specialized study in some area of human communication.

The available facilities include fully-equipped new laboratories for basic and applied research into every major aspect of the hearing and speech sciences. The Scottish Rite Institute for Childhood Aphasia has a close connection with the program; this affiliation plus a direct relation with the Division of Otolaryngology of the Stanford Medical School makes it possible to offer excellent opportunities for training and research in the clinical aspects of communication disorders. Strong working relationships with other departments of the University, both within the School of Medicine and elsewhere, provide further for a well-balanced graduate academic environment.
PROGRAMS OF STUDY

Each student's doctoral program is planned individually with the needs and interests of the candidate in mind. Candidates may include a formal minor as part of their program. The minor is chosen in consultation with the candidate's major advisor, 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. The general University requirements for the doctorate are followed as they apply to residence, application for candidacy, etc. (See the section “Degrees” in this bulletin.)

A limited number of postdoctoral research fellows will be accepted each year. For further information write to the Director.

COURSES

200. Individual Study—Study under direction in fields or subjects of special interest. Prerequisite: consent 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.
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

221. Instrumental Phonetics — Techniques of instrumental research in speech perception and production. Theory and instrumentation for analysis and manipulation of speech signals. Laboratory.
2 units, Aut (Huntington) Th 3–5

223. Speech and Language Development—Study of phonology, syntax, semantics, and sociolinguistics in the evolving linguistic system of the child. Contributions of cognitive, learning, and linguistic theory to language acquisition.
3 units, Spr (Morehead) MWF 1:15

230. Physiology of Speech Production — 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) by arrangement

231. Acoustic Characteristics of Speech — Perceptual and physiological correlates of the acoustic constituents of speech.
3 units, Spr (Huntington) by arrangement

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: consent of instructor.
3 units, Win (Morehead) TWF 1:15
Sum (Eisenson) MTWF 9

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, Aut (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. Special Topics in Speech Science.
3 units, Win (Huntington, Bush)
by arrangement

4 units, Aut (Huntington) by arrangement

311. Experimental Phonetics: Acoustic Anal-
ysis of Speech—Special reference to evaluation of constituent features.

4 units, Win (Huntington) by arrangement

312. Experimental Phonetics: Physiological Analysis of Speech — Motor processes of speech production with reference to acoustic and perceptual correlates.

4 units, Spr (Huntington) by arrangement

330. Special Topics in Phonetic Theory.

4 units, Spr (Bush) by arrangement

340. Seminar in Biological Approaches to Language.

4 units, Aut (Morehead) by arrangement

3 units, Sum (Morehead) by arrangement

370. Clinical Internship—In-service clinical practice and observation in selected speech and hearing centers.

1 to 12 units, any quarter (Staff)

380. Selected Topics in Audiology.

3 to 4 units, Aut (Dewson)

by arrangement

381. Bioacoustics and Animal Communication.

1 to 4 units, Win (Dewson)

by arrangement

390. Seminar in Neural Substrates of Human Communication.

2 to 4 units, Spr (Dewson)

by arrangement


3 to 4 units, Win (Schubert)

by arrangement

393. Peripheral Auditory Mechanisms — 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.

3 to 4 units, Spr (Schubert)

by arrangement


3 to 4 units, Spr (Dewson)

by arrangement

400. Doctoral Research.

1 to 15 units, any quarter, (Staff) T 4:15

**MEDICAL MICROBIOLOGY**

Emeriti: Charles E. Clifton, Edwin W. Schultz (Professors); Helen S. Thayer (Instructor)

Chairman: Sidney Raffel

Professors: Leonard Hayflick, Sidney Raffel, Carlton E. Schwerdt, Bruce A. D. Stocker

Associate Professors: Robert J. Roantree, Leon T. Rosenberg. Clinical: Orland A. Soave

Assistant Professors: Alfred A. Amkraut, Bernard W. Nelson

**PROGRAMS OF STUDY**

The Department of Medical Microbiology offers, in addition to the courses intended for 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, 200, 202, 204, 205, 206, 207, 270; in addition, Biochemistry 200 and 201 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. Under special circumstances candidates are accepted for the degree of Master of Arts. They 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, 200, 202, 204, 205, 206, 207, 270, and Biochemistry 200 and 201. At least 15 units of research bearing on the thesis subject
must be completed. The candidate is expected to pass an oral examination of two hours' duration covering the fundamentals of medical microbiology, bacterial genetics, 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 200, 201), statistics (Psychology 60 or Statistics 50), the principles of computer science (e.g., Computer Science 136, 208), 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); embryology and histology (Anatomy 200, 203, or Biology 103); genetics (Biology 248, 249, 252, Genetics 212); biochemistry (e.g., Biochemistry 211, 212, 213, 214, 215, 217); physical chemistry (e.g., Chemistry 171, 173); calculus (Mathematics 10, 11, 21, 22, 23). The choice among these (or other) formal courses should be discussed with an adviser.

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 202, 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 Microbiology—Survey of fundamental aspects of microbiology. Prerequisites: Biology 4, 5, and Chemistry 1, 2, 3.

2 units, Aut (Hayflick) WF 1:15; lab. WF 2:15-4:05

200. Basic Medical Microbiology — An introduction to the principles of immunology and bacteriology.

2 units, Aut (Staff) WTh 10

201. Diseases of Laboratory Animals — Seminar on the spontaneous diseases of laboratory animals and their influence on research results. Emphasis is placed on diagnosis, treatment, pathology, control, and prevention of the diseases of common species of laboratory animals. Open to students of the School of Medicine and to graduate students in the biological sciences. Prerequisite: consent of instructor.

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

202. 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, of laboratory diagnosis, and of preventive measures.

4 units, Win (Staff) MW 10–12 and Th 11–12

204. Topics in Bacterial Genetics—Lectures and demonstrations on inheritance in bacteria, 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 (Stock) MWF 1:15 alternate years, given 1971–72

205. Immunology and Serology—Lectures, demonstrations covering infection, immunity, antigen-antibody reactions. Prerequisites: 101 or 202, Biology 103 or Anatomy 203, and Biochemistry 200.

3 units, Win (Amkraut, Raffel, Roantree, Rosenberg) MWF 1:15, alternate years, given 1970–71

206. Virology — Lectures, demonstrations on general nature of plant, animal viruses, their relationships with their hosts. Prerequisites: 101 or 202, and Biochemistry 200.

3 units, Spr (Schwerdt) TThF 1:15

209. Techniques in the Use of Animals for Research—Lectures and demonstrations of the methods of restraint, anesthesia, venipuncture, and surgical techniques used on the common species of laboratory animals.
The place of animal research in the biomedical sciences and responsibilities of investigators using animals are emphasized. Prerequisite: consent of instructor.

1 unit, Spr (Soave) by arrangement

260. Literature Reviews—Review of literature on special topics to be assigned by instructor.

3 to 5 units, any quarter (Staff) by arrangement

261. Current Topics in Immunology—A review of the current literature in one or a few selected areas of interest. Prerequisite: consent of the instructor.

2 units, any quarter (Amkraut, Raffel, Roantree, Rosenberg) by arrangement

270. Seminar—Reports, discussions on selected topics by outside speakers. Required of all graduate students.

1 unit, Aut, Spr (Staff) by arrangement

299. Research — Students who have satisfactorily completed necessary foundation courses may elect research work in: general bacteriology, including genetics; pathogenic bacteriology; immunology and serology; or virology. Grade average of B in bacteriological subjects required for admission to research or thesis work.

15 units maximum, any quarter (Staff) by arrangement

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### PHARMACOLOGY

**Emeritus:** Leon Kolb (Clinical Associate Professor)

**Chairman:** To be announced.

**Professors:** Lewis Aronow (on leave 1970–71), Robert H. Dreisbach (on leave 1970–71), Avram Goldstein, Oleg Jardetzky, Sumner M. Kalman, Tag E. Mansour, Robert T. Schimke

**Visiting Professors:** Ralph I. Dorfman, Richard K. Richards

**Assistant Professors:** Tatiana A. Assaykeen, Leslie Wilson

**Lecturer:** Dora B. Goldstein

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### PATHOLOGY

**Emeritus:** Bruno Gerstl (Professor)

**Chairman:** David Korn

**Professors:** Klaus G. Bensch, David Glick (on leave), David Korn, Lelland J. Rather, Lucien J. Rubinstein

**Associate Professors:** Amico Bignami, Ronald F. Dorfman, Richard L. Kempson, Paul L. Wolf

**Assistant Professors:** George W. H. Bailey, Luis J. Fajardo, Lysia K. Forno, Mary M. Herman, Jon C. Kosek, Howard Sussman, Irving Weissman. **Visiting:** Robert W. Archibald, John Gough, Klaus Lewin

**Instructors:** Errol C. Friedberg (on leave). **Visiting:** Rosemary Millis. **Acting:** John E. Lund. **Director of Electron Microscopy:** Glen B. Haydon

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### PROGRAMS OF STUDY

The Department presents a series of basic courses in contemporary pharmacology (201–203) and advanced courses open to qualified medical and other graduate students.

A program of study and research training is offered leading to the Ph.D. degree. Postdoctoral research training is available to graduates having the Ph.D. or M.D. degree. Research opportunities also exist for medical students and a limited number of undergraduate students during the summer. Financial support for predoctoral and postdoctoral trainees includes full tuition and stipends at current national levels.

The Ph.D. program is designed for students with a background in biology, chemistry, physics, or mathematics who wish to pursue a career of research in a field that lies between biology and medicine. Modern pharmacology is concerned with understanding the mechanisms of drug action at the cellular and molecular levels, and utilizing this knowledge for the rational development of new drugs, and their proper use in man. The two major fields of research interest in the Department are molecular phar-
macology, and clinical pharmacology and toxicology.

Research in molecular pharmacology seeks to extend our knowledge of the interactions of chemical agents with biological systems at the molecular level in order to shed more light on the precise mechanisms whereby drugs exert their specific effects. Present fields of investigation include hormone actions on target cells and organs, regulation of hormone secretion, cell regulatory mechanisms in carbohydrate metabolism, regulation of macromolecular synthesis in mammalian cells, mechanism of action of antimitotic agents, nuclear magnetic resonance studies of the nature of the interactions between drugs and macromolecules, and biochemical mechanisms associated with drug addiction. Research in clinical pharmacology and toxicology is directed toward gaining a better understanding of the variables that influence drug action in man in order to improve the clinical effectiveness of drugs and reduce their toxicity. A corollary aim is to develop an understanding of chemical hazards in the environment in order to safeguard society against this danger. Topics of interest to members of the Department include drug metabolism, dosage scheduling, pharmacogenetics, and environmental pharmacology.

Students desiring to become candidates for advanced degrees should consult the general University regulations regarding such degrees, as summarized in the section "Degrees" in this bulletin. Further information can be obtained from the Department. Consult Time Schedule for additional advanced courses.

BASIC COURSES

Principles of Pharmacology (201) is considered basic to the understanding of drug action, and will generally be taken by second-year medical students in conjunction with the course in systematic pharmacology (202) which deals with the major classes of drugs used in man. Pharmacology 203 (Pharmacology of the Nervous System) is concerned specifically with drugs that affect the nervous system, and is offered for both medical students and students more specifically interested in behavioral sciences. Students may elect a program within this context that best meets their individual needs, and while many students will choose to take the entire sequence in their second year, others will defer or omit entirely certain of these courses.

201. Principles of Pharmacology—A lecture course on the principles of drug action. Topics to be considered will include kinetic aspects of drug absorption and distribution, drug metabolism, and drug-receptor interaction. Other topics will include drug resistance, tolerance, pharmacogenetics, toxicity, carcinogenesis, mutagenesis, and teratogenesis. This course is considered necessary for further study in pharmacology and therapeutics. Prerequisites: mammalian physiology and biochemistry, or consent of the instructor.

3 units, Aut (Staff) MWF 1:15

202. Systematic Pharmacology — A lecture and demonstration course in systematic pharmacology and elementary aspects of therapeutics. The major drug groups will be discussed with emphasis on their use in man. Prerequisite: 201 or consent of instructor.

4 units, Win (Staff) TWThF 1:15

203. Pharmacology of the Nervous System —A lecture course on mechanisms of action and therapeutic uses of drugs affecting the central nervous system. Drugs discussed include convulsants, anti-convulsants, sedatives, analgesics, tranquilizers, and other psychoactive drugs. Problems of drug abuse are also considered.

3 units, Spr (Staff) TWTh 9

ADVANCED COURSES

Advanced courses are open to students in all parts of the University, but the instructor's consent is required prior to registration. In general, these courses require as a prerequisite a good knowledge of physiology and biochemistry and sometimes of microbiology or genetics. Previous or concurrent registration in Principles of Pharmacology (201) will usually be assumed by the instructor. Students are advised to consult with the instructor about the adequacy of their preparation.

213. Cellular Regulatory Mechanisms in Carbohydrate Metabolism — Lectures and discussions on the different regulatory processes that keep carbohydrate catabolic reactions in the cell in pace with its energy requirement and the effect of different hor-
mones on carbohydrate metabolism at the cellular and subcellular level.

