STANFORD UNIVERSITY BULLETIN
Series 21, No. 1 / May 16, 1969

COURSES AND DEGREES
1969/70
[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.]

Stanford, California

Published by the University
### UNIVERSITY CALENDAR

**AUTUMN QUARTER, 1969**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day(s)</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 29-30</td>
<td>Mon-Tue</td>
<td>Registration</td>
</tr>
<tr>
<td>Oct. 1</td>
<td>Wed</td>
<td>Instruction begins</td>
</tr>
<tr>
<td>Oct. 2</td>
<td>Thur</td>
<td>Conferring of degrees</td>
</tr>
<tr>
<td>Oct. 5</td>
<td>Sun</td>
<td>Matriculation Sunday</td>
</tr>
<tr>
<td>Oct. 21</td>
<td>Tue</td>
<td>Last day for registration</td>
</tr>
<tr>
<td>Oct. 28</td>
<td>Tue</td>
<td>Last day for filing advanced degree applications: A.M., M.S., Engineer for April conferral; Ph.D. for June</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Day(s)</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 27-30</td>
<td>Thur-Sun</td>
<td>Thanksgiving Recess</td>
</tr>
<tr>
<td>Dec. 1</td>
<td>Mon</td>
<td>Last day for filing A.B. and B.S. applications</td>
</tr>
<tr>
<td>Dec. 15</td>
<td>Mon</td>
<td>Last day for filing A.M., M.S., Engineer theses, and Ph.D. Dissertations</td>
</tr>
<tr>
<td>Dec. 15-19</td>
<td>Mon-Fri</td>
<td>End-quarter examinations</td>
</tr>
</tbody>
</table>

**WINTER QUARTER, 1970**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day(s)</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 5</td>
<td>Mon</td>
<td>Registration</td>
</tr>
<tr>
<td>Jan. 6</td>
<td>Tue</td>
<td>Instruction begins</td>
</tr>
<tr>
<td>Jan. 8</td>
<td>Thur</td>
<td>Conferring of degrees</td>
</tr>
<tr>
<td>Jan. 15</td>
<td>Thur</td>
<td>Last day for filing Fellowship and Graduate Scholarship applications</td>
</tr>
<tr>
<td>Jan. 26</td>
<td>Mon</td>
<td>Last day for registration</td>
</tr>
<tr>
<td>Jan. 30</td>
<td>Fri</td>
<td>Last day for filing A.B. and B.S. applications for April and June conferral</td>
</tr>
<tr>
<td>Feb. 2</td>
<td>Mon</td>
<td>Last day for filing advanced degree applications: A.M., M.S., Engineer for June conferral; Ph.D. for September</td>
</tr>
<tr>
<td>Feb. 23</td>
<td>Mon</td>
<td>Observance of Washington’s Birthday</td>
</tr>
<tr>
<td>March 9</td>
<td>Mon</td>
<td>Founders’ Day</td>
</tr>
<tr>
<td>March 16</td>
<td>Mon</td>
<td>Last day for filing A.M., M.S., Engineer theses; and Ph.D. Dissertations</td>
</tr>
<tr>
<td>March 16-20</td>
<td>Mon-Fri</td>
<td>End-quarter examinations</td>
</tr>
</tbody>
</table>

**SPRING QUARTER, 1970**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day(s)</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 30</td>
<td>Mon</td>
<td>Registration</td>
</tr>
<tr>
<td>March 31</td>
<td>Tue</td>
<td>Instruction begins</td>
</tr>
<tr>
<td>April 2</td>
<td>Thur</td>
<td>Conferring of degrees</td>
</tr>
<tr>
<td>April 20</td>
<td>Mon</td>
<td>Last day for registration</td>
</tr>
<tr>
<td>April 27</td>
<td>Mon</td>
<td>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>Fri</td>
<td>Last day for filing Undergraduate Scholarship applications, matriculated undergraduates</td>
</tr>
<tr>
<td>May 18</td>
<td>Mon</td>
<td>Last day for filing Ph.D. Dissertations</td>
</tr>
<tr>
<td>May 29</td>
<td>Fri</td>
<td>Observance of Memorial Day</td>
</tr>
<tr>
<td>June 4</td>
<td>Thur</td>
<td>Last day for filing A.M., M.S., Engineer theses</td>
</tr>
<tr>
<td>June 5-10</td>
<td>Fri-Wed</td>
<td>End-quarter examinations</td>
</tr>
<tr>
<td>June 13</td>
<td>Sat</td>
<td>Senior Class Day</td>
</tr>
<tr>
<td>June 14</td>
<td>Sun</td>
<td>Commencement</td>
</tr>
</tbody>
</table>

**SUMMER QUARTER, 1970**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day(s)</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 22</td>
<td>Mon</td>
<td>Registration</td>
</tr>
<tr>
<td>June 23</td>
<td>Tue</td>
<td>Instruction begins</td>
</tr>
<tr>
<td>July 3</td>
<td>Fri</td>
<td>Observance of Independence Day</td>
</tr>
<tr>
<td>Aug. 14-15</td>
<td>Fri-Sat</td>
<td>Eight-week term examinations</td>
</tr>
<tr>
<td>Aug. 15</td>
<td>Sat</td>
<td>Eight-week term closes</td>
</tr>
<tr>
<td>Sept. 1</td>
<td>Tue</td>
<td>Quarter closes</td>
</tr>
</tbody>
</table>
## CONTENTS

### DEGREES
- 5

### COURSES OF INSTRUCTION 14

### SCHOOLS OF THE UNIVERSITY

**School of Business (Graduate)**  15

**School of Earth Sciences**  15
- Geology  17
- Geophysics  26
- Mineral Engineering  29
- Petroleum Engineering  36

**School of Education**  41

**School of Engineering**  65
- Engineering  75
- Aeronautics and Astronautics  79
- Applied Mechanics  94
- Chemical Engineering  101
- Civil Engineering  105
- Electrical Engineering  115
- Engineering-Economic Systems  130
- Industrial Engineering  136
- Materials Science  142
- Mechanical Engineering  148
- Nuclear Engineering  160
- Operations Research  163

**School of Humanities and Sciences**  169
- Aerospace Studies  169
- Anthropology  172
- Applied Physics  179
- Art and Architecture  182
- Asian Languages  192
- Biological Sciences  198
  - Biophysics Program  207
  - Marine Biology and Oceanography  208
- Systematic Biology  210
- Chemistry  211
- Classics  219
- Communication  225
- Computer Science  234
- East Asian Studies  240
- Economics  240
- English  251
- French and Italian  264
- Geography  271
- German  271
- History  277
- Humanities Special Programs  289
  - Honors Programs Religious Studies  289
- Language Laboratory  297
- Latin American Studies  297
- Linguistics  298
- Mathematics  303

**Military Science**  314
**Music**  316
**Naval Science**  323
**Philosophy**  325
**Physical Sciences (General Program)**  335
**Physics**  337
**Political Science**  345
**Psychology**  355
**Slavic Languages and Literatures**  362
**Social Sciences (Special Program)**  365
**Sociology**  366
**Spanish and Portuguese**  372
**Speech and Drama**  378
**Statistics**  386

**School of Law**  393

**School of Medicine**  395
- Allied Medical Sciences  396
  - School of Nursing  396
  - Division of Physical Therapy  396
- Anatomy  398
- Biochemistry  399
- Genetics  400
- Medical Microbiology  402
- Pathology  404
- Pharmacology  405
- Physiology  407
- Speech and Hearing Sciences, Program in  409

### OTHER DEPARTMENTS, INSTITUTES, AND PROGRAMS

**African Studies**
- African Languages and Area Center  413
- African and Afro-American Studies, Undergraduate Program in  413
- Computation Center  414
- Food Research Institute  415
- General Studies Program  419
- Graduate Division Special Programs  420
- Hoover Institution on War, Revolution and Peace  422
- Hydrology  423
- Inter-University Center for Japanese Studies in Tokyo  424
- Inter-University Program for Chinese Language Studies in Taipei  425
- Libraries  425
- Physical Education for Men  429
- Physical Education for Women  433
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Colloquia</td>
<td>437</td>
</tr>
<tr>
<td>Special Opportunities in</td>
<td></td>
</tr>
<tr>
<td>Graduate Study</td>
<td>440</td>
</tr>
<tr>
<td>Institute for Plasma Research</td>
<td>440</td>
</tr>
<tr>
<td>Space Science and Related Programs</td>
<td>440</td>
</tr>
<tr>
<td>Stanford Linear Accelerator Center</td>
<td>441</td>
</tr>
<tr>
<td>Undergraduate Special Programs</td>
<td>442</td>
</tr>
<tr>
<td>Freshman Seminars</td>
<td>443</td>
</tr>
<tr>
<td>INDEX</td>
<td>444</td>
</tr>
</tbody>
</table>
This section describes requirements for degrees which apply to all students at Stanford University. Special departmental or school requirements are described in the section on the school or department itself.

Candidates may be presented for graduation in January, April, June, and September, but all diplomas are awarded in June.

No degree will be conferred upon any person who has not spent at least three quarters in resident study at the University. No honorary degrees are given.

UNDERGRADUATE DEGREES

GENERAL STUDIES PROGRAM

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

There is much in the Program which is aimed at enriching the undergraduate's years at Stanford. On the academic side, students may be awarded up to 45 units of credit toward graduation for superior work completed in high school. Such advanced credit will be 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 is also an essential part of the student's undergraduate experience. In addition, good English is expected in all University course work and is a consideration in grading. It is not an exercise limited only to English classes.

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

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

1. English 1, 2, 3. Freshman English (Composition and Literature).
2. History 1, 2, 3. History of Western Civilization.
3. Foreign Language or Mathematics. Students may choose to complete either a foreign language or a mathematics series.
   a) Foreign Language. Acquisition of a reading ability equivalent to that reached in the following courses: Chinese 21, French 23, 82, German 22, 52, 82, Greek 23, Hausa 333A, Hebrew 23, Italian 23, 82, Japanese 21, Latin 23, Portuguese 23, Russian 52, Spanish 23, 53, Swahili 335A, Yoruba 343A.
   b) Mathematics. Completion of the final course, or its equivalent, of any of the following sequences:
      1) Mathematics 10, 11, 21, 22, 23
      2) Mathematics 31, 32, 33, 34, 35
      3) Mathematics 41, 42, 43
      4) Mathematics 41, 52, 53

B. Area Requirements for All Students

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

1. Humanities. A minimum total of 8 units selected from General Studies courses in at least two of the following three fields:
   a) The Fine Arts (including Archaeology, Art, Music, Speech and Drama)
   b) Philosophy, Religion (Philosophy 3 may not be credited here)
   c) Literature

2. Social Sciences. A minimum total of 10 units selected from the General Studies courses listed below. The units must be distributed between at least two of the departments represented.
   a) Anthropology 1, 102, 103, 106, 108, 109, 113, 116, 119
   b) Communication 1
   c) Economics 1
   d) Food Research Institute 1 (Human Geography)
   e) Political Science 1
   f) Psychology 1
   g) Sociology 1, 50, 55, 103, 105, 123

3. Natural Sciences. One of the following complete series:
   a) Biology 4, 5 (8 units)
   b) Biology 10, 11 (8–10 units)
   c) Biology 10, 12 (8–10 units)
   d) Chemistry 1, 2, 3 (13 units)
   e) Geology 1, 2 (10 units)
   f) Physical Sciences 1, 2, 3 (9 units)
   g) Physics 21, 23, 29 (12 units)*
   h) Physics 51, 53, 54, 55, 56 (14 units)*

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

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

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

1. One of the following
   a) Mathematics 1 and 2, Statistics 50, Math 44 or a more advanced course making use of calculus, if mathematics was chosen under “A” above.
   b) Philosophy 3 (Logic).
   c) 4 units of additional reading in the foreign language which the student took under “A.” (This requirement may be fulfilled either in consultation with the
student's own major department or by taking French 54, German 53, Portuguese 54, Russian 53, Spanish 54, or by taking a 4-unit language reading course numbered 100 or higher. Certain courses in Chinese and Japanese with lower numbers will be accepted.) This requirement may also be fulfilled by the language instruction at an overseas campus other than Stanford-in-Britain.