1 unit, Win (Mansour) T 4:15

214. Hormonal Control of Cellular Metabolism and Development — Lectures, discussions, and readings concerned with mechanisms of hormone effects on regulation of metabolism and development at the cellular and subcellular levels dealing primarily with various vertebrate systems.

1 unit, Win (Schimke) T 4:15, given 1971–72

215. Drug Metabolism — Lectures and discussions on the metabolic conversion of foreign compounds in the mammalian organism, including factors such as species, age, and genetic variability.

1 unit, Spr (Aronow) M 4:15, given 1972–73

216. Drug Addiction, Tolerance, and Physiological Dependence — Lectures and discussions with emphasis on recent research into the biochemical basis of these phenomena.

1 unit, Aut (A. Goldstein) T 4:15, given 1972–73

217. Problems of Population Growth — Lectures and seminar discussion on population growth and its control through the use of pharmacologic agents.

2 units, Aut (Kalman) T 4:15–6:05

218. Environmental Toxicology — Lectures and discussions on environmental hazards in smogs and other products of a complex society.

2 units, Spr (Dreisbach) given 1971–72

219. Alcohol and Alcoholism — Lectures and discussions on the pharmacologic actions of alcohol and on various aspects of alcoholism.

1 unit, Win (D. B. Goldstein) T 4:15, given 1972–73

220. Topics in Molecular Pharmacology.

1 unit, Spr (Jardetzky) T 4:15, given 1970–71


1 unit, any quarter (Staff) Th 4:15–6:05

280. 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

299. Research.

Any quarter (Staff) by arrangement

PHYSIOLOGY

Emeritus: James P. Baumberger (Professor)

Acting Chairman: Maurice E. Krahl

Professors: Jefferson M. Crismon, Ronald Grant, Maurice E. Krahl, Eugene D. Robin

Associate Professors: Julian M. Davidson (on leave 1970–71), George A. Feigen

Visiting Associate Professor: Ardis J. Krahl

Acting Assistant Professor: Noel Thompson

Lecturer: Ann G. Taylor

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 under-
take 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: General Biochemistry 200 and 201 (without laboratory), Physical Chemistry (Chemistry 171 and 173), and Physiology courses 200, 201, 202, 203, and 214. In addition, students will take at least three other courses selected from Departmental or extradepartmental offerings. Courses in computer science, mathematics, statistics, chemistry, physics, biology, or engineering may be arranged by agreement between the student and his faculty supervisor.

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.

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


6 units, Spr (Krahl, Crismon, Harrison) MWF 9–11

201. Clinical Physiology (Physiology and Medicine) — (Formerly 250.) 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.

6 units, Aut (Krahl, Crismon, Fletcher, Robin) M 8–10; T 8–11 and F 8–12

202. Clinical Physiology (Physiology and Medicine) — (Formerly 251.) Endocrinology, reproductive and gastrointestinal function. An interdepartmental course.

7 units, Win (Krahl, Davidson, Reaven, Greenberg, Gray) MW 8–10 and TThF 8–9

203. Neurophysiology — (Formerly 350.) Lectures on the basic physiology of the mammalian central nervous system. Prerequisite: neuroanatomy must be taken previously or concurrently.

3 units, Aut (Grant) MWTh 9–10

204. Peripheral Circulation — (Formerly 301.) Lectures and demonstrations on regulation of the peripheral circulation with emphasis on special features of the circulation in man. Prerequisite: 200 or equivalent.

3 units, Aut (Crismon) W 4:15–6:05 and F 4:15–5:05, alternate years, given 1971–72

205. Biological Systems Analysis — (Formerly 302.) A lecture course for biologists on the mathematical approach to comparative mechanical, electrical and biological systems. Includes treatment of first- and second-
PHYSIOLOGY 445

Requisite: one year of calculus.

3 units, Win (Thompson) W 4:15–6:05 and F 4:15–5:05, alternate years, given 1970–71

207. Immunophysiology Laboratory—(Formerly 304.) 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) T 7:30–9:00 p.m.; lab. Th 9:00–4:05

208. Current Problems in Muscle Physiology—(Formerly 306.) Discussion of selected biophysical, pharmacological, and immunological aspects of muscle contraction; evaluation of modern theories of contractility.

2 units, Spr (Feigen) T 7:30–9:30 p.m., alternate years, given 1970–71

209. Central Autonomic Neurophysiology—(Formerly 307.) A lecture and discussion course on recent advances in understanding of central nervous mechanisms involved in regulation of body temperature, food and water intake, the cardiovascular system, etc. Predominantly neuroendocrine mechanisms will not be taken up. See Course 210. Prerequisite: Neurophysiology 203.

2 units, Spr (Grant) T 7:30–9:30 p.m.

210. Neuroendocrinology—(Formerly 308.) A lecture and discussion course on selected topics of current interest in the general area of nervous and endocrine system interrelations. Special emphasis will be placed on mechanisms for control of pituitary function and behavioral aspects of neuroendocrinology. Prerequisites: basic knowledge of neurophysiology, neuroanatomy and endocrinology; consent of instructor.

2 units, Spr (Davidson) T 7:30–9:30 p.m., alternate years, given 1971–72

212. Nerve, Muscle and Synapse—(Formerly 150.) Lectures on the ionic basis of excitation, conduction and excitatory and inhibitory synaptic action in nerve and all types of vertebrate muscle. Intended mainly for incoming students who have not previously mastered this material and as introduction to 203 in which prior knowledge of this basic material will be assumed.

1 unit, Spr (Grant)

One hour weekly, by arrangement

213. Special Topics in Physiology—A seminar course of guided reading and discussion in both introductory and advanced physiological topics. Topics are agreed upon by an individual instructor and interested students. Prerequisite: consent of instructor.

(Staff) by arrangement

214. Physical Chemical Principles in Physiology—(Formerly 310.) 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 2:15–5:05

215. Tutorial in Clinical Physiology—Guided study, with readings and discussions in both introductory and advanced physiological topics, to supplement 200, 201, 202.

1 or 2 units, any quarter (Taylor, Krahl, Staff) by arrangement

260. Advanced Readings in Neurophysiology—A tutorial course involving guided study in depth of aspects of neurophysiology selected by individual students in consultation with the instructor. Ordinarily, the student will be expected to present orally and defend a paper based on his reading to other registered students in an open seminar, but critical written review in which the student is involved may be incorporated in these papers. Prerequisite: Neurophysiology 203.

Units flexible, any quarter (Grant) by arrangement

299. Advanced Research—Investigation sponsored by individual faculty members may be undertaken by interested, qualified medical or graduate students. The hours and units may be arranged by the student. The fields of research open to students include: endocrinology, neuroendocrinology, central nervous system function, adrenal cortical functions, regional blood flow in skin and nerve, immune reactions and anaphylaxis, reproductive physiology, cybernetics (systems analysis and instrumental techniques).

Any quarter (Staff) by arrangement
AFRICAN STUDIES

The NDEA African Language and Area Center offers courses in beginning and advanced Hausa, Swahili and Yoruba through the Department of Linguistics. In other departments in the University, courses are offered which cover the history of pre-colonial Africa, 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 particular developing countries, and other courses dealing in whole or in part with the study of Africa. A Bachelor's degree is offered in African and Afro-American Studies. (See listing of the Undergraduate Program in African and Afro-American Studies.) No graduate degree is offered in African Studies as such. Graduate 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, Political Science, and Sociology.

For further information please write to Joseph H. Greenberg, Chairman, Committee on African Studies, and director, NDEA African Language and Area Center, Stanford University, Stanford, California 94305.

COMPUTATION CENTER

Director: Paul Armer
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: William H. Yundt

Affiliated Faculty:

Associate Professor: Robert W. Floyd

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. The system includes a text editor and file handler, a remote job entry facility, and a time-sharing system as well as the usual batch processing capabilities.

In addition to the above, 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, BASIC, 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 Programming Concepts

This course is intended to acquaint the prospective computer user with computer concepts and terminology and to introduce him to the methods of organizing problems for computer solution. A brief introduction to computer systems including a description of software services and a typical hardware configuration will be presented. The concept of an operating system and the need for Job Control Language will be discussed. Problem analysis and flowcharting techniques will be described, and the student will be given some exercise in flowcharting.

0 units, Aut, Win, Spr

5, 6. BASIC—This course is designed to introduce the student to time-sharing concepts and to the time-sharing language BASIC. For the researcher who is not a sophisticated programmer, this language is uniquely valuable in solving small day-to-day problems. In addition, the immediate and informative responses by BASIC to programming errors makes this an ideal language for beginning programmers. Through the extensive use of examples, the student gains not only a comprehensive introduction to the language, but also a knowledge of the types of problems for which BASIC is particularly well suited. Two sections of the course will be offered. One section (5) will be for those students who have had no previous programming experience and requires completion of Introduction to Programming Concepts as a prerequisite; the other section (6) will be for experienced programmers and will focus on such higher level capabilities as matrix operations.

0 units, Aut, Win, Spr

10. WYLBUR—This class is intended to familiarize new terminal users with the text-editing capabilities of WYLBUR. Users who complete this course will have a good understanding of the available features, and will be able to create, modify, and use data sets which contain other programs, data, or textual material. Users who plan to use the text-editor for preparing reports need no prior programming experience. While not required, some typing experience will prove helpful. Users who plan to use WYLBUR for preparing programs should know a programming language.

0 units, Aut, Win, Spr

15, 16. FORTRAN IV (level H) — This course is designed to provide a thorough introduction to FORTRAN programming with emphasis on the effective use of the various FORTRAN compilers available on the Campus Facility system. The student will solve fairly complicated problems which require him to input and output data under format control. He will learn to use the available program library facilities, and to create his own subprograms. Some attention will be given to the numerical problems encountered when using a digital computer, and good programming practices will be emphasized. Two sections of the course will be offered. One section (15) will place emphasis upon problems and techniques suited to the fields of social science and education; the other section (16) will be directed toward physical scientists, engineers, and mathematicians. A knowledge of elementary algebra and a knowledge of the material covered in Introduction to Programming Concepts is essential.

0 units, Aut, Win, Spr

17. FORTRAN/OS Interface—This course introduces the FORTRAN programmer to the Job Control Language for Operating System/360, and explains the job, execute, and data definition statements in detail. The FORTRAN H catalogued procedure is used extensively as a source of examples of these
statements and the way in which it can be altered to meet specific program requirements is discussed. The student learns to use the FORTRAN sequential and direct access file manipulation statements, and to create the Job Control statements required for their use. Students are given an opportunity to utilize this information in writing and running class problems. Programmers who plan to use tape or disk devices should find this course valuable. A knowledge of FORTRAN programming is required.

0 units, Aut, Win, Spr

19. LISP—This course is designed to teach the student the language LISP. The intent is not to emphasize techniques in the theory of list-processing but to develop skills in the features inherent in the language itself. There will be laboratory sessions during which the student will solve a series of programming problems using LISP. He will also have at his disposal a terminal for initial debugging using the time-shared LISP facility. The problems will be oriented around the list-processing area (information retrieval, symbol manipulation, etc.). However, no previous knowledge of the area is required.

0 units, Aut, Spr

20. 360 ASSEMBLER Language Programming—This course introduces experienced FORTRAN programmers to the 360 assembler level language. In addition to receiving a complete introduction to the language, the individual should gain a knowledge of the various applications of the language through the extensive use of examples. Particular attention is given to the linkage of assembler language routines with FORTRAN programs. Throughout the course, the student will gain experience in actually coding problems for the computer. A thorough knowledge of FORTRAN and a high degree of programming sophistication are absolute necessities.

0 units, Win

25. 360/Data Management — This course provides a general introduction to the data management facilities of the IBM 360. Particular emphasis will be given to the physical dataset layout, the formation of source and load module libraries, and the services provided by the IBM utility programs. In addition, efficient use of data storage facilities will be discussed. Individuals who make extensive use of disk and tape storage, including remote terminal (WYLBUR) users, should find the course worthwhile. A knowledge of FORTRAN and Job Control Language is required.

0 units, Aut, Win, Spr

The above courses carry no credit and normally meet two hours per day for six days over a period of three weeks as announced. The classes include an informal supervised programming laboratory. Contact the Information Services Office at the Campus Facility for registration or information about these courses. Do not register officially with the Registrar.

Other introductory courses:
Introduction to Computing—See Computer Science 105, 106, 111.
the framework of overall economic development, and problems of population control.

Graduate teaching has become an integral part of the Institute's program. The give and take between graduate students and faculty members is intended to be mutually stimulating and productive. The program is designed for graduate students with solid undergraduate training in economics or agricultural economics, who possess a special interest in problems lying within the Institute's areas of research. A Ph.D. degree in applied economic research is conferred upon those students who complete the Institute's program of courses and directed research.

The Institute's specialized library contains some 60,000 items, including up-to-date series of periodicals from over fifty countries, and is open for reference to students and others.

Food Research Institute Studies in Agricultural Economics, Trade, and Development, published three times a year, reflects the research interests in the Institute.

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 University requirements for advanced degrees, as set forth under "Degrees" elsewhere in this bulletin, should be consulted by all prospective students. The following are Departmental requirements.

MASTERS OF ARTS

The Master of Arts degree is awarded upon completion with an average grade of B or better of an approved program of 45 units in courses numbered 100 or above, of which 25 must be in Food Research Institute courses. The first 45 units of graduate work to be taken within four quarters must meet this standard. (See also under "Doctor of Philosophy.")

DOCTOR OF PHILOSOPHY

A. The first year program for pre-doctoral students consists of a three-quarter core colloquium in Applied Economics taken in the Food Research Institute, a three-quarter sequence in Price and Allocation Theory, a two-quarter sequence in Econometrics, and a 5 unit Mathematics course. The Master of Arts degree is awarded upon successful completion of this program.

B. The Institute Ph.D. program, starting in a student's second year, stresses planning and conducting applied economic research. Through close contact with faculty members in lectures, seminars, and individual reading and research, the student prepares three fields for defense in Institute administered written and oral examinations at the end of the second year. Normally these are chosen from the following Institute fields: Economics of Agriculture; Commodity Prices and Markets; Economics of Tropical Agriculture; Applications of Economics to Development; International Trade Problems and Policies; and Demography. A student wishing to offer a field outside this list or outside the Institute must secure approval.

C. Each student is required to prepare a detailed prospectus of his doctoral dissertation, which is subject to committee approval, and to defend this in a University-administered oral examination. The completed dissertation is subject to faculty approval, but no further formal defense is required.

D. To meet the foreign language requirement, a candidate must demonstrate a reading knowledge of one language other than English. The requirement may be satisfied in either of two ways: (a) by completion with passing grade of an approved reading course for the language concerned or, (b) by passing a special reading examination, to be given by a qualified member of the Food Research Institute or in the relevant language department.

E. At least two years (6 quarters) of graduate registration in the Institute program satisfactorily completed is required for each candidate.

FELLOWSHIPS AND SCHOLARSHIPS

The Food Research Institute has available a limited number of fellowships and scholarships for qualified students. Several of these are University Ph.D. fellowships which provide four years support at the level of $2,000 to $2,200 per year plus tuition. Applications for all fellowships and scholarships should be made to the Admission Office, Stanford University, Stanford, California 94305.
COURSES

100. 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, given 1972

101. Physical Resources and Problems of Their Efficient Use in Agriculture: The Tropics—(May be taken as 201 by graduate students.) The determinants of patterns of physical resource use in tropical agriculture are considered. Principles of soil science, hydrology, climatology, crop ecology, are discussed in terms comprehensible and relevant to students of the economic and social problems of agriculture and agrarian societies. Both the economic ecology of traditional cropping systems and recent development in agricultural research are discussed.

5 units, Spr (Mandell) MTWThF 3:15, given 1971

102. The Geography of Latin America—(May be taken as 202 by graduate students.) 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 1:15, given 1972

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, Spr (Gray) MW 4:15-6:05

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) MTWTh 9

160. Trade and Development Problems of Tropical Africa—(May be taken as 260 by graduate students.) Analysis of selected international aspects of tropical African economic development. Topics include African-non-African international trade and economic relations (theoretical background, historical perspective, case studies of export-led growth and of the impacts of international capital flows) and intra-African trade and economic integration (customs union theory, historical perspective, case studies of African economic integration).

3 to 5 units, Win (Pearson) W 4:15-6:05

180. Mathematics for Economists—Basic calculus and linear algebra required for graduate work in economics. Topics include partial and total differentiation, simple and multiple integration, Taylor's series, quadratic forms, optimization, linear transformations, systems of linear equations, and characteristic value problems.

3 units, Aut (Staff) by arrangement

COURSES PRIMARILY FOR GRADUATE STUDENTS

201. Physical Resources and Problems of Their Efficient Use in Agriculture: The Tropics—See 101.

202. The Geography of Latin America—See 102.

205. Commodity Futures Markets and Prices—See 105.

5 units, Spr (Gray) MW 4:15-6:05

Courses in the group below are continuous. Registration will be accepted and grades given only for the entire sequence.
210, 211, 212. Food Research Institute Colloquium.

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


211. Applied Economics II—Applications of production, location, and marketing theory. Prerequisite: 210.

212. Applied Economics III — Applications of macroeconomic, trade, and development theory. Prerequisite: 211.

218. The Economic Development of Open Economies—Readings and discussion of the development aspect of open economies, including regional development problems. Term paper.

5 units, Spr (Reynolds)

220. Economics of Consumption—Applications of the theory of consumer behavior and price determination. Analytic techniques and analysis will be stressed.

5 units, Aut (Timmer) by arrangement, given 1971-72

221. Economics of Production — Applications of the theory of the firm; aggregate agricultural production and product supply functions; static and dynamic efficiency in production.

5 units, Win (Yotopoulos, Timmer) by arrangement, given 1971-72

224. Empirical Investigations in the Economics of Development — The course concentrates on empirical propositions in the theory of economic development. It deals with the formulation of operational hypotheses and the construction of tests and it surveys recent empirical research. It examines selectively some of the important variables of development, e.g., capital, labor; and also some of the significant features of the structure of growth, e.g., efficiency, sectoral change and interrelationships, choice of techniques and investment criteria, financial and monetary structure, international trade. The agricultural sector receives special emphasis. Prerequisites: one course each in microeconomic theory, economic development and econometrics.

5 units, Win (Yotopoulos) by arrangement

225, 226. Agricultural Development and Economic Growth I and II—A theoretical-historical approach with emphasis on open economies and agriculture's role in the development process. Attention will be given to Mexico, Japan, and Taiwan as case studies and to selected issues; intersectoral relationships and resource flows, dualism, economic rationality and labor-leisure allocations, production functions and technical change, land tenure and taxation, and criteria relevant to the choice of strategies for agricultural development. Research papers initiated early in the first quarter will emphasize the formulation and testing of hypotheses or empirical analysis of historical experience.

10 units, Aut, Win (Johnston, Reynolds, Yotopoulos) by arrangement, given 1971-72


5 units, Win (Staff) by arrangement

231. Microeconomic Theory—Continuation of 230. Similar to Economics 203 and 204 but somewhat more selective. Topics include viability of competitive equilibrium, theory of monopoly, game theory and oligopoly, theories of managerial behavior, applied welfare economics, capital theory, and intertemporal allocation. Prerequisites: 180 and 230, or equivalents.

5 units, Spr (Massell) by arrangement


310, 311, 312. Workshop in Microeconomics and Public Policy.

9 units, Aut, Win, Spr (Baxter, Comanor, Massell, Timmer) by arrangement

365. 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 consent of instructor.

3 units, Win (Jones) MTW 11
366. Seminar: Economics of Tropical Agriculture—Continuation of 365.
   3 units, Spr (Jones) T 4:15–6:05

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: Lincoln E. Moses

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 Graduate Studies:

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 Graduate Studies, 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

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.
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
260. Trade and Development Problems of Tropical Africa.

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 pre-contact and early European contact, emphasis is given to the European penetration, conquest, and administration of Africa.

4 units, Win (Gann)

HUMANITIES
251. Basic Humanistic Problems.

INDUSTRIAL ENGINEERING
229. Engineering Economy.
HOOVER INSTITUTION
on WAR, REVOLUTION and PEACE

Emeriti: Harold H. Fisher (Chairman), Joseph S. Davis, Edgar E. Robinson, Graham H. Stuart (Councilors), Witold S. Sworakowski (Professor)

Director: W. Glenn Campbell

Associate Director: Richard F. Staar

Associate Director for Administration: Alan H. Belmont

Consultant: Witold S. Sworakowski

Information Officer: James R. Hobson

Senior Fellows: William C. Bark, Rita R. Campbell, Milorad M. Dachkovitch, Peter Duignan, Roger A. Freeman, Lewis H. Gann, Stefan T. Possony, Richard F. Staar, E. Berkeley Tompkins

Senior Research Fellows: Karl Brandt, Kiangau Chang, Dan T. Smith, Eric Voegelin, Bertram D. Wolfe

Research Fellows: Theodore Draper, John K. Emmerson, Manfred Henningsen, Dimitri von Mohrenschildt, Antony C. Sutton, Yuan-li Wu (on leave for government service)


Head, Publications Department: Brien G. Benson

Editor: Carole Norton

Curators: Joseph W. Bingaman (Latin American Collection), Anna M. Bourguina (Nicolaevsky Collection), Dennis J. Doolin (on leave for government service) (East Asia Collection), Peter Duignan (Africa Collection), Richard W. Lyman (Honorary Curator, British Labor Collection), John T. Ma (East Asia Collection), Karol Maichel (East European Collection), Agnes F. Peterson (Western European Collection), George S. Rentz (Middle East Collection). Deputy Curator: David H. L. Tseng (East Asia Collection)

Archivist: Franz G. Lassner

Librarian, Western Languages Collection: Kenneth M. Clazier

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 principal area collections (Western Europe, Eastern Europe, East Asia, Africa, the Middle East, and Latin America) 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 some 200 volumes have been published by the Institution. Aided by several substantial grants, the Institution is focusing anew on an area traditional to its
interests—the problems of peaceful change. The favorable reception of “Peaceful Change in Modern Society,” an international scholarly conference held in connection with the Institution’s 50th anniversary, has led to plans for a meeting to assess the United Nations’ first quarter-century, tentatively scheduled to coincide with the 25th anniversary of the first General Assembly session in January, 1971. Other notable long-term research topics include African colonialism, the Communist International, and the “new Left” both as a national and global development.

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 and Political Science for other courses offered by staff members.

COMMITTEE on HYDROLOGY

Committee in Charge: Ray K. Linsley (Chairman), Joseph B. Franzini, John W. Harbaugh, Paul Kruger, Perry McCarty, Byrne Perry, Irwin Remson

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 will normally 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>Civil Engr. 178.</td>
<td>Environmental Radioactivity</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engr. 205.</td>
<td>Environmental Fluid Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>Civil Engr. 207.</td>
<td>Open Channel Hydraulics and Sedimentation Problems</td>
<td>4</td>
</tr>
<tr>
<td>Civil Engr. 222.</td>
<td>Water Resources Planning</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engr. 233.</td>
<td>Statistical Models in Civil Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engr. 236.</td>
<td>Stochastic Processes and Decision Statistics for Civil Engineers</td>
<td>4</td>
</tr>
<tr>
<td>Civil Engr. 254.</td>
<td>Construction with Nuclear Explosions</td>
<td>2</td>
</tr>
<tr>
<td>Civil Engr. 260A,B,C.</td>
<td>Advanced Hydrology</td>
<td>12</td>
</tr>
<tr>
<td>Civil Engr. 261.</td>
<td>Nuclear Hydrology</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engr. 264.</td>
<td>Ocean and Coastline Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engr. 265.</td>
<td>Flow in Permeable Media</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engr. 266.</td>
<td>Engineering Hydrology</td>
<td>4</td>
</tr>
<tr>
<td>Civil Engr. 269.</td>
<td>Water Resources Engineering Seminar</td>
<td>1</td>
</tr>
<tr>
<td>Civil Engr. 273.</td>
<td>Water Resources Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>Civil Engr. 276.</td>
<td>Water Quality in Water Resources Development</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 110.</td>
<td>Introduction to Marine Geology</td>
<td>4</td>
</tr>
<tr>
<td>Geol. 115.</td>
<td>Introduction to Biological Oceanography</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 171.</td>
<td>Introduction to Geochemistry</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 204A,B.</td>
<td>Computer Applications in the Earth Sciences</td>
<td>6</td>
</tr>
<tr>
<td>Geol. 233.</td>
<td>Principles of Geomorphology</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 284.</td>
<td>Engineering Geology</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 285.</td>
<td>Hydrogeology</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 286.</td>
<td>Development of Groundwater Resources</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 487.</td>
<td>Seminar in Hydrogeology</td>
<td>2</td>
</tr>
<tr>
<td>Engr. 171.</td>
<td>Nuclear Energy</td>
<td>3</td>
</tr>
</tbody>
</table>
Engr. 172. Nuclear Science 3
Engr. 175. Radiation Measurements Laboratory 3
Engr. 177. Radioactivation Analysis 3
Pet.E. 151A,B. Reservoir Fluids 6
Comp. Sci. 105. Introduction to Algorithmic Processes 3
Indus. Engr. 141A. Utilization of Computers 4
Stat. 110. Statistical Methods in Engineering 4

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. Inclusion of more than 10 units not listed above may be approved if this aids in assembling a coherent program. 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 3.0. 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 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

Administrated by Stanford University

The Inter-University Center for Japanese Language Studies in Tokyo, Japan, is a cooperative enterprise of 11 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 may be 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 465, Building 460
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, sponsored by ten 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 465, Building 460
Stanford University
Stanford, California 94305

LIBRARIES

Emeriti: Minna Stillman (Associate Librarian); 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: David C. Weber
Associate Director for Resources: Elmer M. Grieder
Assistant Director for Undergraduate and Branch Services and Librarian, J. Henry Meyer Memorial Library: Robert A. Goller
Assistant Director for Bibliographic Operations: Allen B. Veanner

Business Services: John Jeavons
Financial Manager: Michael Oman
Department Chiefs: Julius P. Barclay (Special Collections); Jennette E. Hitchcock (Catalog); Judy H. Fair (Government Document); Jack Plotkin (Central 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 Institute Library
Librarian: Charles C. Milford

Hoover Institution—See listing elsewhere in this catalog.