2. Additional courses in the Natural Sciences.
That number of units which, when added to the work completed under "B.3.," brings the total to 17 units. This additional work must be selected from the following courses in such a way as not to duplicate subject matter covered under "B.3."
Courses listed under "a" through "e" may be taken without laboratory in satisfaction of this requirement, but credit will be correspondingly reduced.

a) Biology 4, 5; 10, 11, 12
b) Chemistry 1, 2, 3
c) Geology 1, 2
d) Physical Sciences 1, 2, 3; 5, 6, 7; 50, 100, 150
e) Physics 21, 23, 29; 51, 53, 54, 55, 56, 57
f) Mathematics 1, 2
g) Mathematics 9, 10, 11, 21, 22, 23; 31, 32, 33, 34, 35; 41, 42, 43; 52, 53
h) Philosophy 3 (Logic)
i) Statistics 50
j) Psychology 60
k) Computer Science 50A, 126
l) Civil Engineering 170
m) Anatomy 213
n) General Studies 110, 111 (Elementary Human Physiology)

3. Senior Colloquia. One 2-unit colloquium, as listed in the Time Schedule under "Senior Colloquia." The following A.B. candidates are exempt from the Senior Colloquium requirement:

a) Students taking their senior year of undergraduate study as their first year in the School of Law or School of Medicine.
b) Students enrolled in Honors programs in Humanities or in Social Thought and Institutions.

In working to fulfill General Studies requirements, the following general rules should be remembered: (1) all courses approved for General Studies requirements are marked "#" in Courses and Degrees and in the quarterly Time Schedules; (2) no course may be used to satisfy more than one General Studies requirement; (3) except in the case of Senior Colloquia, courses taken to satisfy General Studies requirements may not be taken Pass-Fail; (4) while the General Studies requirements are firmly applied, reasonable variations within the structure of approved courses may be requested by petition. Petitions are obtained at the Information window in the Registrar's Office.

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

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

In applied science the school may prescribe as much of the entire 180 units as it shall deem essential to the technical or professional requirements of the major subject.
Within these limitations the work is elective, and the student may freely choose any
course which his previous studies have prepared him to undertake.

**BACHELOR OF ARTS OR BACHELOR OF SCIENCE**

The degree of Bachelor of Arts (A.B.) or the degree of Bachelor of Science (B.S.) is conferred upon candidates recommended by the Subcommittee on Graduation who, in addition to fulfilling the following requirements, have applied in advance for graduation: (see deadlines in Time Schedule calendar.)

1. Completion of 180 (quarter) units of University work, including General Studies 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 General Studies 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 General Studies 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 the Graduate Division. Candidacy is valid for five years from date of such approval and may be renewed by the submission and approval of a new application, or extended upon the recommendation of the major department. All applications or petitions to the University Committee on the Graduate Division must be submitted to the
major department for approval before being filed with the Graduate Study Office. Communications should be addressed to the Graduate Study Office, Old Union Building, Stanford University, Stanford, California 94305.

MASTER OF ARTS OR MASTER OF SCIENCE

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

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

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

MASTER OF ARCHITECTURE

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

MASTER OF BUSINESS ADMINISTRATION

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

**ENGINEER**

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

**Admission to Candidacy**—Admission to candidacy for the degree of Engineer is granted by the University Committee on the basis of an application formally approved by the student's major department and filed with the Graduate Study Office not later than the fourth week of the quarter preceding the final quarter of candidacy. (The application should be submitted to the major department early enough to allow for departmental consideration before the University deadline. The required time varies with departments.) Candidacy, when granted by the University Committee, is valid for five years and may be renewed by the approval of a new application by the major department and the University Committee, 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 the Graduate Division, and suitably bound. Upon acceptance, two copies are placed in the University Library, and the third copy is sent to the major department. Directions for the preparation and submission of theses are available in the Graduate Study Office, Old Union Building.

**MASTER OF FINE ARTS**

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

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

(Further information concerning these requirements will be found elsewhere in this bulletin and may be secured from the secretary of the Committee on Advanced Graduate Degrees of the School of Education.)

**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 the Graduate Division, the
DEGREES

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.

BACHELOR OF LAWS

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

MASTER OF LAWS

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

The degree of Master of Laws is conferred upon students so admitted to candidacy upon the completion, with distinction, of one academic year (26 term units) of work in this School in accordance with the rules of the University and of the School of Law.

Upon his admission to candidacy, each student must present for the approval of the School of Law Committee on Graduate Study the program which he wishes to pursue for this degree.

DOCTOR OF THE SCIENCE OF LAW

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

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

DOCTOR OF MEDICINE

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

DOCTOR OF PHILOSOPHY

General Regulations

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

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

Admission to Candidacy

When a student has completed the major department's required preliminary procedures, the major department may certify him to the University Committee on the Graduate Division for admission to candidacy. If the student's program includes a minor, certification by the minor department is also required. If the student offers no minor, his application must show at least three units of work taken (or to be taken) as a graduate under each of four or more Stanford faculty members. Application for admission to candidacy is made on Form G34, which must be filed with the Graduate Study Office not later than the fourth week of the final three quarters of candidacy. Candidacy, when approved by the University Committee, is valid for five years and may be renewed by the submission and approval of a new application, 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 from 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. In cases where the dissertation topic makes advice from outside the department useful, the appointment of an appropriate outside reader should be made early, and he should be encouraged to follow and advise on the progress of the research. In any case, the Form G81 is due in the Graduate Study Office by the end of the next to the last quarter of candidacy. Each member of the reading committee will certify by signature on the final copies of the dissertation that he has read the dissertation, and that in his opinion it is of a scope and quality acceptable in fulfillment of this requirement for the degree. At least one member of the committee will read the dissertation in its final submitted form and so certify on Form G82.

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

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

Directions regarding the form of the dissertation, title and signature pages, and the abstract may be obtained from the Graduate Study Office. The abstract (600 words or fewer in length) will be published in Dissertation Abstracts by University Microfilms. The candidate will be charged a $40 fee to cover the cost of microfilming the dissertation, binding four copies of the dissertation, and publishing the abstract. This fee is payable at the Cashier’s office on or before the last day of instruction in the final quarter of candidacy.
COURSES of INSTRUCTION
1969-70

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

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

SUMMER SESSION

The Summer Session of 1970 will be eight weeks in length, except in certain schools which will offer ten-week courses.

This announcement includes, for the Summer Session of 1970, 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, 1970.
GRADUATE SCHOOL of BUSINESS

Dean: Arjay R. Miller
Associate Deans: James E. Howell, Samuel A. Pond
Lecturers: C. Sidney Cottle, Mark D. Larkin, Lamar Lee, Samuel A. Pond, Karl M. Ruppenthal, 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 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 scholastic career. The adviser's approval of the study plan must be obtained before registration is completed at the beginning of each quarter.

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

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

GRADUATE PROGRAM

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

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

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

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

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

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

SPECIAL PROGRAMS

MECHANICAL PROCESSES AND EARTH MATERIALS

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

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

Geol. 200. Mechanics of Earth Materials
Geol. 204. Computer Applications in the Earth Sciences
Geol. 209. Physics of Underground Fluids
Geol. 305. Theoretical Foundations of Geology
Geol. 320. Advanced Structural Geology
Min.E. 200. Introduction to Rock Mechanics
Geophys. 326. Mechanisms of Rock Deformation
Geophys. 327. Experimental Rock Mechanics
Geophys. 328. Theoretical Structural Geology
Mat. Sci. 50. Introductory Science of Materials
Mat. Sci. 238. Fracture of Solids
Applied Mech. 211. Elementary Theory of Plasticity

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

PROGRAM IN ENVIRONMENTAL EARTH SCIENCE STUDIES

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

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

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

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

Geol. 233. Principles of Geomorphology
Geol. 235. Photogrammetry and Photogeology
Geol. 361. Permafrost
Geol. 284. Engineering Geology
Geol. 285. Hydrogeology
Civ. Engr. 170. Man and His Environment
Civ. Engr. 190. Soil Mechanics and Foundations

GEOLoGY

Emeriti:
Siemon W. Muller, Charles F. Park, Jr. (Professors)
Chairman: John W. Harbaugh
Vice Chairman: Robert R. Compton
Consulting: Harold W. Hoots
Assistant Professors: James C. Ingle, Jr., Arvid M. Johnson (Mineral Engineering), Paul Switzer (Statistics). Acting: Keith A. Kvenvolden

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

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

All students planning to continue graduate study are strongly urged to complete an appropriate foreign-language sequence as most geology departments require a foreign language for graduate study.

In addition to General Studies courses the following courses are required of all students:
Course No. | Subject | Quarter | Given | Units
---|---|---|---|---
Chemistry 1, 2, 3. General Chemistry | AWS | 13
Mathematics 10, 11. Analytical | Any | 6
Geology 1. Geoscience I | Any | 5
(See Note 1)
Geology 2. Geoscience II | W or S | 5
Geology 25. Elementary Mineralogy and Crystallography | A | 5
Geology 51. Elementary Petrology | W | 5
Geology 105. Structural Geology | S | 5
Geology 120. Field Geology (See Note 2) | Summer | 15
Total | | | 59

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

Note 2.—A student who takes Geology 120 during the summer following his junior year will normally graduate at the end of winter quarter in his senior year.

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

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

Course No. | Subject | Quarter | Given | Units
---|---|---|---|---
Geology 112. Elementary Paleontology | A | 5
Geology 171. Introduction to Geochemistry | A | 3
At least 5 additional units in geology (see Note 2) | Any | 5
Geophysics 190. General Geophysics | A | 3
Physics 51, 53, 54, 55, 56. Elementary Physics | WSA | 14
Mathematics 21, 22. Calculus | Any | 6
Mathematics 23, or Statistics 50 or 110 | Any | 3-5
Total | | | 39-41

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

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

Course No. | Subject | Quarter | Given | Units
---|---|---|---|---
Geology 171, 271. Geochemistry | AW | 6
Geology 204A, B. Computer Applications in Earth Sciences | AW | 6
Geology 110. Introduction to Marine Geology | W | 4
Geophysics 190. General Geophysics | A | 3
Physics 51, 53, 54, 55, 56. Elementary Physics | Any | 12
Total | | | 46

Electives.—A student entering Stanford with credits for two years of high school language and four years of mathematics will normally have 26-30 units of free electives, depending on which of the above curricula he chooses (based on an average load of 15 units per quarter). If his preparation is less adequate, the number of electives is correspondingly smaller. Electives should be chosen after consultation with the adviser. They may be courses offered by the Geology Department or by any other department in the University. The following geology courses are particularly recommended as electives, depending on a student’s individual interests: Geology 234 and 235, Photogrammetry and Photogeology; Map Interpretation; Geology 220, Optical Mineralogy; Geology 160, Stratigraphy; Geology 282, Petroleum Geology and Subsurface Mapping; Geology 281, Ore Deposits; Geology 294, Engineering Geology; Geology 285, Hydrogeology; Geology 289, Economic Geology. (Courses numbered in the 200’s are open to qualified undergraduates.)

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

Grade requirements—In addition to the
University requirement of an overall mean
grade of C or better for graduation, the De-
partment requires that the mean grade in re-
quired courses in each of the fields of mathe-
matics, chemistry, physics, biology, and
earth sciences must be C or better.

Special programs—Students whose inter-
ests lie in special fields such as mineralogy,
economic geology, geomorphology, geo-
chemistry, oceanography, or particular
branches of paleontology should use some
of their elective units to broaden their back-
grounds in these fields. Special programs in
these fields, involving possible substitutions
for requirements listed above, may be ar-
ranged in consultation with the adviser and
may be submitted to the faculty of the De-
partment for approval.

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-sci-
ence teachers. For details about the pro-
gram, inquiries should be addressed to the
School of Education.

Honors Program—The Geology Honors
Program is designed to give a limited num-
ber of undergraduates with superior scho-
lastic records, interest, and ability the oppor-
tunity to undertake independent study and
research during their last year or two of un-
dergraduate training. Admission to the pro-
gram 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 com-
pletion of Geology 1, 2, 25, 51, and 105. Entry
is possible at any time after the end of the
sophomore year. The Honors Program con-
sters of the following:

1. The courses required of all geology ma-
jors: Chemistry 1, 2, 3; Mathematics 10, 11;
Geology 1, 2, 25, 51, 105, 120.
2. The courses in other science depart-
ments required for any one of the three regu-
lar curricula of the department.
3. Geology 150A,B,C and 6 units of Ge-
ology 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 satis-
factorily will receive the degree of Bachelor
of Science in Geology with Honors upon the
recommendation of the faculty of the De-
partment of Geology.

Master of Science

Objectives—To round out the student's train-
ing 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 specializa-
tion.

Requirements for the Degree—For admis-
sion to the Graduate Division of the Uni-
versity, the candidate must have taken the
Aptitude Test (Verbal and Quantitative) of
the Graduate Record Examination. The can-
didate must fulfill the following require-
ments:

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 Sci-
cences 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 train-
ing. Previous training should be approxi-
mately equivalent to one of the three cur-
ricula leading to the B.S. degree in Geology
at Stanford. Geology 220 and either 222 or
223 (or equivalents) and one course in eco-
nomic geology must be taken, if these
courses or equivalents have not previously
been completed.
4. Demonstrate in one of the following ways his knowledge of basic principles and research methods in his general field of study: (a) By writing a thesis, as may be recommended at the discretion of individual advisers. (b) By preparing a report, ordinarily a term paper written for the 6 units of research, to be submitted to at least two faculty members.

Courses taken for the Master of Science degree must include at least 4 units in each of four of the following fields:

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

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

**Doctor of Philosophy**

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

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

**Requirements for the Degree**—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. The candidate must demonstrate by examination in the appropriate language department his ability to read German, French, or Russian. Another language may be substituted on approval of the Department chairman. The choice of language must be made in consultation with the student's adviser and must be passed before taking the Departmental oral. His record must indicate outstanding scholarship, and deficiencies in previous training must be removed. Although he need not obtain an M.S. degree, the candidate will be expected to have, or to obtain, a training approximately equivalent to the Stanford M.S. program. He must pass the Departmental oral examination. He must fulfill the requirements of the minor department, if a minor is elected. He must prepare under faculty supervision a dissertation which is a contribution to knowledge and the result of independent work. (The dissertation must be reasonably concise, prepared in a form suitable for publication of a part or the whole.) He must pass the University oral examination, which is centered around the dissertation problem.

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

**Courses**

**GENERAL GEOLOGY**

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

#1. Geoscience I — Study of the earth, with emphasis on its materials, its internal constitution, and the processes that affect it. Introduces geological and geophysical methods of investigating problems. Lectures, one 3-hour laboratory period per week, and field 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 (Dickson) MWF 9; lab, field trips by arrangement
Spr (Compton) MWF 10; lab, field trips by arrangement
Sum (8 weeks), MWF 9; lab, field trips by arrangement

#2. Geoscience II — Continuation of Geoscience I, with emphasis on the history of the earth and life, the origin of major features of the earth's crust, and the relation of earth science to humanity. 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 (Ingle) MWF 9; lab, field trips by arrangement

3. Current Topics of Geoscience — An introductory course aimed toward understanding the nature and significance of investigations in the earth sciences. Chiefly but not exclusively for science and engineering students. An analytical approach to selected geological and geophysical problems is emphasized. Lectures and laboratory, with discussion periods or short field trips as required. A transportation fee may be charged for field trips. Recommended: elementary chemistry and physics, Geoscience I and/or Geoscience II.

3 units, Spr (Jahns) TTh 10; lab, field trips by arrangement

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


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


4 units, Win (Ingle) MWF 9; field trips and research conferences by arrangement (given alternate years, beginning 1969)

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, Sum (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 of an extensive area of moderate geological 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 traverse and plane table 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: 105.

15 units, Sum (Staff)

140. History of Geological Science — Development of the scientific discipline in geology during the past several centuries. Two discussion periods. Prerequisite: 1 or equivalent.

2 units, Sum (Mutter) MW10

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. Mechanics of Earth Materials — Field, laboratory, and theoretical studies of physical geologic processes such as intrusion, folding, 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 — 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, manipulation of data files, least-squares surface and space-fitting techniques, and numerical taxonomy methods. Emphasis is placed on the mathematical tools of simulating dynamic systems, including feedback control, 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.

3 units, Aut (Harbaugh) MWF11

204B. Computer Applications in Earth Sciences — Continuation of 204A: Includes a seminar in which students previously enrolled in C204A present results of their research.

3 units, Win (Harbaugh) MWF 11

205. Statistical Problems in Earth Sciences — 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, and other topics chosen from participants’ interests. No prerequisites.

3 units, Spr (Switzer) 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. Prerequisites: 1, 51, and 105.

5 units, Aut (Howard) MWF 9; 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 Geochernistry.

Each quarter (Staff) by arrangement


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

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

337. Seminar in Geomorphology. Topics for consideration to be posted. Prerequisite: 233.

2 units, Win (Howard) by arrangement

400. Research in Various Fields of Geology and Geochernistry.

Any quarter (Staff) by arrangement

MINERALOGY, PETROLOGY, AND GEOCHEMISTRY

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

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


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

171. Introduction to Geochemistry—Application of elementary chemical principles to geologic problems. Prerequisites: 1, Chemistry 3 or 5, and Geology 25; the last may be taken concurrently.

3 units, Aut (Krauskopf, Parks) MWF 9

203. 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 chemical 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 spectroscopy; 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

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

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

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

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

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

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. Equilibria in Aqueous Systems—(Enroll in Mineral Engineering 227.)

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

3 units, Win (Krauskopf) TTh 9; lab. 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. (b) Systematic study of mineral particles, with special reference to those of high density. Prerequisites: 221 and permission of instructor.

6 units, Win (Hutton)

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. Prerequisites: 222, 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 (Jahns) 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 of organic materials that become constituents of sedimentary rocks. Geological occurrences of all classes are discussed, and chemical relationships between biological compounds and their transformation products in sedimentary rocks are considered. Application of organic geochemistry to origin and evolution of life is also treated. 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

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

1 unit, Spr (Keen) by arrangement

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


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

211. Marine Paleoecology—Techniques and principles of interpreting relationships between fossil marine organisms and their paleoenvironments. Emphasis on integration of biologic, sedimentary, stratigraphic, and geochemical evidence. Discussion of relevant characteristics of selected modern marine environments and their ancient analogs with extensive reading from the current scientific literature. Introduction to simulation of paleoenvironments utilizing computer techniques. An original field investigation of a modern or fossil environment serves as basis for required term paper. Prerequisites: 1, 2, and 112. Recommended: 160, 218, and 223.

4 units, Win (Ingle) MWF 1:15; field trips and research conferences by arrangement, alternate years, given 1970

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

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

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

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

218. Introduction to Micropaleontology—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 qualitative investigation of fossil or modern foraminiferal fauna serves as a basis for required term paper. Instruction in laboratory and field techniques. Prerequisites: 2 and 112.

5 units, Aut (Ingle) MTW 11; lab. M 1:15–4:05 and one lab. by arrangement, alternate years, given 1969

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 stratigraphic problems. Prerequisite: 112 or consent of instructor.

5 units, Win (Evitt) 3 lec and 2 labs. by arrangement, given 1971

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

367. Seminar in Paleontology and Stratigraphy—Enrollment by approval of instructors.

2 units, any quarter (Staff)

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.)

281. Ore Deposits—The geologic environments, characteristic mineral associations and genesis of ore deposits, with emphasis on the processes of ore deposition. Examination of rock and mineral suites in the labora-
26 SCHOOL OF EARTH SCIENCES

tory and in the field. The course is designed as a background course in ore deposits for students in geological sciences and as a beginning course for students primarily interested in economic geology. The lecture portion of the course involves study of assigned material in textbook and selected readings of topics in the literature; written mid-term and final examinations. The laboratory and field portion involves hand-lens examination of rock and mineral suites requiring about 3 hours per week; brief written reports are requested. Thin section and polished surface studies by arrangement for those students with optical mineralogy backgrounds. Prerequisites: 51 and 105. Recommended: 171 or Chemistry 171 and 220.

4 units, Win (Dickson) MWF 10; lab. and field trips by arrangement

282. Petroleum Geology — Course consists of seminar and directed reading and problem solving. Topics include origin, migration, and entrapment of petroleum, with emphasis on application of subsurface mapping techniques. Paleogeologic, structure, isopach, lithofacies, and hydrodynamic maps are treated. Digital computers are used in several of the mapping applications.

3 units, Spr (Harbaugh) MWF 11


4 units, Win (Williams) M 1:15-4:05; two labs. and one seminar 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 (Jahns, Johnson, Remson) TTh 8; field trips and seminars by arrangement


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

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

289. Economic Geology — Relationships of ore deposits to local and regional structure, using descriptive geometry to develop a three dimensional viewpoint. Emphasis on economic considerations.