J. Hugh Jackson Library of Business
Director: Marion M. Smith
Reference Librarians: David Zaehringer, Martha Ashmon, Catalog Librarian: Mildred Wagner

Lane Medical Library
Chief Librarian: Clara S. Manson
Reference Librarian: A. V. Hoen

Law Library
Law Librarian: J. Myron Jacobstein
Acquisition Librarian: Howard W. Sugarman; Head Catalog Librarian: Rosalee Long; Reference Librarian: George Torzsay-Biber

Linear Accelerator Center Library
Department Head: George E. Owens
Head Librarian: Robert Gex
Reference: Louise Addis

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. Students wishing an explanation of library services are urged to see the Chief, General Reference Department, in the Main Library or the Chief Librarian of the J. Henry Meyer Memorial Library.

Information regarding special borrowing privileges for individuals not connected with the University may be obtained at the Service Desk in the Central Circulation Department 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 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 Central Circulation Service Desk attendant or their own school librarians for information. Industrial firms wishing to use the Libraries should consult the Head of the Technical Information Service for information regarding subscriptions.

The Libraries of the University altogether contain about 3,275,000 volumes, 1,800,000 manuscripts, 110,000 sheet maps, 491,000 microtext sheets, and considerable other material. Part of the Libraries' collections is concentrated in the stack of the Main Library, which houses about 1,225,000 volumes on its seven levels, and in the Meyer Library basement. 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 91,000 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 noon to midnight on Sunday during school sessions; extended study will be possible until 2:30 a.m. 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 a.m. to 11 p.m. On Saturday the hours are 8 a.m. to 5 p.m., and on Sunday from 1 p.m. to 11 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 Reference Room in the Main Library contains reference and subject collections totaling about 30,000 volumes and current issues of more than 2,400 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 Document 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 Department of Special Collections services the Library’s rare and valuable books and manuscripts and administers a number of specialized research collections. The main reading room for books is the Albert M. Bender Room and for manuscripts is Room 310.

Among the most important of these collections are: the Frederick E. Brasch Collection on Sir Isaac Newton and the History of Scientific Thought covering the history of several branches of the physical sciences centering around the life and thoughts of Newton; 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 authors, supplemented where possible with manuscripts, proofs, letters, and association items); the Memorial Library of Music, devoted to musical manuscripts and first issues of important and rare musical scores; the Elmer E. Robinson Collection on American History and Constitutional Law; the Morgan A. and Aline D. Gunst Memorial Library, composed of examples of fine printing, binding, etc., and books on the history and the art of the printed book; and the general Rare Book Collections where emphasis is placed on sixteenth century continental books, particularly Italian literature, the Reformation, the classics, and history and biography. There is also a collection of books pertaining to the French Revolution and the Napoleonic Era.

Of the manuscript collections (Room 310), those with prominence are the Antoine Borel Collection, manuscript material on California political history; the Bernard DeVoto Papers covering his career in literature, history, and politics; and the papers of authors represented in the Felton Library, particularly D. H. Lawrence, James Joyce, Ambrose Bierce, Jack London, and Mary Halleck Foote.

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: Art and Architecture, 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, Mathematical Sciences, and Physics.

The Frederic M. Falconer Biology Library, located on the top floor of the Teaching Wing of the Biological Sciences Center, 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 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-Radioscience Library, the Ryan Nuclear Technology Library, the Engineering-Economic Planning Library, the Electrical Engineering-Solid State Library, and the Timoshenko Collection.

The Branner Geological Library, located in Room 333 of the Outer Quadrangle, houses collections on geology, mineralogy, paleontology, 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 Mathematical Sciences 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 136,000 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 4,000 trade, financial, labor, and general business periodicals and continuations. In addition, it subscribes to many of the leading labor, financial, marketing, and business research services. A branch library serves the International Center for Advanced Management Education.

FOOD RESEARCH INSTITUTE

The Food Research Institute Library, located in the Food Research Institute Building, is intended primarily for staff research and instruction in international commodity economics. Its collection of over 60,000 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 180,000 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 Otolaryngology and the Medical History Collection are notable special collections. Specialized branches include the Anatomy Library and the Medical Microbiology Library.

**PHYSICAL EDUCATION for MEN**

**Emeriti:** Allen Elward, Edward M. Twiggs, Harry M. Wolter (Directors); C. Myron Sprague (Associate Director); Ernest P. Hunt (Associate Professor)

**Chairman and Director of Physical Education and Athletics:** Charles A. Taylor

**Assistant Director of Athletics:** Robert G. Young

**Professor:** John E. Nixon (Director of Professional Education)

**Associate Professor:** Wesley K. Ruff (Director of Physical Education)

**Directors:** Howard Dallmar (Basketball), William P. Fehring (Intramurals and Club Sports), Charles E. Finger (Golf), James Gaughran (Aquatics), Richard Gould (Tennis), Payton Jordan (Track), Peter Kmetovic (Rugby), Raymond E. Lunny, Jr. (Boxing), Dan J. Millman (Gymnastics), Fred J. Priddle (Soccer), John Ralston (Football), David M. Reed (Wrestling), J. Ray Young (Baseball)

**Assistant Directors:** Clayton Bowling (Basketball), Jack Christiansen (Football), Marshall Clark (Track), Clyde F. Devine (Diving), Thomas Dunton (Baseball), Robert Gambold (Football), James Jones (Baseball), Max McCartney (Football), William Moultie (Football), Edward Peasley (Football), Charles Range (Basketball), James Smith (Aquatics), Roger C. Theder (Football), Michael White (Football)

**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.

2 units, Aut, Win, Spr (Staff) T 10

See also Senior Colloquia.

**STANFORD LINEAR ACCELERATOR CENTER**

The Stanford Linear Accelerator Center Library (SLAC) is located in the Central Laboratory Building on Sand Hill Road. The collection is primarily for use by the staff of the Center.

**OFFERINGS AND FACILITIES**

**Athletics**

In keeping with our cultural heritage and American university tradition, Stanford offers 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, wrestling, gymnastics, rugby, soccer, water polo, and cross country. Other sports which have regular schedules include, among others, crew and rifleshootng.

**Physical Education, Intramurals, and Club Sports**

The Physical Education Program is designed to accommodate the interests and
needs expressed by our students. Students may elect the available 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 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, weight lifting, 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, riflery, bowling, table tennis, horseshoes, handball, weight lifting, wrestling, basketball, softball, tennis, swimming, golf, gymnastics, and track and field 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 Physical 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 new all-weather surface, and used for intercollegiate competition in football and track.

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 recreational jogging and physical conditioning.

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-surfaced, with stands for spectators, and fourteen practice tennis courts.

_Roscoe Maples Pavilion_, the new basketball pavilion seating 8,000 spectators, and used for intercollegiate basketball, intramurals, recreation, and volleyball.

The old Pavilion houses gymnastics, judo, wrestling and karate.

_Encina Gymnasium_, including a basketball floor, three bleacher-flanked swimming pools, offices, rooms for weight training, faculty lockers, student lockers, showers, training quarters, and team rooms.

Facilities used jointly by men and women include the riding stables and an 18-hole championship golf course on the campus.

_The Department of Physical Education and Athletics_ is near the Gymnasium and the Pavilion and contains offices of the director, his staff, and all coaches.

**FEES**

Fees are charged for enrollment in bowling, equitation, golf, rifle marksmanship, and scuba diving.

**CREDIT**

Unless otherwise noted courses may be taken for one unit of credit or on a non-credit basis. If taken for credit the credit will count toward graduation and in the student's grade point average, like any other college credit. A maximum of two courses are allowed per quarter and a maximum of twelve (12) units will be counted toward graduation and G.P.A. Graduate students are encouraged to register for classes but graduate credit is not available.

**KEY TO COURSE NUMBERS**

Numbered courses are instructional at the beginning level. Letters added to the numbers are: A—advanced instruction; R—recreational; F—Frosh; I—intercollegiate.

**SPORTS INSTRUCTION**

02. Individual Programs—Individually prescribed exercise programs adapted to meet special needs.

_Aut, Win, Spr (Ruff) three periods weekly by arrangement_

05. Physical Education Leadership — Provides sports instruction leadership opportunities.

_Aut, Win, Spr (Ruff) by arrangement_

08. Club Sports.

_Aut, Win, Spr (Staff) by arrangement_

11R. Basketball.

_0 units, Aut, Win, Spr (Staff) TTh 11 or 1:15_


_Aut, Win, Spr (Lunny) MW 4:15_

14R. Touch Football.

_0 units, Aut (Staff) MW 3:15_

15. Golf, Beginning.

_Aut, Win, Spr (Finger) TTh 11, 1:15, 2:15_

15A. Golf, Advanced.

_Aut, Win, Spr (Finger) MTWThF by arrangement_

16. Trampoline and Gymnastics.

_Aut, Win, Spr (Millman) MW or TTh 1:15_

16A. Trampoline and Gymnastics, Advanced.

_Aut, Win, Spr (Millman) MW or TTh 2:15_

17. Volleyball.

_Aut, Win, Spr (Staff) TTh 2:15 or 3:15_


_Aut, Win, Spr (Staff) MW 11 or 1:15; TTh 9, 10, or 11_

19A. Bowling, Tournament.

_Aut, Win, Spr (Staff) by arrangement_

20. Swimming and Diving, Beginning.

_Aut, Win, Spr (Staff) MW 10_

20A. Swimming, Advanced.

_Aut, Win, Spr (Staff) MW 10 or 3:15_

21. Tennis, Beginning.

_Aut, Win, Spr (Staff) MW 11, 1:15, 2:15, 3:15, or 4:15_

21A. Tennis, Advanced.

_Aut, Win, Spr (Staff) TTh 11, 1:15, 2:15, 3:15, or 4:15_

22. Track, Individual Programs.

_Aut, Win, Spr (Clark) TTh 10_

29. Water Polo.

_Aut, Win, Spr (Smith) TTh 2:15 or MW 11_
30R. Softball.  
0 units, Spr (Staff) TTh 2:15

39. Soccer.  
Aut, Win, Spr (Priddle) MWF 3:15 or 4:15

41. Physical Conditioning.  
Aut, Win, Spr (Staff) MW 4:15

42. Skin and Scuba Diving.  
2 units, Aut, Win, Spr (Gaughran) MWF 2:15

45. Life Saving and Water Safety.  
Aut, Win (Gaughran) TTh 2:15

3 units, Spr (Gaughran, Staff) MTWThF 3:15

53. Weight Training.  
Aut, Win, Spr (Staff) MW 11, 1:15, 2:15, 3:15, or 4:15

92. Techniques of Athletic Management.  
Aut, Win, Spr (Taylor, Staff) by arrangement

95. Intramural Sports Management.  
Aut, Win, Spr (Fehring) by arrangement

**INTERCOLLEGIATE SPORTS**

**FROSH, VARSITY, AND JUNIOR VARSITY SPORTS**

111F. Frosh Basketball.  
Aut, Win (Bowling) MTWThF 2–4 p.m.

111I. Basketball.  
Aut, Win (Dallmar) MTWThF 4–6 p.m.

114F. Frosh Football.  
Aut (Moultrie) MTWThF 2–4 p.m.

114I. Football.  
Aut, Spr (Ralston, Staff) MTWThF 4–6 p.m.

115I. Golf.  
Aut, Win, Spr (Finger) by arrangement

116I. Gymnastics.  
Aut, Win, Spr (Millman) MTWThF 3–5 p.m.

120I. Swimming and Diving.  
Aut, Win, Spr (Gaughran) MTWThF 3:15

121I. Track.  
Aut, Win, Spr (Jordan, Clark) MTWThF 3:15

123I. Wrestling.  
Aut, Win (Reed) MTWThF 3:15

129I. Water Polo.  
Aut, Spr (Gaughran) MTWThF 3:15

130I. Baseball.  
Aut, Win, Spr (Young) MTWThF 3:15

139I. Soccer.  
Aut, Win, Spr (Priddle) MTWThF 4:15

140I. Rugby.  
Win (Kmetovic) MWTh 4:15

**INTRAMURAL SPORTS**

Competing organizations are urged to contact the IM office during registration to obtain meeting dates and times to assure representation. Sign-up lists are often posted at the beginning of each quarter so early organization of competing groups is essential.

**CLUB SPORTS**

The Club Sports program has achieved remarkable stability in recent years due to enduring student interest. Those clubs currently affiliated with this Department are listed below. The scheduled meeting and practice times and availability of credit are normally published in the quarterly time schedule.