3 units, Win (Park) TTh 10; lab. by arrangement


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

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

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

287. 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, Aut (——) by arrangement

GEOPHYSICS

Chairman: George A. Thompson

Professors: Allan V. Cox, George A. Thompson

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

Assistant Professor: Jon F. Claerbout

Research Associates (By Courtesy): Sheldon Breiner, Richard R. Doell, David G. Willis
OBERINGS AND FACILITIES

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

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

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

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry 1, 2, 3 or 4, 5</td>
<td>General Chemistry</td>
<td>AWS 13 or 8</td>
</tr>
<tr>
<td>Math. 10, 11, 21, 22, 23 and 44 or 41, 42, 43 and 44</td>
<td>Analytical Geometry and Calculus</td>
<td>Any 18</td>
</tr>
<tr>
<td>Math. 130</td>
<td>Ordinary Differential Equations</td>
<td>A or W 3</td>
</tr>
<tr>
<td>Math. 131</td>
<td>Partial Differential Equations</td>
<td>W 3</td>
</tr>
<tr>
<td>Geophysics 190</td>
<td>Elementary Geophysics</td>
<td>A 3</td>
</tr>
<tr>
<td>Physics 51, 53, 54, 55 and 56</td>
<td>Elementary Physics</td>
<td>WSA 14</td>
</tr>
<tr>
<td>Physics 110, 111</td>
<td>Mechanics</td>
<td>WS 6</td>
</tr>
<tr>
<td>Physics 120, 121</td>
<td>Electricity and Magnetism</td>
<td>AW 6</td>
</tr>
</tbody>
</table>

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

As electives in the Geophysics Curriculum the following courses are recommended: 191, Geology 106, Physics 57, 58, and 122, Mathematics 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 122 and three of the following: Physics 210, 211, 212, or Applied Physics 213, 214, 215; and advanced courses selected from the following topics: Applied Physics, Astrophysics, Atomic and Nuclear Physics, Communication Theory, Electromagnetic Theory, Engineering Mechanics, Geology, Geophysics

Geology 1, 2, Geoscience | AWS 10 |
Geology 25, Mineralogy | A 4 |
Geology 51, Elementary Petrology | W 5 |
Geology 105, Structural Geology | S 5 |
Geology 108, 109, Field Geology* | S 15 |
Geology 171, Geochemistry | A 3 |
(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**


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

3 units, Win (Cox) MWF 11

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

3 units, Aut (Claerbout) by arrangement

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

3 units, Win (Claerbout) by arrangement

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

1 unit, Spr (Claerbout) by arrangement

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

301. Problems in Geophysics.

Any quarter (Staff) by arrangement

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

3 units, given annually except 1969-70

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

2 units, given annually except 1969-70

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

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

397. Seminar in Geophysics.

1 unit, any quarter (Staff) by arrangement

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

Research Associates (By Courtesy): Weston Bourret, Donnel F. Hewett

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

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

UNDERGRADUATE PROGRAMS OF STUDY

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

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

COURSES TAKEN BY ALL UNDERGRADUATES

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>English 1, 2, 3. Freshman English</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>History 1, 2, 3. History of Western Civilization</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Math. 41, 42, 43. Analytical Geometry and Calculus</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Group Activities (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humanities (including Speech 20)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Social Sciences (including Economics 1)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>54</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 4 and 5. General Chemistry</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Engr. 11 and 12. Engineering Mechanics</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Engr. 15. Mechanics of Materials (See Note 1)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Engr. 21. Mechanics of Fluids (See Note 2)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Engr. 41 and 42. Circuits, Electronics, and Electromechanics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geol. 1. Geoscience I</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geol. 25. Elementary Mineralogy</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Geol. 204A. Computer Applications in Earth Sciences or Computer Science 136</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.E. 100. Industrial Report</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Min.E. 101. Elements of Mining</td>
<td>3-5</td>
<td></td>
</tr>
<tr>
<td>Min.E. 103. Principles of Mineral Processing</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Min.E. 105. Extractive Process Metallurgy</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Min.E. 276A. or B. Field Trip</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Physics 51 to 56. Engineering Physics</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>70-72</strong></td>
</tr>
</tbody>
</table>
MINING OPTION

Course No. | Subject | Units
--- | --- | ---
C.E. 180 | Elementary Structural Analysis | 4
C.E. 245 | Advanced Construction Equipment and Methods | 3
Geol. 51 | Elementary Petrology | 5
Geol. 105 | Structural Geology | 5
Geol. 281 | Ore Deposits | 5
Engr. 9 | Introduction to Engineering Design | 4
Engr. 161 | Engineering Economy | 3
I.E. 133 | Industrial Accounting | 4
Geol. 289 | Economic Geology | 3
Min.E. 118 | Mining Methods | 2
Min.E. 219 | Mine Exploration | 5
Min.E. 200 | Introduction to the Mechanics of Earth Materials | 3
Electives | | 13
Total | | 59

CHEMICAL AND EXTRACTIVE METALLURGY OPTION

Course No. | Subject | Units
--- | --- | ---
Chem. 171, 173, 175, 176 | Physical Chemistry | 12
Ch.E. 10 | Introduction to Chemical Engineering | 3
Ch.E. 130B | Transport Phenomena | 3
Engr. 50 | Introductory Science of Materials | 3
Math. 44 | Advanced Calculus | 3
Math. 130 | Ordinary Differential Equations | 3
Mat.Sci. 104 | Crystallography and Mat.Sci. 127 | X-ray Diffraction and Spectroscopy, or Geol. 220 | Optical Mineralogy, or Min.E. 272 | Spectrochemical Analysis | 5
Mat.Sci. 124 | Phase Equilibria | 3
Mat.Sci. 125 | Structural Transformation in Materials, or Min.E. 225 | Surfaces and Interfaces, or Min.E. 227 | Equilibria and Kinetics in Aqueous Systems | 3-4
Min.E. 106 | Engineering Aspects of Mineral Processing, or Min.E. 107 | High Temperature Laboratory, or Min.E. 109 Separation Flow-sheets Development | 2
Min.E. 207 | Physical Chemistry of Metal Refining | 3
Min.E. 226 | Electrometallurgy | 3
Min.E. 233 | Rate Processes in Chemical Metallurgy | 3
Electives | | 4
Total | | 53-54

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

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

RECOMMENDED ELECTIVES

Course No. | Subject | Units
--- | --- | ---
C.S. 136 | Use of Automatic Digital Computers | 3
Geol. 171 and 271 | Geochemistry | 6
I.E. 152 | Introduction to Operations Research | 3
Stat. 110 | Statistical Methods in Engineering | 4
Stat. 116 | Theory of Probability | 4

Mining Option

Course No. | Subject | Units
--- | --- | ---
C.E. 240 | Construction Planning | 2
Chem 171 | Physical Chemistry | 3
Geophys. 190 | General Geophysics | 3
Math. 44 | Advanced Calculus | 3

Chemical and Extractive Metallurgy Option

Course No. | Subject | Units
--- | --- | ---
Chem. 121 | Organic Chemistry | 3
Engr. 161 | Engineering Economy | 3
Geol. 283 | Microscopic Study of Ore Minerals | 3
I.E. 133 | Industrial Accounting | 3
Mat.Sci. 105 | Imperfections in Crystalline Solids | 3
Min.E. 200 | Introduction to the Mechanics of Earth Materials | 3
Phys. 57 | Atomic Physics | 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 en-
gineering 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.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>
<td></td>
<td>21-22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-32</td>
</tr>
</tbody>
</table>

Geol. 204A, B. Computer Applications 4
Geol. 205. Statistical Problems 3
Geol. 281. Ore Deposits 5
Geol. 283. Laboratory Study of Ore Minerals 4
Geol. 383. Genesis of Metallic Ores 6
Geophy. 190. General Geophysics 3
Geophy. 191. Geophysical Field Techniques 4
Min.E. 219. Mine Exploration 3-5
Min.E. 280. Quantitative Exploration 2
Decision Making 2
Geol. 289. Economic Geology 3
Min.E. 296A, B. Geologic Remote Sensing 6-7
Geol. 387. Seminar in Ore Deposits 3

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>
<td></td>
<td>21-22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-32</td>
</tr>
</tbody>
</table>

Geol. 182. Petroleum Geology and Subsurface Mapping 3
Geol. 204A, B. Computer Applications in Earth Sciences 4
Geol. 205. Statistical Problems 3
Geol. 209. Physics of Underground Fluids 5

GROUP B

Geophy. 190. General Geophysics 3
Geophy. 191. Geophysical Field Techniques 4
Pet.E. 150A, B, C. Formation Evaluation 8
Min.E. 280. Quantitative Exploration 2
Min.E. 296A, B. Geologic Remote Sensing 6-7

Mineral Processing

Min.E. 215. Mineral Economics 3-4
Min.E. 225B. Surfaces and Interfaces, or Min.E. 227. Equilibria and Kinetics in Aqueous Systems 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

30-31

Chemical and Extractive Metallurgy

Min.E. 207. Physical Chemistry of Metal Purification 3
Min.E. 215. Mineral Economics 3-4
Min.E. 224. Physical Chemistry of Metals Seminar or 228. Extractive Metallurgy Seminar or 229. Principles of Steelmaking 3
Min.E. 226. Electrometallurgy or Min.E. 227. Equilibria in Aqueous Systems 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

30

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>
</tr>
</thead>
<tbody>
<tr>
<td>C.S. 136.</td>
<td>Use of Automatic Digital Computers</td>
<td>3</td>
</tr>
<tr>
<td>I.E. 229.</td>
<td>Engineering Economy</td>
<td>2</td>
</tr>
<tr>
<td>I.E. 230.</td>
<td>Advanced Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td>I.E. 252.</td>
<td>Operations Research</td>
<td>4</td>
</tr>
<tr>
<td>Min.E. 300.</td>
<td>Advanced Work (Thesis)</td>
<td>10</td>
</tr>
<tr>
<td>Stat. 110.</td>
<td>Statistical Methods in Engineering</td>
<td>4</td>
</tr>
<tr>
<td>Electives</td>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

*In addition to requirements for Master's degree.

DOCTOR OF PHILOSOPHY

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

The Department requires either (a) a reading knowledge of two foreign languages in addition to English, at least one useful in research. The other must be useful in the career of a mineral engineer, or (b) a speaking, writing, and reading knowledge in one foreign research language in addition to English.

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) by arrangement

103. Principles of Mineral Processing—Study of mineral separation techniques and auxiliary operations aimed at recognizing the basic principles involved and the means by which they may be applied in practice. Topics include comminution, sizing, solid-liquid separations and gravity, magnetic, electrostatic, and flotation techniques of solid-solid separation. Guided reading, occasional lectures, and periodic interviews. Prerequisites: Chemistry 5, Physics 55, and Mathematics 43.
4 units, Aut (Parks) MWF 10 and one hour by arrangement

105. Extractive Process Metallurgy—Introduction to metallurgical thermodynamics, and fundamentals of the processes used in the production and refining of metals. May be taken as an introduction to metallurgical thermodynamics by enrolling for 2 units. Prerequisite: Chemistry 5.
2 to 3 units, 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 1969–70


2 units, Win (Parks) by arrangement

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

2 units, Win (Kruger) by arrangement, alternate years, given 1969–70

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 (O’Hara) MWF 9

203A. Advanced Mineral Processing: Separations—A sequel to 103. Advanced study of solid-solid separation methods. Prerequisite: 103 or equivalent, Geology 25, and Engineering 50. Enrollment in Engineering 50 may be concurrent.

4 units, Aut (Parks) MWF 11 and one discussion session by arrangement

203B. Advanced Mineral Processing: Auxiliary Operations—Advanced independent study of solid-fluid separations, comminution, and sizing. Periodic discussions. Prerequisites: 103 or equivalent and Engineering 50.

3 units, Win (Parks, Staff) by arrangement

204A. Computer Applications in Earth Sciences—(Enroll in Geology 204A.)

3 units, Aut (Harbaugh) MWF 10

204B. Computer Applications in Earth Sciences Seminar—(Enroll in Geology 204B.)