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**CO-ED ACTIVITIES OFFERED IN THE WOMEN’S DEPARTMENT**

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<td>Field Research in Handicapped</td>
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<tr>
<td>Recreation for the Handicapped</td>
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</tbody>
</table>

464 OTHER DEPARTMENTS, INSTITUTES, AND PROGRAMS
PHYSICAL EDUCATION for WOMEN

Emeriti: Maud L. Knapp (Professor), Margaret C. Barr (Associate Professor), Sylvia P. Cain (Instructor)
Chairman: Pamela L. Strathairn
Associate Professors: Luell W. Guthrie, Miriam B. Lidster, Marian S. Ruch, Pamela L. Strathairn
Assistant Professor: Carroll S. Gordon
Instructors: Marianna C. Fowler, Heidi A. Klaus, Mary Margaret Neal, Inga Weiss
Teaching Specialists: Jean P. Helliwell, Shirley H. Schoof

INSTRUCTIONAL PROGRAM

Since the founding of Stanford University in 1891, physical education courses have been a part of the University academic curriculum. Each change in purpose and content through the years has been dictated by the needs and interests of Stanford students as interpreted by the University and Physical Education Departments.

The scope of the instructional program is broad, encompassing knowledges, understandings, and skills with educational value for the student in the realm of self-perception and understanding and of reacting to and interacting with those about him. The courses are concerned with education through, not of, the physical and provide a unique medium for learning—one in which non-verbal intelligence and communication is expressed.

The program is designed specifically to: (1) increase understanding of the value and role of various physical activities in developing and maintaining total fitness throughout life; (2) provide opportunity for discovering, on a pre-professional level, possible careers or educational experiences related to a major interest in some other subject field; (3) develop leadership abilities which have particular application to community service; and (4) encourage, through satisfying learning experiences, continued participation in physical activities appropriate to health status as well as interest.

Each student is afforded the opportunity for developing interest in a wide variety of activities (aquatic, contemporary and ethnic dance, sports, and designed exercises) and for developing a high level of competency in selected activities. Homogeneous skill groupings and limitations placed on class-size enable each student, the beginner through the advanced performer, to achieve success within the limits of individual capability. Educational opportunities for the highly skilled in sports activities are included within the curriculum through a scheduled intercollegiate program. Master lessons with guest artists are regularly planned for the students in Contemporary and Ethnic Dance courses. The Department arranges field experience with local school districts for students interested in working with the handicapped and retarded.

RECREATIONAL OPPORTUNITIES

In conjunction with the Women's Recreation Association, the Department sponsors intramural and recreational activities throughout the year. The facilities are available for badminton, basketball, fencing, gymnastics, swimming, tennis, volleyball, and folk dancing.

AFFILIATIONS

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 Committees, the National Association and Western Society for Physical Education of College Women, and the Women's Extramural Committee of the Pacific-Eight Conference.

Policies governing women's participation in intercollegiate competition are formed by the Department and the WRA in keeping with policies of the University and 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, locker, and dressing rooms.

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 field hockey and golf.
In addition the Riding Stable, 18-hole championship Stanford Golf Course, and Tresidder Bowling Lanes are used jointly by men and women.

All equipment, except badminton and tennis rackets and golf clubs, is provided by the Department. Golf clubs may be rented.

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.

**Courses**

All courses, except as specifically noted, have a 1-unit value although students may arrange 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 may be repeated for credit.

A maximum of 12 units of credit in coeducational and/or women-only classes will be accepted toward graduation.

Community Leadership courses are designed for developing competency in skills which have particular application to service in the community. Each of these courses is open to men and women students unless otherwise noted.

**COEDUCATIONAL**

Refer to the section on Physical Education for Men for specific information on the following: badminton, bowling, crew, diving, judo, karate, pistol marksmanship, rifle marksmanship, skin and scuba diving, trampoline, and volleyball.

12. Fencing: Elementary — The study of basic movements and practice in coordination and timing.
   *Aut, Win, Spr (Helliwell) MWF 10*

   *Aut, Win, Spr (Helliwell) MWF 11*

19. Bowling — Instruction for all levels of skill in the fundamentals, rules, and etiquette.
   *Aut, Win, Spr (Schoof) TTh 9, 10, or 11*

61. Modern Dance: Elementary — The development of movement and rhythmic skills.
   *Aut (Weiss) MWF 10*

62. Modern Dance Technique: Intermediate — The extension of Modern Dance fundamentals to a clearly defined use of techniques and qualities based on the elements of movement in regard to rhythmic, directional, and dynamic changes in movements.
   *Aut, Win, Spr (Weiss) WF 11:00–12:15*

64. Ballet Technique: Intermediate — Ballet as a discipline for Contemporary Dance. Principles of body alignment and style, terminology of traditional steps and positions (French).
   *Win, Spr (Weiss) TTh 2:15–3:30*

65. Technique and Rhythms for Dance — Variations of simple and more complex rhythms in regular and irregular meter to achieve the necessary intensity, ease, and control essential to perform changing rhythmic patterns.
   *Aut, Win, Spr (Klaus) MWF 3:15*

70. Ethnic Dance, Technique and Styles — A concentration on the dance, music, and dancelore of one given area.

70A. Couple Dances — British Isles, Scandinavia, Central Europe, or Spanish-speaking countries.
   *Aut (Lidster) TTh 11:00–12:15*

70B. Israel.
   *Win (Lidster) TTh 11:00–12:15*

70C. Balkans.
   *Spr (Lidster) TTh 11:00–12:15*

72. Folk Dance: Elementary — Introduction of 25 or more dances from many countries with emphasis on traditional and foundation folk dance steps.
   *Aut, Win, Spr (Lidster) MWF 1:15*

73. Folk Dance: Intermediate — Continued presentation of dances from many countries with definite emphasis on foot and body skills necessary for the styling related to specific countries. Prerequisites: ability to perform basic and traditional folk dance steps, elementary folk dance or equivalent.
   *Aut, Win, Spr (Lidster) TTh 12:45–2:00*
112. Fencing: Advanced — Concentration on practice of attacks. Regular lessons given. Some competition. Prerequisite: promoted from 13 or equivalent.

Aut, Win, Spr (Helliwell) TTh 10 and T 7 p.m.

113. Fencing: Tournament — Practice of all moves regularly with special attention to the psychology of competition. Increased competition in class. Regular lessons given. Prerequisite: promoted from 112 or consent of instructor.

Aut, Win, Spr (Helliwell) TTh 11 and T 7 p.m.

119. Bowling: Tournament — Individualized instruction to prepare for participating in intercollegiate tournaments. Prerequisite: average score of 125 or higher.

Aut, Win, Spr (Schoof) M 8:30 p.m. and by arrangement

148. Equitation.

Elementary — Introduction to the fundamentals of English (forward seat) riding.

Aut, Win, Spr (Melville) MTTh 1:15 or 2:15

Intermediate — Continued development of skill in English (forward seat) riding. Prerequisites: ability to walk, trot, and canter securely and knowledge of leads and diagonals.

Aut, Win, Spr (Melville)

MTTh 10 or 4:15

Jumping — Introduction to and development of jumping skill using low single fences, higher fences, combinations, and courses. Prerequisite: completion of Intermediate Equitation or the equivalent.

Aut, Win, Spr (Melville)

MTTh 10 or 4:15

160. Modern Dance: Advanced Technique — Prerequisites: promoted from 62 or equivalent and consent of instructor.

2 units, Aut (Weiss) MW 4:15-5:30

161. Modern Dance: Contemporary Dance Forms — Sequences for manipulation of movement and advanced techniques. Prerequisite: consent of instructor.

2 units, Win (Weiss) MW 4:15-5:30

162. Modern Dance: Advanced Repertory — Dance sequences, phrases, and contrasting progressions emphasizing fluency of movement, accuracy of timing, and clarity of form. Study of theme and variations. Prerequisite: consent of instructor.

2 units, Spr (Weiss) MW 4:15-5:30

165. Dance Workshop — Emphasis on new approaches in design and improvisation, involving exploration of movement and the study and manipulation of creative concepts for dance composition and choreography. Solo and group forms. Prerequisite: consent of instructor.

3–4 units, Aut (Weiss) F 4:15-5:30 and by arrangement

166. Dance Workshop — Prerequisite: consent of instructor.

3–4 units, Win (Weiss) F 4:15-5:30 and by arrangement

167. Dance Workshop — Prerequisite: consent of instructor.

3–4 units, Spr (Weiss) F 4:15-5:30

172. Folk Dance: Advanced — Presentation of dances with complex combinations and intricate step patterns. Emphasis on styling and footwork. Prerequisites: ability to perform more complex step patterns; promoted from 73 or the equivalent.

Aut, Win, Spr (Lidster) Th 4:15 and T 7-9 p.m.

173. Folk Dance: Exhibition — Advanced and exhibition dances mastered in order to participate in dance demonstrations, exhibitions, and festivals. Prerequisite: consent of instructor.

Aut, Win, Spr (Lidster) T 8-10 p.m. and by arrangement


Aut, Win, Spr (Lidster) TTh 3:15-4:30

213. Fencing: Tournament — Practice of all moves regularly with special attention to the psychology of competition. Increased competition in class. Regular lessons given. Graduate students only. Prerequisite: promoted from 112 or consent of instructor.

Aut, Win, Spr (Helliwell) TTh 9 and T 7 p.m.
WOMEN STUDENTS

1. **Posture**—Figure control and posture improvement with individual conditioning.
   - *Aut, Win (Ruch) MWF 10 or 1:15
   - *Spr (Ruch) MWF 10

2. **Conditioning**—Group and individual exercises to improve agility, strength, balance, coordination, and endurance for sports and swimming.
   - **2A. Sports.**
   - *Aut, Win, Spr (Klaus) MWF 2:15
   - **2B. Swimming.**
   - *Win (Ruch) MWF 2:15

3. **Rhythmic Gymnastics** — This course focuses upon developing beauty and grace in movement, fitness and self-discipline through the use of free movement and small hand-apparatus. Emphasis will be placed on developing rhythmic exercise routines to music.
   - *Aut, Win, Spr (Klaus) MWF 11

4. **Gymnastics: Elementary**—The development of flexibility, strength, endurance, balance, coordination, grace of movement, and weight control through instruction and conditioning for tumbling, vaulting, and free exercise. Use of the uneven parallel bars and balance beam.
   - *Aut, Win, Spr (Klaus) TTh 12:50-2:05

5. **Gymnastics: Intermediate**—Review of basic gymnastic skills and emphasis on more advanced and difficult maneuvers. Prerequisite: promoted from 4 or equivalent.
   - *Aut, Win, Spr (Klaus) TTh 11:00-12:15

15. **Tennis: Elementary**—This course covers the fundamental strokes (forehand, backhand, service, and volley), rules and scoring.
   - *Aut, Spr (Guthrie) MWF 10 or 1:15;
   - *(Neal) TTh 12:50-2:05
   - *Win (Guthrie) MWF 10 or 1:15

16. **Tennis: Intermediate**—Review of fundamental strokes, introduction to the lob and overhead strokes, and utilization of strategy and tactics in game playing. Prerequisites: knowledge of rules and scoring, average ability in the fundamental strokes.
   - *Aut, Spr (Gordon) MWF 11, (Guthrie) MWF 9 or 2:15 or TTh 10 and by arrangement, (Neal) MW 4:15-5:30
   - *Win (Gordon) MWF 11, (Guthrie) TTh 10 and by arrangement or MWF 2:15, (Neal) TTh 12:50-2:05

21. **Basketball**—This course focuses upon conditioning, ball handling, and goal shooting skills, individual tactics, team play, strategy, and rules.
   - *Win (Fowler) MW 4:15-5:30

24. **Field Hockey**—This course focuses upon conditioning, stick work, individual tactics, team play, strategy, and rules.
   - *Aut (Schoof) TTh 3:30-5:00 and alternate W 4

31. **Swimming: Elementary**—Basic understanding of buoyancy, balance, propulsion, coordination, water safety, and introduction to basic swimming strokes. Prerequisite: inability to swim safely in deep water.
   - *Aut (Fowler) MWF 1:15
   - *Spr (Fowler) MWF 2:15

32. **Swimming: Intermediate**—Review of basic swimming skills, refinement of strokes, and introduction of additional strokes and skills. Prerequisite: promoted from 31 or average ability and strength in basic strokes.
   - *Aut (Fowler) MWF 2:15
   - *Spr (Fowler) MWF 3:15

35. **Lifesaving**—This course focuses upon increasing awareness of water hazards and avoiding accidents, preventing accidents for others, utilizing appropriate rescue techniques. Students will receive the American Red Cross Senior Lifesaving Certificate upon successful completion of the course. Prerequisites: strong swimmer; ability to swim a quarter mile without rest, to swim underwater, and to surface dive.
   - 2 units, *Win (Strathairn) MW or TTh 12:50-2:05
   - 2 units, *Spr (Strathairn) TTh 11:00-12:15

36. **Aquatic Art**—The utilization of swimming skills, body control, and creativity in stunts and figures, synchronized swimming, and water ballet. Prerequisite: above average ability in performing the crawlstroke, backstroke, breaststroke, and sidestroke.
   - *Aut (Strathairn) MW 3:15 and by arrangement

44. **Golf: Elementary**—Fundamentals of the golf swing, use of various clubs, golf etiquette, and knowledge of the rules to enable a beginner to play a round of golf.
   - *Aut, Win, Spr (Gordon) TTh 11 or 2:15; each with one practice hour

45. **Golf: Intermediate**—Improvement and perfection of previously learned funda-
mentals. Utilization of these skills in the game. Prerequisite: promoted from 44 or the equivalent or ability to score in the 60's for nine holes on a regulation length course.

_Aut, Win, Spr (Gordon) TTh 1:15 or MW 2:15; each with one practice hour_

104. **Gymnastics: Advanced** — Emphasis is upon striving toward a high level of achievement in all gymnastics skills for free exercise, tumbling, uneven bars, balance beam, and vaulting. Prerequisite: promoted from 5 or equivalent.

_Aut, Win, Spr (Klaus) TTh 2:15-3:30_

114. **Tennis: Advanced** — Refinement of strokes and utilization of strategy in game playing. Prerequisite: promoted from 16 or extensive experience which has resulted in above average ability in all strokes.

_Aut, Spr (Guthrie) TTh 11:00-12:15; (Neal) TTh 2:15-3:30 or MW 3:15-4:30 Win (Guthrie) TTh 11:00-12:15; (Neal) MW 3:15-4:30_

115. **Tennis: Tournament** — Emphasis is placed upon building endurance and skill through drills and practice with others who have strong strokes and good knowledge of strategy. Competitive experience is scheduled with club and college teams as well as intercollegiate tournaments. Prerequisite: promoted from 114 or equivalent experience including USLTA tournaments or school team participation.

_Aut, Spr (Neal) T or Th 3:15-5:00 and by arrangement
Win (Neal) T or Th 2:15-4:00 and by arrangement_

121. **Basketball: Tournament** — Emphasis is upon developing a high level of ability in the fundamental and advanced skills as well as conditioning in preparation for intercollegiate games. Prerequisites: above average ability and two seasons playing experience.

_Win (Fowler) TTh 4:15-5:30 and by arrangement_

124. **Field Hockey: Tournament** — Emphasis is upon developing a high level of ability in the fundamental and advanced skills as well as conditioning in preparation for intercollegiate games. Prerequisite: above average ability or one season playing experience.

_Aut (Schoof) TTh 3:30-5:00 and alternate W 4_

130. **Swimming: Advanced** — Emphasis is placed upon stroke analysis, principles underlying swimming skills, and endurance. Prerequisite: promoted from 31 or 32 or above average ability in performing the crawlstroke, backstroke, breaststroke, and sidestroke.

_Aut, Spr (Fowler) TTh 3:15 and one practice hour
Win (Fowler) TTh 2:15 and one practice hour_

131. **Swimming: Competitive** — Conditioning, training, learning, and refining starts, turns, and racing strokes as preparation for intercollegiate meets. No prior racing experience is necessary. Prerequisite: strong swimmer in at least one of the racing strokes.

_Aut, Spr (Fowler) MTh or TTh 4:15 and by arrangement_

144. **Golf: Advanced** — This course focuses upon understanding and refining the golf swing as well as increasing power and distance. Prerequisites: ability to hit the ball well with relative accuracy and to play on a full 18-hole course with an average score of 115.

_Aut, Win, Spr (Gordon) MW 3:15 and by arrangement_

145. **Golf: Tournament** — Individualized instruction for the well-skilled who wants to specialize in golf and to prepare for team and tournament participation. Prerequisite: average scores under 100 for a regulation length 18-hole course.

_Aut, Win, Spr (Gordon) TTh 3:15 and by arrangement_

**COMMUNITY LEADERSHIP AND OTHERS**

122. **Basketball Officiating** — Emphasis upon the principles and techniques of officiating which requires a thorough knowledge of and ability to apply the rules of girls' basketball. Prerequisite: above average playing ability or two seasons playing experience.

_2 units, Win (Fowler) by arrangement_

135. **Water Safety Instructor's Course** — This course focuses upon the analysis and evaluation of swimming fundamentals and strokes and lifesaving techniques for the primary purpose of teaching water safety to others. Students who fulfill class requirements will
receive the American Red Cross WSI Course Completion Certificate. Prerequisites: current American Red Cross Senior Lifesaving Certificate and ability to swim the basic strokes in good form.

3 units, Spr (Strathairn) MWF 12:50-2:05 and by arrangement

181. Golf Officiating and Tournament Organization — This course focuses upon planning various types of golf tournaments according to USGA rules, with main emphasis on collegiate events.

3 units, Aut, Win, Spr (Gordon) by arrangement

182. Tennis Officiating and Tournament Organization — This course focuses upon understanding the principles and mechanics of organizing and conducting a variety of tennis tournaments and upon developing the knowledge and ability to become USLTA rated tennis officials.

2-4 units, Aut, Win, Spr (Guthrie) by arrangement

183. Fencing Tournament Organization and Officiating — Students learn how to run a fencing meet and get practice in directing, scoring, judging and time keeping.

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

184. Swimming Meet Officiating and Organization — This course focuses upon understanding the principles and mechanics of organizing and conducting meets and upon developing knowledge and skill in the duties of all officials needed for a swimming meet.

2-5 units, Aut, Spr (Fowler, Strathairn) TWTh 4:15 and by arrangement

190. Leadership in Physical Education for the Retarded — Basic principles, methods, and materials as well as field experience in leading motor activities for retarded children. Prerequisite: consent of instructor.

2 units, Aut, Win, Spr (Ruch) MW 8 and TTh 11:00-12:15 or 12:50-2:05

191. Leadership in Physical Education for the Handicapped — Individual and group projects relating to devising or modifying games, physical activities, equipment, and instruction for physically handicapped children. Field work is conducted at the Stanford Convalescent Home and Palo Alto schools. Prerequisite: consent of instructor.

1-3 units, Aut, Win, Spr (Ruch) by arrangement

192. Aquatic Leadership — This course encompasses both an overview of the aquatics field and selected in-depth study of such topics as pool management, pool operation, community programs, fitness programs, swimming for the handicapped, waterfront management, and programming.

3 units, Aut, Win, Spr (Strathairn) by arrangement

193. Leisure: Community Development or Disintegration — A study of the trends, practices, and values of recreation related to the use of leisure time.

3-5 units, Aut, Win, Spr (Guthrie) by arrangement

194. Dance and Its Relationship to Society — A study of dance and its sociological importance from primitive to present-day.

3-4 units (Lidster) by arrangement

235. Water Safety Instructor’s Course: Advanced — Discussion, demonstration, and exploration of various teaching methods, class organization patterns, and evaluative techniques for swimming, lifesaving, and water safety. Prerequisite: current American Red Cross WSI Course Completion Card.

3 units, Aut, Win, Spr (Strathairn) by arrangement
INSTITUTE FOR PLASMA RESEARCH

Executive Committee: Peter A. Sturrock (Chairman), Daniel Bershadner, Oscar Buneman, I-Dee Chang, Marvin Chodorow, Frederick W. Crawford, Von R. Eshleman, Robert H. Eustis, Krishnamurty Karamcheti, Charles H. Kruger, Morton Mitchner, Sidney A. Self

The Institute is an interdepartmental organization coordinating teaching and research in plasma physics at Stanford and incorporates six specialized research groups.

The Aerophysics Group (Baganoff, Bershadner, Chang, Devoto) 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 Astrophysics Group (Petrosian, Sturrock) is engaged in astrophysical studies related to the sun, supernova remnants, radio galaxies, quasars and cosmic rays.

The Gas Kinetics Group (Karamcheti, Koutsoyannis) is engaged in theoretical studies (kinetic theory, spectroscopy, discharge theory) and experimental studies related to the interaction of plasma and radiation.

The Plasma Gasdynamics Group (Eustis, Kruger, Mitchner) concentrates on experimental and theoretical research related to magnetohydrodynamic energy conversion, such as nonequilibrium thermodynamics, transport processes, spectroscopy and plasma diagnostics.

The Experimental Plasma Physics Group (Crawford, Self) carries out experimental research, with supporting theoretical studies, on waves and instabilities, beam-plasma interactions, and nonlinear processes such as wave-wave and wave-particle interactions.

The Theoretical Plasma Physics Group (Buneman) concentrates on the kinetic theory of low-density plasmas as related to plasma containment.

The facilities of the Institute are available to any interested and qualified student, who must be admitted by and registered in a department. The Departments of Aeronautics and Astronautics, Electrical Engineering, Mechanical Engineering, and Applied Physics 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 members of each group and from the Chairman of the Executive Committee.

SPACE SCIENCE AND RELATED PROGRAMS

Committee in Charge: Peter A. Sturrock (Chairman), Daniel Bershadner, Ronald N. Bracewell, Frederick W. Crawford, Von R. Eshleman, Robert A. Helliwell, Robert L. Kovach, John R. Spreiter

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 medium 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 Radio-science 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.

The experimental work is supported by theoretical studies and by a program of laboratory simulation of space plasma wave and instability phenomena.

A program in theoretical astrophysics provides for study and research over a wide range of topics including solar physics, solar-terrestrial relations, and nonthermal phenomena related to pulsars, radio galaxies, quasars and cosmic rays.
Courses related to many of the above topics will be found listed under Aeronautics and Astronautics, Applied Mechanics, 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. The Departments of Aeronautics and Astronautics, Applied Mechanics, Electrical Engineering, and Applied Physics 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.

TRAINEESHIPS IN EDUCATIONAL RESEARCH

The doctoral student in any department who is preparing himself to investigate matters related to education may be supported under the Research Traineeship Program administered by the School of Education (see p. 50).

STANFORD LINEAR ACCELERATOR CENTER

Director: Wolfgang K. H. Panofsky
Deputy Director: Sidney D. Drell
Associate Directors: Joseph Ballam (Research Division); Robert H. Moulton, Jr. (Administrative Services Division); Richard B. Neal (Technical Division); Frederick V. L. Pindar (Business Services Division).


Associate Professors: Frederick J. Gilman
Senior Research Associates: Karl L. Brown, Jean V. Lebacqz, Richard B. Neal

The Stanford Linear Accelerator Center (SLAC) is devoted to experimental and theoretical research in elementary particle physics and to the development of new techniques in high energy accelerators and elementary particle detectors. The Center is located on 480 acres of Stanford property west of the main campus, parallel to and south of Sand Hill Road and is operated under a contract with the United States Atomic Energy Commission. The major experimental facility of the Center is a two-mile-long linear electron accelerator.

The accelerator, which began operations for physics research during 1966, can provide an electron beam at energies up to 21 BeV and at beam intensities up to 30 microamperes average current. Positrons can also be accelerated to a maximum energy of about 14 BeV, at average beam currents up to about one microampere. A "switchyard" of magnetic elements at the end of the accelerator can direct the beams to any of several experimental areas. A large number of secondary beams of special character, including pion, kaon, muon, and photon beams, are available. A complement of large research instruments available for use with the accelerator includes three magnetic spectrometers capable of analyzing momenta up to 1.6, 8, and 20 BeV/c; two bubble chambers, a 40-inch diameter, cylindrical chamber built at SLAC, and a chamber 82 inches long and 20 inches wide which was transferred to SLAC from the Lawrence Radiation Laboratory in Berkeley; two large-volume magnets, with pole diameters of 54 inches and 80 inches, used in spark-chamber and streamer-chamber experiments. A variety of general purpose apparatus is also available. An electron-positron storage ring facility is under development.

The Center is operated by Stanford as a national facility so that qualified scientists from universities and research centers throughout the country and world, as well as those at Stanford, may participate in the high energy physics research program of the Center. As of January 1970, physicists from 25 other institutions have had research pro-
grams accepted for execution at the Center. The faculty of the Center leads a group of some 60 physicists in research programs on theoretical and experimental particle physics. In addition, the faculty offers lecture series on various aspects of high energy physics, and conducts seminars on topics of current interest.

The experimental research program at SLAC deals with almost all areas of elementary particle physics at high energies. To name but a few, experiments are in progress on high energy elastic and inelastic electron scattering, the study of high energy photon and hadron interactions both with bubble chamber and electronic techniques, and studies of decay properties of weakly interacting particles. The work in theoretical physics deals with all phases of elementary particle theory with special emphasis on electromagnetic interactions.

Stanford graduate students may, with the approval of their departments, carry out research for the Ph.D. degree with members of the SLAC faculty. (Graduate students from other universities also participate in the research programs of visiting groups.)

Research assistantships are available for qualified students by arrangement with individual faculty members. There are also opportunities for summer employment in the research groups at the Center. Interested students should apply to the Office of the Director.

UNDERGRADUATE PROGRAMS

FRESHMAN SEMINARS
(Program for Undergraduate Creative Development)

Committee in Charge: William A. Clebsch (Director), John Goheen (Chairman), Sanford M. Dornbusch, Paul R. Ehrlich, Arthur Hastings, Mark Mancall, Robert R. Sears, Paul S. Seaver

The Freshman Seminar Program, administered by Humanities Special Programs for the Committee on Undergraduate Studies, allows the first-year student to explore a subject of particular interest to him, in association with a faculty member and other freshmen who share that interest. Applicants who are admitted to the program meet, in groups of no more than 12 freshmen, on a weekly basis for two quarters, usually in the home or laboratory of the faculty member.