1 or more units (Harbaugh) by arrangement

205. Statistical Problems in Earth Sciences—(Enroll in Geology 205.)

3 units, Spr (Switzer) by arrangement

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

3 units, Win (Parlee) 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, discussions. 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 11

224. Physical Chemistry of Metals Seminar
— Lectures, student seminars, guest speakers on topics in the physical chemistry of metals and in properties of liquid metals. Can be repeated with credit.
1 to 3 units, Sum (Parlee) by arrangement, alternate years, given 1969-70

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

225B. Surfaces and Interfaces — Advanced treatment of selected topics in Surface Chemistry with emphasis on inorganic colloidal systems and adsorption. Independent study, lectures, and discussions. Term paper. Prerequisites: 225A or equivalent and Chemistry 173 or equivalent.
3 units, Spr (Parks), three lecs. by arrangement, alternate years, given 1970-71

226. Electrometallurgy — Applications of electrochemistry in metallurgical reduction and purification processes, electrothermics, chemistry and transport properties of fused salts and slags.
3 units, Spr (Bartlett) MWF 10

227. Equilibria in Aqueous Systems—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) three lecs. 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 1969-70

229. Principles of Steelmaking—Systematic development of the physical chemistry underlying ironmaking and steelmaking processes. Treatment generalized to promote understanding of the physical chemistry of other metals as well. Seminar treatment of important processes. Prerequisite: 105 or Chemistry 171 in special cases.
3 units, Spr (Parlee) by arrangement, alternate years, given 1970-71

230A. Mining Seminar — Survey of recent and current improvements in practice.
3 units, Aut (Kruger) by arrangement

230B. Mining Seminar—Case histories, economics.
3 units, Win (Kruger) by arrangement

230C. Mining Seminar—Valuation, law, organization.
3 units, Spr (Kruger) by arrangement

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: 109, 234, and Engineering 161.
3 units, Spr (Bartlett) MW 1:15 and one hour by arrangement

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 1969–70

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 1969–70

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


2 units, Spr (Harbaugh, Kruger) by arrangement

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

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

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

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

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

3 units, Win (Park) MWF 9

289. Economic Geology — (Enroll in Geology 289.)

3 units, Win (Park) TTh 10; lab.

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

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

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

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

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 — Development of continuum theory of rock behaviors, including viscoelasticity and viscoplasticity. Tensor description of rock behaviors based on constitutive equations. Definition of threedimensional coefficients for rock. 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 (Serata) by arrangement, given 1969–70

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

2 units (Young) by arrangement
SCHOOL OF EARTH SCIENCES

387. Seminar in Ore Deposits — (Enroll in Geology 387.) 2 units, Aut (Kruger) by arrangement

PETROLEUM ENGINEERING

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

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, staff offices, and office study space for graduate students.

PROGRAMS OF STUDY

UNDERGRADUATE

The four-year program provides a foundation for a career in petroleum engineering. Basic sciences and engineering are stressed. Breadth is provided through courses in the social sciences and humanities. The mean grade in required courses in each of the fields of mathematics, chemistry, physics, and earth 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</td>
<td>Analytical Geometry and Calculus</td>
<td>18</td>
</tr>
<tr>
<td>Math. 130</td>
<td>Ordinary Differential Equations or Statistics 110. Statistical Methods in Engineering and the Physical Sciences, or Mathematics 45. Advanced Calculus II</td>
<td>3</td>
</tr>
<tr>
<td>English 1, 2, 3</td>
<td>Freshman English</td>
<td>9</td>
</tr>
<tr>
<td>History 1, 2, 3</td>
<td>History of Western Civilization</td>
<td>12</td>
</tr>
<tr>
<td>Physics 51, 53, 55</td>
<td>Mechanics, Sound, Electricity, Light, and Heat</td>
<td>12</td>
</tr>
<tr>
<td>Physics 52, 54, 56</td>
<td>Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>Engr. 9</td>
<td>Introduction to Engineering Design</td>
<td>4</td>
</tr>
<tr>
<td>Engr. 11</td>
<td>Engineering Mechanics (Statics)</td>
<td>2</td>
</tr>
<tr>
<td>Engr. 12</td>
<td>Engineering Mechanics (Dynamics)</td>
<td>4</td>
</tr>
<tr>
<td>Engr. 15</td>
<td>Mechanics of Materials</td>
<td>3</td>
</tr>
<tr>
<td>Engr. 21</td>
<td>Mechanics of Fluids</td>
<td>4</td>
</tr>
<tr>
<td>Engr. 31</td>
<td>Elementary Engineering Thermo-dynamics</td>
<td>5</td>
</tr>
<tr>
<td>Engr. 41</td>
<td>Circuits, Electronics, and Electromechanics</td>
<td>4</td>
</tr>
<tr>
<td>Engr. 161</td>
<td>Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 1</td>
<td>Geoscience I</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 2</td>
<td>Geoscience II</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 51</td>
<td>Petrology</td>
<td>5</td>
</tr>
<tr>
<td>Geol. 105</td>
<td>Structural Geology</td>
<td>5</td>
</tr>
<tr>
<td>Pet.E. 103</td>
<td>A Survey of the Petroleum Industry</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 150A, 150B</td>
<td>Formation Evaluation</td>
<td>6</td>
</tr>
<tr>
<td>Pet.E. 151A</td>
<td>Petroleum Reservoir Fluids</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 151B</td>
<td>Fluid Behavior in Reservoir Rocks</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 151C</td>
<td>Drilling Fluids</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 151D</td>
<td>Petroleum Reservoir Fluids Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>Pet.E. 151E</td>
<td>Core Analysis Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>Pet.E. 152</td>
<td>Development and Production Technology</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 160</td>
<td>Report on Oil Field Training</td>
<td>1</td>
</tr>
<tr>
<td>Pet.E. 170</td>
<td>Elements of Petroleum Reservoir Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 172</td>
<td>Natural Gas Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Social Sciences* (General Studies Requirement)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Humanities (General Studies Requirement)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Technical Electives from the following: **</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>C.S. 5</td>
<td>Introduction to Programming</td>
<td>3</td>
</tr>
<tr>
<td>C.S. 50A</td>
<td>Introduction to Computer Science</td>
<td>3</td>
</tr>
<tr>
<td>C.S. 136</td>
<td>Introduction to Algorithmic Processes</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 20</td>
<td>Elementary Surveying</td>
<td>3</td>
</tr>
<tr>
<td>Geol. 25</td>
<td>Elementary Mineralogy and Crystallography</td>
<td>5</td>
</tr>
</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.
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>
</tr>
</thead>
<tbody>
<tr>
<td>A.M. 250</td>
<td>Mathematical Methods in Applied Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>A.M. 251</td>
<td>Mathematical Methods in Applied Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>A.M. 252</td>
<td>Numerical Methods in Engineering Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 267</td>
<td>Engineering Valuation and Appraisal of Oil and Gas Properties</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 270A</td>
<td>Advanced Oil Reservoir Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 270B</td>
<td>Applications of Oil Reservoir Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 270C</td>
<td>Applications of Oil Reservoir Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 272A</td>
<td>Natural Gas Engineering</td>
<td>3</td>
</tr>
<tr>
<td>Pet.E. 272B</td>
<td>Natural Gas Engineering</td>
<td>2</td>
</tr>
<tr>
<td>Pet.E. 274</td>
<td>Introduction to Research Methods</td>
<td>3</td>
</tr>
<tr>
<td>Electives*</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

Total: 45

† 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 beyond 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 University 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 Department'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 undergraduate training. The candidate is required to take a minimum of 36 units in Engineering and the Graduate School of Business.

These may be selected from the following:

- Bus. 210-211. Management Accounting 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 economic study. It is to have the approval of the supervising instructor and the University Committee of the Graduate Division.

DOCTOR OF PHILOSOPHY

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

A minimum of three years (nine quarters) of graduate study must be satisfactorily completed. At least two of these years, ordinarily the last, should be spent as a registered student at Stanford. He is expected ordinarily to take at least 90 units of course work including credit for research (Pet.E. 360) beyond the 45 units required for the Master's degree. Approximately 65 units are generally required, exclusive of research units. The 65 units in question should represent graduate courses in petroleum engineering offered at Stanford, plus courses from the following list, and other courses approved by the Department.

**Math and Applied Math**

- Math 130. Ordinary Differential Equations 3
- Math. 131. Partial Differential Equations 3
- Math. 132. Partial Differential Equations 3
- Math 106. Introduction to Theory of Functions of a Complex Variable 3
- Math 113. Linear Algebra and Matrix Theory 3
- Math 114. Linear Algebra and Matrix Theory 3
- Stat. 110. Statistical Methods in Engineering and Physical Sciences 4
- C.S. 136. Introduction to Algorithmic Processes 3
- C.S. 137. Numerical Analysis 3

**Science**

- Chem. 171. Physical Chemistry 3
- Chem. 173. Physical Chemistry 3
- Geophys. 190. General Geophysics 3
- Min.E. 225A. Introduction to Surfaces and Interfaces 3

**Engineering**

- Chem.E. 130A. Transport Phenomena: Momentum Transport 3
- Chem.E. 130B. Transport Phenomena: Energy Transport 3
- Ind. Eng. 229. Engineering Economy 2

**General**

- Geol. 287. Minerals, Politics and Economics 3
- Ger. 10, or French 10, or Russian 10, or Span. 10, or Engl. 29 or 59 (limit of 6 units) 3 ea.
- Engl. 129. Scientific Writing 3

His record must indicate outstanding scholarship. The candidate must demonstrate by examination his ability to read one foreign language: Russian, German, French
or Spanish. 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 re-apply 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) MWF11


3 units, Aut (Ramey) MWF10

150B. Formation Evaluation — Continuation of 150A: Lectures, problems. Radioactivity, sonic and nuclear magnetism logging; formation evaluation programs.

3 units, Win (Marsden) T9-11 and Th10

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) MWF11


3 units, Win (Ramey) MWF10

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

3 units, Spr (Marsden) MW115; lab. MW 2:15-5:05

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

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

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

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

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

3 units, Spr (Miller) T9-11 and Th9, 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) T9-11 and Th9, alternate years, given 1970-71


3 units, Aut (Ramey) MWF11


Any quarter (Staff) by arrangement

267. Engineering Valuation and Appraisal
of Oil and Gas Properties—Seminar, problems. Methods in appraising oil lands; estimation of productive capacity, reserves; operating costs, depreciation of materials, salvage, value of future profits, tax returns. Prerequisite: consent of instructor.

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


3 units, Aut (Miller) MWF 1:15


3 units, Win (Miller) MWF 11

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

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

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

3 units, Win (Ramey) MWF 2:15

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

3 units, Spr (Ramey) MWF 10


Any quarter (Staff) by arrangement


3 units, Aut (Marsden) MWF 9

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
SCHOOL of EDUCATION

Emeriti: A. John Bartky, W. H. Cowley, Paul R. Hanna, Ernest B. Hilgard, Maud M. James, Lucien B. Kinney, Maud L. Knapp, Henry B. McDaniel, Quinn McNemar, 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 Instructor: Lewis E. Knight

Members of the faculties of other divisions of the University giving courses or cooperating in the offerings of the School of Education are Arthur P. Barnes, John D. Black, David C. Blanchard, Howard Dallmar, Charles E. Finger, Richard Gould, James Gaughran, Daniel J. Millman, Payton Jordan, Walter F. W. Lohnes, Raymond E. Lunny Jr., Phillip Petersen, John Ralston, David Reed, and J. Raymond Young.

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.

- Art Education
- Elementary School Education
- English Education
- General Curriculum
- General School Administration*  
  Guidance (Counseling Psychology)
- Higher Education
- History of Education
- International Development Education
- Junior College Administration
- Mathematics Education
- Modern European Languages
- Music Education
- Physical Education for Men
- Philosophy of Education
- Research Training Program
- Psychological Studies in Education
  Educational Psychology

* Elementary School and Secondary School Administration and Supervision are included in the concentrations of Elementary School and Secondary School Education, respectively.
Child Development  
Counseling Psychology  
Mathematical Studies in Educational Processes  
Studies in Curriculum and Instruction  
Studies in School Organization  
Science Education  
Secondary School Education  
Social Foundations of Education  
Social Studies Education  
Teacher Education, or Elementary Education, or Secondary Education, or Special Curriculum, with concentrations in any of the following:  
Art  
Health  
Journalism  
Language Arts or English  
Mathematics  
Modern European Languages  
Music  
Physical Education for Men  
Reading  
Science  
Social Studies  
Speech  

Candidates who select one of the fields of concentration listed above should identify their field as in the following examples:  
Art: Teacher Education  
Science: Secondary Education  
Mathematics: Elementary Education  
Journalism: Special Curriculum  

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

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

MASTER OF ARTS**

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

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

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

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

1. A minimum of 45 units of graduate study is required. At least 36 units must be completed at Stanford. Two-thirds of the program must be in the School of Education. 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 ad-

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

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

3. Preliminary application materials, listed below, are to be submitted to the Master of Arts secretary in the School of Education two quarters before the conferring of the degree:

a) Transcripts of all academic work previously taken, 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 recommendation of the University Committee on the Graduate Division.

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


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

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

MASTER OF ARTS IN TEACHING*

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

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

* 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.
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 (Health, History, Philosophy, Comparative Education, etc.) must be selected in consultation with the adviser in the School of Education.

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

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

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

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

**DOCTOR OF EDUCATION**

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

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

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

Complete information concerning the organization of this program may be secured from the Secretary of the Committee on Ad-
Doctor of Philosophy

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

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

Organization of Program — Considerable flexibility is allowed in projecting a program for the Ph.D. degree. The candidate will be expected to organize his program of work for the degree in conference with 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.

Credentials for Public School Service

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

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

Administration and Supervision Credentials

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

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

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

**Standard Supervision Credential Requirements**

1. Two years of acceptable postgraduate education including a Master's degree or 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.
   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 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, History 60, or History 151.

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

* Stanford does not offer training at this time for the credential in elementary education.*
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 ( Aptitude Test and the Advanced Test in the candidate’s major field) is required for admission. Candidates who intend to earn the credential through a teaching major in a modern foreign language are urged to submit their scores in the ETS-MLA test for advanced students and teachers at the time of their application. These scores may be substituted for the Advanced Test of the Graduate Record Examination.

4. Personal interviews. A personal interview with each applicant by a Stanford staff member at the University or in the candidate’s locality is required. In unusual cases it is possible to petition to have the personal interview waived. Applicants should consult with the Secondary Teacher Education Program Director in order to obtain dates that have been set aside for interviews.

5. Notice of admission. Candidates will be notified of their acceptance into the program no later than April 1, 1970. Candidates must reply within two weeks, or no later than April 15, if they wish to have a place in the 1970 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. (Competency in composition must be demonstrated, either by completing a college course or passing an examination.) This field is required as one of the four.

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

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

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

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

6) A foreign language.

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

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

c) Interns will be responsible for a program of courses totaling 45-54 quarter units over a four-quarter residence at Stanford, which includes approximately one third of the work in academic courses, one third of the work in professional courses in education, and one third in practical teaching experiences, including the micro-teaching clinic in the summer quarter and the internship during the academic year.

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

Education course requirements for the Secondary Teacher Education Program:

**Course No.** | **Subject** | **Quarter Units**
--- | --- | ---
211A | Foundations of Education: Psychological | Summer 3
211B | Foundations of Education: Psychological | A 3
211C | Foundations of Education: Social | W 3
240A | Secondary Education | Summer 3
240B | Secondary Education | A 1
240C | Secondary Education: Seminar | W 2
240D | Secondary Education: Seminar | S 2
246A | Micro-Teaching Clinic | Summer 3
246B,C,D | Intern Teaching | AWS 11

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:

**Course No.** | **Subject** | **Units**
--- | --- | ---
Ed. 230 | Developmental Guidance: Basic Principles and Practices | 2
Ed. 231 | Developmental Guidance: Group Procedures | 3
Ed. 232 | Developmental Guidance: Research | 2
Ed. 233 | Decision Making: Basic Principles and Theory | 3
Ed. 234 | Decision Making: Measurement and Prediction of Outcomes | 3

* This course requirement may be waived at the discretion of the instructor.
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 238, Practicum in Guidance, for an additional 12 units.

COURSES IN OTHER DIVISIONS OF THE UNIVERSITY

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

COURSES IN EDUCATION

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

The various courses are distributed as follows:

Foundations of Education (Digits 00-19), e.g., 218, Health Foundations of Education

Administration (Digits 20-29), e.g., 320A, B, C, Advanced Public School Administration

Guidance and Personnel (Digits 30-39), e.g., 230A, Guidance in Elementary Schools

General Curriculum and Methods (Digits 40-49), e.g., 246B, Internship in Teaching

Statistics, Evaluation and Research (Digits 50-54), e.g., 350, Research Methodology

Physical Education (Digits 55-59 and 70-79), e.g., 155, Elementary Analysis of Body Movement

Special Curriculum and Instruction in Other Fields (Digits 60-69 and 80-99), e.g., 261A, B, C, D, Curriculum and Instruction in Secondary School Art

JUNIOR-SENIOR

These courses are also open to graduate students.

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

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

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 107 or Psychology 60.

3 units, Aut (Coladarci) MWF 10

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

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

GRADUATE

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

200. History of Education — Foundational course in educational history meeting advanced degree requirements. Survey; em-
phasis 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—Detailed study of American educational history in its cultural setting. Education 200 will provide a helpful background but is not a prerequisite.

3 units, Win (Staff) Th 7–10 p.m.
4 units, Sum (Staff) 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 8
Spr (Thomas) TTh 1:15–3:05

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

3 units, Spr (—) TWTh 2:15

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

4 units, Sum (—) MTWThF 2:15

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

4 units, Aut (Baldridge) MW 1:15–3:05
Sum (—) MTWThF 8

The following courses in the Foundations of Education are taken by students admitted to the program for the secondary teaching internship. Students enrolled in other programs select foundation courses from 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 (Koff) 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 (Koff) 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
(Hawkinson) Section 2: M 4:15–6:05, and W 4:15–5:05
(Hawkinson) Section 3: M 9–10, and W 9–11
Spr (Hawkinson) Section 4: M 4:15–6:05, and W 4:15–5:05

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

4 units, Aut (Eisner) MW 4:15–6:05

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

4 units, Aut (Gage) MW 3:15–5:05
Sum (Staff) MTWTh 9 and by arrangement

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: Psychology 60 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. Pre-
requisites: Psychology 60 or equivalent and
Psychology 111 or equivalent, or consent of
instructor.

3 units, Spr (Sieber) MWF11

217. Development of Scientific Explanation
in Children—Examination of studies of chil-
dren's explanations of scientific phenomena
and of conceptions guiding the study de-
signs.

3 units, Aut (Bridgham) Th 3:15-5:05
and by arrangement

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 de-
velopment.

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

220. Introduction to Public School Admin-
istration — School district organization for
administration; emphasis upon develop-
ment, 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 su-
ervisor. For teachers and candidates for ad-
ministrative 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 creden-
tials. Systematic treatment of full range of
problems of administration of schools that
include grades 7-12. Administration viewed
from vantage point of the principal.

3 units, Aut (——) Th 7-10 p.m.
4 units, Sum (——) MTWThF 11

225. Field Practice in School Administra-
tion and Supervision — Field practice in
school administration and supervision that
will meet requirements for California Stan-
dard Administration and Standard Super-
vision Credentials. Consent of instructor re-
quired.

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. Sub-
stance of studies will change periodically.

3 units, Spr (Mayhew) M 3:15-6:05

229. Administration of School Health Pro-
gram—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 Prin-
ciples and Practices — Principles, practices
and program organization in guidance. Or-
ganizing educational environments to de-
velop student potentials, to prevent and ameliorate student problems relevant to
guidance.

2 units, Aut (Staff) Th 1:15-3:05
4 units, Sum (——) MTWThF 9

230A. Guidance in Elementary Schools —
Review of modern guidance practices. Par-
ticularly directed to needs of teachers, ad-
ministrators, guidance workers.

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

231. Developmental Guidance: Group Pro-
cedures—Principles and practices of coun-
seling in groups to enhance student develop-
ment and to solve problems. Limited direct
experiences as group member and leader in-
volved.

3 units, Win (Thoresen) TTh 2:15-4:05

232. Developmental Guidance: Research—
Evaluation of research studies on attempts
to foster student development and to pre-
vent problems. Supervised experience in re-
search activity.

2 units, Spr (Krumboltz) M 3:15-5:05

233. Decision Making: Basic Principles and
Theory — Methods of making decisions in
guidance which maximize various criteria
of success. Application of decision theory
strategies to educational and vocational
planning and to problems in emotional and
social behavior.

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

234. Decision Making: Measurement and
Prediction of Outcomes — Research and
practice on standardized educational and
psychological tests to assess educational out-
comes and estimate probabilities of success
for alternative courses of action.

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

235. Decision Making: Evaluation of Guid-
ance Information Sources—Criteria for as-
sessing sources of educational and voca-
tional information. Supervised experience in
finding, using and evaluating information
relevant to educational and vocational decisions.

1 unit, Spr (Staff) M 2:15


2 units, Aut (Thoresen) T 2:15–4:05


2 units, Spr (Thoresen) W 3:15–5:05

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

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

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

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

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

3 units, Sum (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) W 5:15


2 units, Win (Staff) by arrangement


2 units, Spr (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, Knight) 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

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

250A,B. Statistical Analysis in Educational Research I—Designed for graduate students who expect to use statistical methods in their research. Foundations of statistical inference. Review of special hypotheses and test procedures for the normal distribution. Non-
parametric analysis. Analysis of variance and design of experiments, simple regression and correlation, other measures of association. Prerequisite: Statistics 7.

3 units, Win, Spr (Elashoff) MWF 1:15

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 (Olkin) MWF 11:00-12:30, alternate years, given 1969-70

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: Psychology 60, Statistics 7, or equivalent.

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

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

3 units, Spr (Cronbach, Snow) by arrangement

CURRICULUM AND INSTRUCTION IN SECONDARY SCHOOL MAJOR TEACHING FIELDS

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

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


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


262A. 3 units, Sum (Higgins) 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


263A. 3 units, Sum (Politzer) MTWTh 3:15
263B. 1 unit, Aut (Politzer) T 4:15-6:05
263C. 1 unit, Win (Politzer) T 4:15-6:05
263D.* 1 unit, Spr (——) 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, Tucker) MTWTh 3:15
268B. 1 unit, Aut (Gross, Tucker) T 4:15–6:05
268C. 1 unit, Win (Gross, Tucker) T 4:15–6:05
268D.* 1 unit, Spr (Gross and/or Tucker) T 4:15


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) offered annually, except 1969–70

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, Win (Shopen) MW 3:15

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

3 units, Spr (Petersen) TTh 9 and one hour by arrangement

284. German Applied Linguistics—(Same as German 190.) Phonology and morphology.

2 units, Win (Politzer) TTh 10

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 200.)

3 units, Spr (Lohnes) MWF 11

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

2 units, Aut (Petersen) TTh 1:15

Sum (Petersen) MTWThF 11

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

2 units, Sum, short term (Petersen) MTWThF 11

299. Children’s Literature—General survey of children’s literature for both pre-school and elementary school years.

3 units, Win (Iverson) W 7–10 p.m.