The Freshman Seminar Program is neither an honors program nor an advanced placement program. Few seminars have prerequisites. 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 may apply. Each seminar carries corresponding academic credit, and applies toward the University requirements of courses in certain fields but not toward the major requirement.

In 1969–70, 35 departments or schools participated in the Freshman Seminar Program, offering a total of 66 seminars to approximately 550 members of the freshman class.

APPLICATION AND ADMISSION PROCEDURES

All students who accept admission to Stanford University receive in June a copy of the Freshman Seminar Bulletin describing the program’s offerings for the next academic year. Applications for autumn-winter seminars are received and processed in late summer, and students are notified of their acceptance into a particular seminar before they arrive at Stanford for preregistration. When applications outnumber places, as they usually do, assignments are made on the basis of random selection. 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, Room 241C, Outer Quad, Stanford University, Stanford, California 94305.
Program in Human Biology

Committee in Charge:
Norman Kretchmer (Pediatrics), Chairman; Sanford M. Dornbusch (Sociology); Paul R. Ehrlich (Biology); David A. Hamburg (Psychiatry); Albert Hastorf (Psychology); Donald Kennedy (Biology); Joshua Lederberg (Genetics); Colin S. Pittendrigh (Biology).

Statement of Purpose
This undergraduate program is designed as a major emphasizing the interaction between the biological and behavioral sciences as applied to the study of man in his environment. The Program is an interschool, interdepartmental major, utilizing not only those faculty and courses particularly created for the major, but also pertinent areas of instruction available throughout the university. It is concerned with man as an organism, his adaptation to other men and to nature, his ability to control and to live with the environment, and the mechanism by which these factors relate to his biological and behavioral evolution.

This program is a response to the need for knowledge of the complex relationship of man with nature, exemplified by the dilemmas of medical-social policy, population problems, pollution of the environment and conservation of resources needed by the species. It is now necessary to prepare policy makers and citizens who have an understanding of biological principles. The Program in Human Biology seeks to achieve this goal; it also seeks to provide an alternative route to advanced study in the established biological and behavioral sciences.

Offerings and Facilities
The Program is funded by a grant from the Ford Foundation and leads to an A.B. in Human Biology. The curriculum is designed for those students who desire a knowledge of biology, particularly of man, linked with knowledge of the behavioral sciences. The Program initially involves faculty from the School of Humanities and Sciences and the Medical School. It is expected that representatives from a number of other Schools on campus will teach core and cognate courses.

The core of the program for majors in Human Biology is the Fundamental Program. It consists of nine one-quarter courses required of all majors. These courses form a highly integrated whole whose goal is the presentation of a broad but rigorous overview of the physical nature and behavior of man. The sequence is the necessary academic basis for the more specialized and advanced offerings of the Program.

At present there is no graduate program but the students will be prepared for advanced training in biology, the behavioral sciences, medicine, law, or education, depending on their choice of courses after the Fundamental Program.

An office for Human Biology is now established within the Undergraduate Library. It will contain indices, films, books, and periodicals directly related to Human Biology.

Admission to Program
Undergraduate students can elect Human Biology as a major, provided that they are not on probation. The Committee reserves the right to screen applicants for the Program if the number of students overburdens the resources of the Program in the early years.

Program of Study
Bachelor of Arts
The degree of Bachelor of Arts in Human Biology will require approximately 65 units in the major. The Fundamental Program will consist of 35 units and will satisfy the University Area Requirements in the social sciences and the natural sciences. It is expected that, in addition, at least six advanced courses will be taken in fields related to the biological, social, or physical aspects of Human Biology. Detailed guidance should be sought at the office of the Program in Human Biology so that the program for the individual student can be designed to fit his particular needs and career goals.

Courses in Human Biology will be supple-
mented with workshops, field trips, and laboratories.

**Courses**

*Note:* Students who have elected a major in Human Biology will be expected to take all the courses in the Fundamental Program. For the year 1970–71, Biology 10 previously taken can be used instead of Human Biology 1. The Committee will consider other requests for adjustments in the early phases of the Program.

**Fundamental Programs**

1. **Man and Nature**—The question "what is life" leads to a discussion of the nature of organisms, of organization in general, its dependence on information, and the central position of genetic and evolutionary theory in all biological sciences. A beginning is made in developing an understanding of the role of natural selection in molding the character of organisms and societies as self-reproducing entities adapted to the conditions in which they exist.

   A major section of this course is a substantial treatment of Mendelian and population genetics. The nature/nurture problem is introduced as one of the most important contributions which the biologists as such can make to an understanding of man and political issues that beset him.

   Metabolism in general (the energetics of the organism and traffic with the environment in material constituents) is given only brief treatment. The same is also true of the nervous system as the basis of behavior and the general principles of multicellular structure and function. They are all topics which the sophomore sequence treats in greater depth.

   This introductory course is primarily concerned with broad outlines of the origin and history of life, with special emphasis on the evolution of the vertebrates and the primates in particular. The quarter will close with a discussion of the biological uniqueness of man.

   4 units, Spr (Pittendrigh and Staff)
   MWF11

2A. **Cells, Organisms, and Societies**—The structural and functional prerequisites for life at various levels of organization are treated in this quarter in greater depth, i.e., cellular structure, molecular architecture and structure, and energetics of cellular life. The principles of multicellular organization in animals (primates) is particularly emphasized. Interorganismal relationships: Mutualism, parasitism, and evolutionary endpoints of such relationships will be stressed. Societies as self-reproducing units: The evolution of familial (insect) and associative (primate) societies will be discussed.

   4 units, Aut (Pittendrigh and Staff)
   MWF 9

2B. **Behavior as Adaptation**—Man is a biological organism whose survival requirements are met by food and shelter, defense, reproduction, and the socialization of the young. Strategies to satisfy these needs evolve as different patterns of behavior in various societies. Adaptive patterns among primate, hunting and gathering, agricultural, industrial, and contemporary technical societies will be discussed and compared.

   Individuals and teams will select topics for projects to be completed in spring quarter as part of Human Biology 4B.

   4 units, Aut (Hamburg, Katchadourian, Dornbusch, A. Siegel, and Staff)
   MWF10

3A. **Man as an Organism**—The later stages of human evolution are treated in greater depth than in the introductory course. Human development throughout the life cycle is presented in biological terms. The physiology of sexual reproduction and development, fertilization and ontogenesis is given extended treatment in addition to the physiology of the mature organism. General consideration will be given to the development of human races. The nature/nurture problem is treated in depth.

   4 units, Win (Kretchmer and Staff)
   MWF 9

3B. **The Transformation of Human Society**—Contemporary changes in environmental conditions have drastically affected the significance of behavior patterns which were previously adaptive. This course will focus on the nature of current social systems, with discussion of their implications for individual and group behavior. Bases for stability and change will be analyzed.

   4 units, Win (Dornbusch, Gurley, Hamburg, Katchadourian, A. Siegel, and Staff) MWF10
4A. Biology of Populations — The course will present a systematic approach to populations as biological units; the dynamics of population growth and the control of population size in the non-human and human populations. Demographic principles and community ecology will be emphasized. This course will include treatment of the structure of food webs, the flux of energy through communities, the flux of materials, renewable and nonrenewable resources and how these factors relate to the population dynamics of man.

4 units, Spr (Ehrlich and Staff) MWF 9

4B. Topics in Sociobiology—Specific topics will be examined in depth, building on the material in Human Biology 2B and 3B.

4 units, Spr (Dornbusch, Hamburg, Katchadourian, A. Siegel, and Staff) MWF 10

5. Humanics—(Same as Genetics 101.) Special undergraduate course. Impact of new biological knowledge on further evolution of the human species, the design of human beings. Topics discussed include eugenics, eugenics (control of development), mecha-
nistic foundations of behavior, transplanted and artificial organs, duration of life, symbiosis of men and machines. The course emphasizes the confrontation of new science with social policy.

3 units, Spr (Lederberg, Staff)
by arrangement

6. Workshop in Human Biology — This course can be correlated with any of the above offerings. It will demand actual experience in the field or laboratory either as an individual or as a member of a group. The course will be designed to respond to individual needs and to concentrate on problems particularly in this geographic area.

4 units (Kretchmer or Staff)
by arrangement

ADVANCED COURSES

This curriculum has not been completely designed. The Committee is now working with faculty from many departments and schools in an attempt to develop a variety of courses from which individual students may select advanced work in both biological or behavioral aspects of Human Biology.

INTERNATIONAL STUDIES (COMMITTEE on)

The Committee on International Studies (CIS), appointed by the President of the University, and an affiliated administrative entity, the Center for Research in International Studies (CRIS), provide mechanisms for coordination and cooperation among international, regional, and comparative programs. These programs are University-wide and include research and training activities in the Schools of Humanities and Sciences, Law, Business, Education, Engineering, Earth Sciences, and Medicine. Within the School of Humanities and Sciences, the Departments of Anthropology, Communication, Economics, History, Political Science, Sociology, and the language departments are those primarily concerned. The Food Research Institute and the Hoover Institution on War, Revolution and Peace are heavily involved in international affairs as well. Neither the CIS nor CRIS offers courses or confers degrees.

The CIS is composed of faculty members and administrators representing organizations—schools, departments, institutes, centers—which have significant international components in their research and training programs. The Committee meets several times each year, is concerned with major policy questions and decisions and with the ordering of priorities within the overall program.

The University established the Center for Research in International Studies in 1967 and assigned to its director and staff the role of coordinating various aspects of the international studies program. These include administering some foundation and government financial support for faculty research, student fellowships, library development, and new faculty appointments. CRIS also provides assistance in seeking funds to advance all aspects of the international studies program.

The work of CIS and CRIS is closely affiliated with all of the research and training programs having regional or area orientations. Interdisciplinary subcommittees of the CIS concerned with Africa, East Asia, Latin America, and Russia and East Europe coordinate University resources in the study of each region. All area-related courses are of-
ffered by individual schools, departments, and institutes and are listed thereunder in this bulletin. Undergraduate degree programs are coordinated by the Latin American Studies Committee and the African and Afro-American Studies Committee. At the graduate level, special programs leading to the A.M. in Latin American Studies and East Asian Studies are available. These degree programs are described under the headings of the various area programs in other sections of this bulletin. No Ph.D. is offered in any area studies program, but a qualified doctoral candidate may design a cross-disciplinary specialization which emphasizes his area interest within his discipline preparation for the degree.

CIS and CRIS also work closely with discipline-oriented research and training programs located in centers, institutes, and schools. These include the Food Research Institute, the Center for Research in Economic Growth, the Comparative Politics program, the International Development Education Center, the Institute for Communication Research, and the International Legal Studies program. The emphasis in these discipline-oriented research and training programs is on graduate level education, but faculty have responsibilities for training and counseling undergraduates as well.

A special international relations program for undergraduates is being developed by a subcommittee of the CIS in response to initiatives taken in 1968 to review this aspect of the international studies curriculum. Initial course offerings under this program are described under the rubric “International Relations: Special Offerings for Undergraduates” in the School of Humanities and Sciences section of this bulletin.

Inquiries relating to any of the above should be directed to Carl B. Spaeth, Chairman, Committee on International Studies, Building 460, Room 465, Stanford, California 94305.

**INTERSCHOOL MAJORS**

*Committee in Charge: Mark Mancall (Chairman), John Bowen, W. Bliss Carnochan, John Chowning, Russ Kridel, John Meyer, Walter Mischel, Steve Otto, Herbert Packr, William C. Reynolds, Leonard Stephenson*

The Committee on Undergraduate Studies sponsors a program for undergraduates whose special academic interests lie in more than one school and do not fit into the major requirements of any department. The degree awarded is Bachelor of Arts or Bachelor of Science. A label appropriately identifying the character of his major program is recorded on each student's transcript on graduation.

Sophomores, juniors, and seniors through registration period of the first quarter of their final year are eligible to apply. Applicants must be in good academic standing, but since the interschool major is not an honors program, an honors grade point average is not a requisite.

Each applicant is asked to prepare for the Committee in Charge a statement explaining the rationale for his proposed interschool program, including educational objectives. The program should be clearly interdisciplinary, educationally sound, and significantly articulated. It should not be a random collection of advanced courses in a variety of fields. It should be a program, furthermore, that clearly lies outside, and cannot be approved simply by petitioning for modification of, existing departmental major requirements.

Along with his statement of purpose, the applicant should submit a proposed list of courses numbered above 100 in this bulletin (approximately 60 credit units) to be offered in satisfaction of the requirements for the interschool major. Each application will be judged on its merits rather than merely on a first-come, first-served basis or the applicant's previous record of academic performance.

The proposal must have the approval and bear the signatures of at least three members of the Academic Council (faculty members of the rank of assistant professor or above) from at least two schools of the University. One of these professors, or another person designated by the Dean of Undergraduate Studies, will serve as adviser for the student's program. The Dean of Undergraduate Studies will be responsible at the appropriate time for certifying the eligibility of the candidate for graduation.