COURSES FOR EXPERIENCED TEACHERS OR ADVANCED GRADUATE STUDENTS

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

4 units, Aut (Thomas) TTh 1:15–3:05

303. 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

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 302 or consent of instructor.

4 units, Win (Thomas) MW 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. International Development Education I—(Same as Anthropology 228.) 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.

2 to 5 units, Aut (Textor) T 3:15-6:05 and by arrangement

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

2 to 5 units, Win (Weiler) T 3:15-6:05 and by arrangement

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

2 to 5 units, Spr (Carnoy) T 3:15-6:05 and by arrangement

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

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

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

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

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

2 to 4 units, Spr (Carnoy) Th 4:15-6:05 and by arrangement


Aut, Spr (Weiler) by arrangement

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

Win, Spr (Textor) by arrangement

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

Aut (Carnoy) by arrangement

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

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

310A,B. Research Problems in the Sociology of Education—The aim of this course is to acquaint the doctoral student with the rapidly expanding field of research on sociology of education. The student will be expected to develop the ability to evaluate and criticize as well as the ability to conceptualize basic and applied research in this area. Practical training in the problems of research design and data analysis will be included. Topics considered for Autumn Quarter will be status and social class, alienation, occupational analysis of teachers, and education for the disadvantaged. Topics considered in Winter will be the school as a complex organization, professionalization problems, community power and the educational system, and the sociology of higher education.
Students who are not doctoral candidates in the School of Education must obtain consent of instructor. Either quarter or both may be selected.

310A. 4 units, Aut (Cohen, Baldridge) 
MW 9–11

310B. 4 units, Win (Cohen, Baldridge) 
TTh 8–10

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

3 units, Spr (Hess) by arrangement

313. 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.

3 units, Win, Spr (Carnoy, Levin) by arrangement

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

3 units, Aut (Warren) M 7–10 p.m.
4 units, Sum (Spindler) TTh 3:15–5:05 and one hour by arrangement

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

4 units, Win (______) TTh 11:00–12:30 and by arrangement

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

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

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

4 units, Win (Gage) MW 3:15–5:05

319. Motivation in the Educational Process—Research findings on attentional and motivational processes, including pupil traits and situational determiners. For graduate students in educational psychology. Other students admitted on consent of instructor.

2 to 3 units, Win (Sears) by arrangement

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

320A. Role of Theory in Educational Administration.

3 units, Aut (Odell, Strand) W 7–10 p.m.

320B. Interpersonal Relationships in Staff Development and Personnel Management.

3 units, Win (Odell, Strand) W 7–10 p.m.

320C. Administrative Relationships in Education.

3 units, Spr (Odell, Strand) W 7–10 p.m.

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

3 units, Spr (Staff) M 7–10 p.m.

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

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

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

3 units, Spr (Keller) Th 7–10 p.m.

4 units, Sum (Keller) TWTh 4:15–6:05

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

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

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

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


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

326A. School Finance—Principles 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


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

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

2 to 4 units, Aut, Win, Spr (Black, Lyon) 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 1:15–2:45

343. Secondary School Curriculum, Instruction, and Supervision—For experienced teachers and students working for specialist or doctoral degrees. Comprehensive analysis of problems of curriculum development in
secondary schools; historical, comparative emphases.

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 (——) TTh 2:15-4:05
Sum (——) MTWThF 2:15

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) offered annually, except 1969-70

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, various methodological approaches relevant to research problems. Consideration given to particular concerns relating to doctoral dissertations. Prerequisites: 317A and B or consent of instructor.

4 units, Spr (——) 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. Prerequisites: Statistics 220 or equivalent and consent of instructor.

3 units, Aut, Win (——) 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 (——) 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 equivalent.

3 to 4 units, Aut (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) alternate years, given 1970-71

357. Elementary School Language Arts — For experienced teachers, graduate students. Reviews research, curriculum issues, instructional procedures related to language arts in elementary schools.

3 units, Sum (Eisner) MTW 10-12

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

3 units, Spr (Politzer) offered annually, except 1969-70

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

2 to 3 units, Win (Begle) by arrangement

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

2 to 3 units, Win (Higgins) by arrangement

1 to 3 units, Sum (Higgins) by arrangement

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

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


3 units, Win (Bridgham) M 7-10 p.m.

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

4 units, Spr (Hurd, Bridgham) TTh 1:15-3:05


3 units, Win (Tucker) M 7-10 p.m.

4 units, Sum (Tucker) MTWTh 8 and by arrangement


4 units, Aut (——) MW 2:15-4:05

Sum (——) MTWTh 1:15 and by arrangement


3 units, Aut (Iverson) M 7-10 p.m.

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

3 units, Win (Iverson) M 7-10 p.m.

4 units, Sum (——) MTWThF 9

SEMINARS AND SPECIAL COURSES FOR ADVANCED GRADUATE STUDENTS


3 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 (——) MW 1:15-3:05

404. Seminar in the Philosophy of Education — Intensive study of student-selected topics in comparative philosophies of education. Epistemological emphasis in Winter, values emphasis in Spring. Prerequisite: consent of instructor.

3 units, Win (Waks) 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, Spr (Waks) T 7-10 p.m. and by arrangement
406A. Research Seminar on Education and Development I—A review of methods and techniques appropriate to research in international development education, including approaches used in various disciplines. Discussion will focus on particular concerns relating to doctoral dissertations. Required for all first-year SIDEC doctoral students. Others by consent of instructor.

Aut (Textor) by arrangement

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

Win (Weiler) by arrangement

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

Win (Carnoy) by arrangement

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

1 unit, any quarter (Staff) W 12

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

2 units, Win (Hess) by arrangement


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, given 1969–70

413. Research Problems on Organizational Behavior—Designed for advanced students interested in organizational and administrative problems. Current research on internal operations, as well as the organization in its external environment. Case analyses of organizations, with particular emphasis on the administration and governance of universities and colleges. Theories of organizational change processes will be a critical element in the course. Recommended prerequisites: Sociology 105, or equivalent courses in Education or the School of Business.

4 units, Spr (Baldridge) TTh 9–11

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

2 to 4 units (Staff) by arrangement


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

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

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

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

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

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

423A,B,C. Seminar in School Facility Planning—Designed for advanced candidates in school administration. The autumn quarter will be conducted as a seminar; the winter quarter will be devoted to master-planning the school plant; and the spring quarter to the development of educational specifications for the school plant. Prerequisite: 325 or equivalent, or consent of instructor.

*423A. 3 units, Aut (MacConnell, Strand) Th 3:15-6:05*

*423B. 3 units, Win (MacConnell, Strand) Th 3:15-6:05*

*423C. 3 units, Spr (MacConnell, Strand) Th 3:15-6:05*

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

*424A. 3 units, Aut (Mayhew) W 3:15-6:05*

*424B. 3 units, Win (Mayhew) W 3:15-6:05*

*424C. 3 units, Spr (Mayhew) W 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.

*1 unit, any quarter (Krumboltz, Thoresen) Th 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 Sum (Eisner) MTWThF 9*

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, Aut (———) TTh 1:15-3:05 and by arrangement (Organizational emphasis)*

*2 to 5 units, Win (———) MW 1:15-3:05 and by arrangement (Curriculum and Instruction emphasis)*

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.

*2 units, Aut (———) W 4:15-6:05 (Administration emphasis) Spring (———) T 3:15-5:05 (Teacher Personnel emphasis) 4 units, Sum (Bush) W 7-10 p.m. and by arrangement (Student Personnel emphasis)*


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


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

470. Practicum.

*By arrangement*

480. Directed Reading.

*By arrangement*


*2 to 3 units, Aut, Win, Spr (Begle) 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, Atkinson) T 4:30 and by arrangement*

490. Directed Research.

*By arrangement*

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

*2 to 3 units, Aut, Win, Spr (Begle) by arrangement*
1 to 3 units, Aut (Elashoff) by arrangement
Spr (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. 2 units, Aut (Tucker) Th 7:30-9:30 p.m.
The identification of various schools of thought in the social studies and an analysis of their curricular and instructional theories.

496B. 2 units, Win (Gross) W 7:30-9:30 p.m.
The identification and analysis of significant problem areas and issues in social studies education. Students will be expected to present and defend a position paper on an issue of their choosing.

496C. 2 units, Spr (Gross, Tucker)
W 7:30-9:30 p.m.
The identification of a researchable problem in the social studies and the development of an appropriate design for conducting the research.

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 these credential programs 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.

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

156. Foundations of Physical Education—Psychological, biological and sociological bases of physical education, emphasizing basic research from the above disciplines, the body of knowledge of physical education and the development of sound principles from the above sources.
4 units, Aut, Spr (Nixon) MWF 9 and by arrangement

159. Evaluation in Physical Education—Theory and principles of evaluation in physical education. Emphasis on test construction, the role of evaluation in physical education curriculum and instruction, and research.
3 units, Win (Nixon) MWF 9

171, 172. Curriculum and Instruction in Men's Physical Education—Open only to men physical education major teaching credential candidates who have been admitted formally into the Physical Education Credential Program. Not open to freshmen.
171A. Baseball.
2 units, Win (Young) TTh 9 and
by arrangement

171B. Basketball.
2 units, Aut (Dallmar) Th 11 and by
arrangement

171C. Football.
2 units, Spr (Ralston) TTh 10 and by
arrangement, alternate years, given
1969-70

171D. Track and Field.
2 units, Win (Jordan) MW 10 and by
arrangement

171E. Adapted Physical Education.
1 unit, Spr (Ruff) M 1:15, alternate
years, given 1970-71

171F. Combatives.
2 units, Win (Lunny, Reed)
MWF 3:15

171H. Athletic Training and Conditioning.
2 units, Spr (Blanchard) by arrangement

172A. Aquatics.
2 units, Spr (Gaughran) TTh 11 and
by arrangement

172B. Gymnastics — Curriculum and instruction in gymnastics. Prerequisites: Physical Education 16, Elementary Gymnastics or consent of instructor.
2 units, Spr (Millman) MWF 1:15 and by
arrangement

172C. Golf.
2 units, Win (Finger) TTh 11 and
by arrangement

172D. Tennis.
2 units, Aut (Gould) by arrangement

172E. Volleyball, Soccer, Speedball.
2 units, Spr (Ruff) MWF 2:15, alternate
years, given 1970-71

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

177. Physiology of Exercise—Physiological adaptations of the human organism to exercise stress. Prerequisite: Biology 4 or equivalent.
3 units, Aut (Ruff) lec. T 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 114.
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 (Ruff) 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) MWF 10

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, Ruff)
by arrangement

377. Research Seminar on Human Physical Performance — Recent research in physical education, sports medicine, physiology and related fields concerning man’s ability to adapt to various forms of environmental stress while engaging in sports, dance, and designed exercise. Prerequisites: 177 and 277, or equivalent.
4 units, Spr (Ruff) 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), Donald J. Grace (Part-time Graduate 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, course offerings are limited to some of the basic courses for undergraduates, a few other undergraduate courses, and selected graduate courses.

UNDERGRADUATE ADMISSION

Students admitted to the University are permitted to major in the School of Engineering if they elect to do so; there are no additional procedures, course requirements, or examinations for admission to the School.

PREPARATION RECOMMENDED FOR FRESHMEN

Students who enter as freshmen intending to major in engineering should take mathematics in high school to as high a level as is offered, including trigonometry. Placement tests are given by the Department of Mathematics during the registration period. Students who do not place high enough in the test will be required to take Mathematics 0, Algebra and Trigonometry, in addition to the normal graduation requirements in engineering. High school courses in physics and chemistry are strongly recommended but not required. Additional elective course work in English is also recommended.