Students interested in this program should inquire at the Office of the Dean of Undergraduate Studies.
STANFORD WORKSHOPS on POLITICAL and SOCIAL ISSUES (SWOPSI)

Stanford Workshops on Political and Social Issues (SWOPSI) is a student-initiated, student-led program organized in an effort to turn Stanford’s curriculum more directly toward urgent social and political problems, and to involve Stanford students in actively seeking solutions. It is based on the assumption that one of the major responsibilities of the university in such times of concern and urgency is to help cultivate a community in which concern with respect to social problems is founded in knowledge and understanding of the facts, and in which the translation of a sense of urgency into action is thoughtfully directed.

SWOPSI was organized during the summer of 1969, and began the following autumn quarter with an offering of 10 workshops on such topics as: air pollution in the Bay Area, California logging policy, the delivery of health services, University research policy, and disarmament negotiations. The program expanded to 18 workshops in the winter, and, depending on the interest of students in investigating particular problems, and on the desire of instructors (faculty, students, others) to help students explore them, it will probably consist of an average of 20-25 workshop offerings per quarter.

The basic objective of all SWOPSI workshops is to develop new insights into contemporary issues of political and social consequence; and, ultimately, to affect more people than are actually members of the workshop. This might be done through informing the community of their conclusions in publications or public forums, or by using the results to form the basis of concrete legal, political or community action.

Workshops are generally concerned with issues which can be studied firsthand in the Bay Area, through the experiences of people in the Stanford community, or through primary materials available at Stanford. Since each problem may require a different approach, the specific structure of a workshop is determined by the faculty and students who are involved in it.

Workshops are open to both undergraduates and graduates, as well as other interested members of the Stanford community. There are occasionally prerequisites for a workshop, but past experience has indicated that a diversity of backgrounds enhances the possibility of a more perceptive analysis and more imaginative solutions. In general, the workshops meet weekly as seminars, but the largest part of the work is done through individual research, interviews, and other sorts of field work. Credit is available for most workshops, primarily on a Pass/Fail basis.

Each workshop is provided with a small amount of financial support for operating expenses. There is also a general program fund available to cover large expenses such as the publication of a workshop report.

Further information and the specific workshop offerings for any quarter may be found in the SWOPSI catalogue distributed each registration day. There is no pre-registration for workshops, and enrollment limits are determined by the instructor.

Any person interested in organizing a workshop on a particular issue should contact Robert Jaffe, Ext. 82266.

THE STUDENT CENTER for INNOVATION in RESEARCH and EDUCATION

The Student Center for Innovation in Research and Education is a mechanism established to encourage and facilitate student innovation in individual academic programs, as well as in the overall University curriculum. The “Student Center” is funded by the University Fellows, and as a formal Subcom-
operate with virtual autonomy on an experimental basis from April, 1970, to April, 1971. Policy will be determined by the six students and five faculty members of the Student Center Policy Board, and will be carried out in the daily operations of the Center by a staff consisting of a half-time Director, a part-time administrative assistant, and a full-time secretary.

Among its specific functions are: to allow students to experiment with subject matter and methods of study that may not be found in the traditional curriculum; to help students contact appropriate faculty and other qualified persons to sponsor and aid in the evaluation of student projects such as field work, independent research, or the development of new course offerings; and to encourage and facilitate student efforts directed toward improving individual academic programs or making changes in the traditional University curriculum. The Student Center is neither a student department, administering specific programs for students, nor a student "think tank" trying to implement its own innovative ideas. It is a facilitating mechanism for educational projects, specifically designed to respond to student proposals.

The staff of the Student Center will also be available to help a student locate and contact appropriate sources for the possible financial support of his project.

Work will generally be graded on a Pass/Fail basis; no student will receive more than 27 units of academic credit from the Student Center. All work must be evaluated by an individual holding a regular or temporary faculty appointment, and decisions involving academic credit will require a two-thirds majority of the Policy Board, including at least one student and one faculty member.

The office of the Student Center Director is located near the Volunteer Services Center in the basement of the Men's Clubhouse, where the Art and Architecture department used to be.

For further information call the ASSU office, extension 4331.

TECHNOLOGY and SOCIETY PROGRAM

A program entitled "Technology and Society" is available to undergraduate students in the School of Engineering. (See the "School of Engineering" section of this catalogue.) It allows the interested student the opportunity to explore the interface between technology and society in some depth. Adequate technical courses are included so that understanding of technology can be acquired. Adequate flexibility exists in the program so that the student may tailor the coursework to his own career goals and interests.

A list of courses specifically dealing with the interaction of Technology and Society is available in the Office of the Dean of Engineering. This list was assembled for the use of engineering students in fulfilling the Technology and Society requirement in the undergraduate engineering curriculum. However, it contains many courses available to all students, regardless of major. A few engineering courses of general interest to non-engineering undergraduate majors are: Engineering 2. Peopleynamics Laboratory; Civil Engineering 130. Transportation Engineering; Civil Engineering 170. Man and His Environment; Engineering 1. The Engineer in Modern Society; Industrial Engineering 50. Human Values in a Technological Society; Mechanical Engineering 101. Visual Thinking.


In 1964 the Committee on Undergraduate Education established a new category of courses for undergraduates to be called "Undergraduate Special Courses." These are now sponsored by the Committee on Undergraduate Studies. 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 profession-
al 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 auspices 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 three units may be given for participation in such courses. Grades shall be given in the normal manner, with the pass-fail option available upon the instructor’s approval.

3. All proposed courses must be approved by the Committee on Undergraduate Studies or such subcommittees as it may designate for that purpose. Responsible faculty members are to file with the Committee the following:
   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. Such assistants will normally be advanced graduate students or others with comparable qualifications
   e. A statement assuming full academic responsibility for the course

4. 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.

5. 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>

6. A student may take 12 Undergraduate Special courses, or 36 units of Undergraduate Specials, whichever is lower. Up to 27 of these units may be Undergraduate Specials, SC (Student Center for Innovation in Research and Education).

99. Individual Work for Undergraduates—Individual work which is an extension of other Undergraduate Special courses or carried on under the direction of a professional school or institute staff member not normally teaching undergraduates. Application should be made to the Committee on Undergraduate Studies.

101. Humanics — Special undergraduate course. 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.

   3 units, Aut (Lederberg, Genetics) 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.

   3 units, Aut, Spr (Serbein, Graduate School of Business) MTh 4:15

103. Comparative Perspectives on Race Relations in America, Africa, and the Caribbean—The course will focus on the historical, sociological, and psychological causes and effects of racial attitudes in the areas included. Each student will research a particular area and report both orally and in writing.

   Sample Readings: Melvin Tumin, Com-
481. Comparative Perspectives on Race Relations; Anthony Reuck, Caste and Race.
3 units, Aut (Samuda, Counseling and Testing) T 3:15–5:05

104. Symbols and Meaning in Science and Culture — An exploration into the meaning and uses of symbols, symbolic forms and structures. Two oral reports are expected of each student: one of these to be a critical examination of the symbolic structures, their meaning and validity, within his own major; the other to be a similar examination in another discipline of his own choosing.
Reading will consist of such books as S. Langer, Philosophy in a New Key; E. Casimir, An Essay on Man; M. Polanyi, Personal Knowledge; and F. S. C. Northrop, The Logic of the Sciences and the Humanities.
3 units, Aut (Ripley, Physical Sciences) W 2:15–4:05

105. The Meaning of Death — Reading and discussion of attitudes toward death as reflected in certain social phenomena (e.g., suicide, funerals) and in some philosophical and literary works (e.g., Agee, Camus, Tillich), aiming toward clarification of the meaning of death for human values.
3 units, Aut (Black, Counseling and Testing) W 7:30–9:30 p.m.

106. Interrelations Between People and Geography — Attempts to develop a composite picture of a region or a nation, stressing the relationship between man and planet earth.
3 units, Aut (Terry, Undergraduate Studies) W 7:30–9:30 p.m.

107. An Introduction to Poetry — The course attempts to introduce the student to poetry as an important means of ordering, understanding, and communicating human experience. Readings will include J. V. Cunningham, The Exclusions of a Rhyme, and Yvor Winters, Collected Poems.
3 units, Spr (Dahl, Undergraduate Studies) Th 3:15–5:05

108. Right of Privacy — A study of the theoretical background of the legal concept of privacy, and of the current status of law on the subject. Readings will include some Law Review articles and Supreme Court cases.
3 units, Win (Gregory, Office of Vice President for Finance) Th 2:15–4:05

109. World of Aldous Huxley — Traces Huxley’s development as a writer and philosopher. Readings will include Point Counter Point, Eyeless in Gaza, Devils of Loudun, and Island.
3 units, Spr (Gregory, Office of Vice President for Finance) Th 2:15–4:05

110. Masters of Twentieth Century Architecture — Introduction to the work of Wright, Gropius, Mies, LeCorbusier, and their followers, with an emphasis on American architects, to discover the fundamental principles underlying the modern movement in architecture.
Readings will include Coles and Reed, Architecture in America, and Sherban Cantacuzino, Great Modern Architecture.
3 units, Win (Cole, Speech and Drama) TTh 2:15

111. The Human Maturation Process — A conscious, realistic approach to human values and an awareness of the importance of people’s feelings are of obvious importance to anyone dealing with people. This course will be focused on values, relationships, communication, participation, awareness, self-image, and motivation.
3 units, Aut (Fitton, Undergraduate Studies) W 8–10 p.m. (First meeting at 7:00 p.m.)

112. Mystics and Mysticism: The Christian Tradition — The course seeks to introduce the student to the literature of mysticism as found in the Western world and to the distinctive elements of mysticism as a type of thought and experience. After preliminary reading in Evelyn Underhill, Mysticism, each student will take the writings of one of the great mystics and give a report presenting mysticism as reflected in that figure.
3 units, Spr (Watkins, Political Science) Th 2:15–4:05

113. 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.

3-4 units, Aut, Win, Spr (Hilton, Romanic Languages) TTh 10

114. The Destiny of Europe—An important problem discussed in many books from different viewpoints is the destiny of Europe, of the individual countries which compose it, and of the various facets of its culture. Each student selects, with the advice of the instructor, one book for careful analysis, and prepares a critical paper. The course is of special interest to students going to Europe, who may earn an extra unit of credit for fieldwork there.

3-4 units, Aut, Win, Spr (Hilton, Romanic Languages) TTh 11

115. Economics of Health—An economist's approach to the problems of one of our largest industries. Selected readings are from publications of governments; organizations of suppliers, financial agents and consumers; and analytical studies by economists and physicians.

3 units, Win (R. Campbell, Hoover Institution) Th 2:15-4:05


3 units, Aut, Spr (Bube, Materials Science) T 4:15-6:05

117. The Place of Aircraft, Missiles, and Spacecraft in Twentieth Century Civilization—The course is conducted as a seminar in which students present essays of their own choice on topics such as the history of aeronautics, the economics of air transportation, the design of jumbo jets and supersonic transports, technical and strategic concepts of aerial warfare, the uses of satellites for communication, geophysical research and navigation, international air law, etc. Only the first three classes are lectures by the instructor and during the rest of the course the students discuss the problems raised in the essays with the participation of the instructor.

3 units, Win (Hoff, Aeronautics and Astronautics) Th 2:15-4:05

118. Dance and Its Relationship to Society — A study of dance and its sociological importance from primitive to present-day.

3-4 units, Aut (Lidster) W 4–6

119. The Pursuit of Peace: Case Studies in the Western Hemisphere—The purpose of the course is to study and examine the procedures which have been used for peaceful settlement of disputes in the Inter-American system, and to explore the possibility of applying or adapting these procedures for use in other parts of the world. Cases will include selections from International Peace Observation: A History and Forecast by David Wainhouse and others.

3 units, Aut (Hanley, Overseas Campuses) MWF 1:15

120. The Italian Government—The course introduces a small class to the principal Italian political institutions and organs of government, examines major current problems of Italian public policy, and stimulates interest in the way the Italian political system operates. Dante Germino and Stefano Pasighi, The Government and Politics of Contemporary Italy, and H. Stuart Hughes, The United States and Italy, include most of the required readings.

3 units, Win (Hanley, Overseas Campuses) MWF 1:15

121. Crisis and Change in Latin America—The course reviews and evaluates the principal factors causing economic, social, and political change in Latin America, and discusses changes which are taking place in response to those pressures. Readings include Charles W. Anderson, Politics and Economic Change in Latin America: The Governing of Restless Nations, and current reports of the Alliance for Progress.

3 units, Spr (Hanley, Overseas Campuses) MWF 1:15

122. Management Problems of International Business—Class meetings are devoted primarily to discussions of student reports selected on the basis of individual interest. Subjects may range from broad issues, such as adaptation of company policies to conform to distinctive cultural features or government policies in different countries, to
more technical problems, such as those involving corporate financing across national boundaries or the measurement of consolidated income.

3 units, Win (Smith, D. T., Graduate School of Business) by arrangement

123. U.S. Foreign Policy Toward the Middle East.

3 units, Win (Nabti, Hoover Institution)
Th 2:15–4:05
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