PREPARATION RECOMMENDED FOR TRANSFER STUDENTS

Students who do the early part of their college work elsewhere and then transfer to Stanford to complete their engineering programs should follow an engineering or pre-engineering program at the first school, selecting insofar as possible courses applicable to the requirements of the School of Engineering, i.e., courses comparable to those listed 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 applied to School of Engineering requirements whenever the courses are equivalent or substantially similar. Substitution of transfer credits for courses that are required by the General Studies Program is administered by the University Committee on General Studies. The policy of the School of Engineering is to study each transfer student's preparation and make a reasonable evaluation of the courses taken prior to transfer. Inquiries
may be addressed to the Dean of Engineering at Stanford.

**THE 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 seven components: Humanities and Social Sciences, 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 General Studies requirements outlined in the first pages of this bulletin. The mathematics and natural science components of the General Studies requirements will normally be satisfied by the mathematics and science courses selected as part of the engineering program. Students who qualify for advance placement will be held to correspondingly fewer units in the math and sciences areas.

**Humanities and Social Sciences (39 units)**

Engineering students must satisfy the humanities and social sciences components of the General Studies requirements outlined in the first pages of this bulletin. Engineering students are encouraged to take other courses in these areas as part of their free electives.

**Mathematics (21 units)**

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.

The Math/Language component of the General Studies requirements will normally be satisfied as part of the engineering mathematics requirement.

**Science (24 units)**

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, and will satisfy the natural science component of the General Studies requirement.

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)**

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 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.)

Alternatively, a student may, with the help of his adviser, draw up a combination of courses which provides technical breadth and is compatible with his career goals. Such a program can be approved by the Undergraduate Council if it satisfies the spirit of the 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.

There are many courses which may be used in each of the categories listed below. New courses are frequently added. A typical list of approved courses is given below. A complete current list may be obtained at any time from the office of the Dean of the School of Engineering.

### 1. Mechanics of Solids and Fluids

**Course No. Subject Units**

| Engr. 11 | Applied Mechanics: Statics and Stress Analysis | 4 |
| Engr. 12 | Applied Mechanics: Dynamics | 4 |
| Engr. 21 | Mechanics of Fluids | 4 |
| Phys. 110, 111 | Intermediate Mechanics | 3, 3 |
| Ch.E. 115A, 116A | Unit Operations: Fluid Flows | 3, 1 |

### 2. Electric Circuits and Devices

**Course No. Subject Units**

| Engr. 41, 41A, 42, 42A | Circuits and Devices | 4, 1, 4, 1 |
| Phys. 105 | Introductory Electronics | 3 |
| Phys. 120, 121, 122 | Intermediate Electricity and Magnetism | 3, 3, 3 |

### 3. Thermodynamics

**Course No. Subject Units**

| Engr. 31 | Engineering Thermodynamics | 5 |
| Phys. 170 | Thermodynamics | 3 |
| Chem. 171 | Physical Chemistry | 3 |
| Ch.E. 120 | Chemical Engineering Thermodynamics | 3 |
| Mat.Sci. 181 | Thermodynamics and Phase Equilibria | 4 |
| M.E. 131A | Thermosciences: Thermodynamics | 5 |

### 4. Materials Science and Properties

**Course No. Subject Units**

| Engr. 50 | Science of Materials | 3 |
| C.E. 118 | Materials Engineering | 3 |
| Chem. 121 | Organic Chemistry | 3 |
| Mat.Sci. 180 | Atomic Arrangement in Solids | 5 |
| Mat.Sci. 185 | Mechanical Behavior of Solids | 3 |
| Mat.Sci. 188 | Electrical, Optical and Magnetic Properties of Materials | 3 |
| M.E. 111 | Failure Prevention | 3 |

### 5. Logic and Computer Systems

**Course No. Subject Units**

| Phil. 3 | Introduction to Logic | 5 |
| C.S. 139 | Computer Organization | 3 |
| I.E. 141 | Utilization of Computers | 3 |
| E.E. 204 | Brains, Machines, and Math | 3 |
| C.S. 50A,B | Introduction to Computer Science | 3, 3 |

### 6. Systems Analysis and Control

**Course No. Subject Units**

| Engr. 104 | Dynamic Response | 3 |
| Engr. 105, 106 | Control System Analysis and Design | 3, 3 |
| Ch.E. 155 | Process Control | 3 |
| I.E. 108 | Work Design and Measurement | 3 |
| I.E. 161, 162 | Design of Production Systems; Scheduling and Control of Production Systems | 3, 3 |
| E.E.S. 201A,B,C | Introduction to Systems Analysis | 3, 3, 3 |
| E.E.S. 221 | Probabilistic Systems Analysis | 3 |

### 7. Transfer and Rate Processes

**Course No. Subject Units**

| Ch.E. 115B | Unit Operations: Heat and Mass Transfer | 3 |
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 (30 units)
To meet the special desires and needs of individual students, the Stanford engineering curriculum includes an unusually large number of free electives. Elective courses might be used to increase professional competence, to satisfy unusual career objectives, or to pursue nontechnical interests.

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 approximately one 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 currently accredited at the Master's degree level. The following Interdisciplinary Majors are accredited under General Engineering: Resource Strategy and Product Design.
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>
</tr>
</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>Ch.E. 115C</td>
<td>Unit Operations</td>
<td>3</td>
</tr>
<tr>
<td>Ch.E. 116C, D</td>
<td>Chemical Engineering Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>Ch.E. 128</td>
<td>Process Kinetics</td>
<td>3</td>
</tr>
<tr>
<td>Restricted Electives</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</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>3</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. 180a</td>
<td>Soil Mechanics and Foundations</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 197</td>
<td>Engineering Synthesis</td>
<td>4</td>
</tr>
<tr>
<td>Restricted Electives</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

**Electrical Engineering**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.E. 101, 102, 103</td>
<td>Circuits and Networks</td>
<td>10</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>Engr. 105</td>
<td>Control Systems</td>
<td>3</td>
</tr>
<tr>
<td>E.E. 124, 126, 139, 145, 171 or 179</td>
<td>Laboratory or Project</td>
<td>3</td>
</tr>
<tr>
<td>Restricted Electives</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

**Industrial Engineering**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.E. 101</td>
<td>Manufacturing Technology</td>
<td>4</td>
</tr>
<tr>
<td>I.E. 100</td>
<td>Industrial Organization and Management</td>
<td>4</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>6</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</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>7</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>36</strong></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>Manufacturing Technology</td>
<td>4</td>
</tr>
<tr>
<td>M.E. 102</td>
<td>Visual Thinking</td>
<td>3</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>2</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>36</strong></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**

<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>A.A. 100</td>
<td>Introduction to Aeronautics and Astronautics</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>
A.A. 131. Experimentation in Aeronautics and Astronautics 4
C.E. 114. Mechanics of Materials 3
M.E. 131A. Thermosciences: Thermodynamics 5
A.A. 200A. Engineering Analysis of Flight Vehicles 3
A.A. 192. Vector Analysis and Cartesian Tensors 3
Math. 130. Ordinary Differential Equations 3
A.A. 210A. Fundamentals of Compressible Flow 3
A.A. 298. Seminar in Aerospace Technology 1
Restricted Electives 5

**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

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.E. 101. Manufacturing Technology</td>
<td>4</td>
</tr>
<tr>
<td>M.E. 102. Visual Thinking</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 107. Mechanical Systems</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 115A,B. Introduction to Product Design and Environmental Design</td>
<td>6</td>
</tr>
<tr>
<td>M.E. 116A,B,C. Advanced Product Design</td>
<td>9</td>
</tr>
<tr>
<td>Art 40. Basic Drawing and Painting</td>
<td>2</td>
</tr>
<tr>
<td>Art 50. Basic Sculpture</td>
<td>3</td>
</tr>
<tr>
<td>Art 60. Basic Design</td>
<td>3</td>
</tr>
<tr>
<td>Art 160. Design 1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

**Product Design**

M.E. 101. Manufacturing Technology 4
M.E. 102. Visual Thinking 3
M.E. 107. Mechanical Systems 3
M.E. 115A,B. Introduction to Product Design and Environmental Design 6
M.E. 116A,B,C. Advanced Product Design 9
Art 40. Basic Drawing and Painting 2
Art 50. Basic Sculpture 3
Art 60. Basic Design 3
Art 160. Design 1 3

<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>C.E. 150. Transportation Engineering</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 160. Water Resources Engineering</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 170. Man and His Environment</td>
<td>3</td>
</tr>
<tr>
<td>Econ. 118. Underdeveloped Economies</td>
<td>5</td>
</tr>
<tr>
<td>Ed. 206A. Comparative Education</td>
<td>3</td>
</tr>
</tbody>
</table>

**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>C.E. 150. Transportation Engineering</td>
<td>3</td>
</tr>
<tr>
<td>C.E. 160. Water Resources Engineering</td>
<td>4</td>
</tr>
<tr>
<td>C.E. 170. Man and His Environment</td>
<td>3</td>
</tr>
<tr>
<td>Econ. 118. Underdeveloped Economies</td>
<td>5</td>
</tr>
<tr>
<td>Ed. 206A. Comparative Education</td>
<td>3</td>
</tr>
</tbody>
</table>

**I.E. 50. Human Values in a Technological Society** 2
**I.E. 100. Industrial Organization** 4
**Restricted electives** 8

Additional programs, such as Bioengineering, may be developed as required.

**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 minimum requirements are prescribed for the Technology and Society Program: Humanities and Social Sciences (39 units); Mathematics (21 units); Science (24 units); a plan of courses in Technology and Society forming a coherent program to satisfy a well-defined educational objective, including 36 units of engineering courses (51 units); Functional Balance; Free Electives (45 units).

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.

* 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.
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 departmental 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 procedure 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 com-
prise three years of study at the college, with
some emphasis on mathematics and science,
followed by two years of study of engineer-
ing 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 require-
ments, 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.
This policy applies to transfer students en-

Inquiries concerning this “three-two” pro-
gram may be addressed to the Dean of Engi-
eering 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 stu-
dents for study at one of the Stanford over-
seas 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. In-
struction 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 Meca-
nique of Nantes, to which substantially the
same remarks apply.

RESERVE OFFICERS’ TRAINING CORPS

Reserve Officers’ Training Corps are main-
tained at Stanford by the Army, the Navy,
and the Air Force (see Aerospace Studies,
Military Science, and Naval Science in this
bulletin). The individual requirements of
each of the Aerospace Studies, Military Sci-
ence, and Naval Science programs are so
varied in the nature of specialized work that
the appropriate sections of this bulletin
should be consulted in preparing an engi-
neering program including ROTC. All ser-
VICES offer a two-year program and the Army
and Navy have four-year programs. The ad-
ditional units of specialized work under a
four-year program, together with those of
accredited engineering programs, will nor-
mally require from one to three extra quar-
ters of study depending upon individual cir-
cumstances. ROTC students staying for
more than one extra quarter may often ar-
range their programs to include an overseas
campus and one or even two sequences of
graduate courses in their major while work-
ning for their baccalaureate degrees. Resi-
dence credit toward an advanced degree,
however, cannot be obtained until the bac-
calaureate degree program has been com-
pleted, unless the student qualifies for the
combined B.S.-M.S. program above.

GRADUATE ADMISSION

Application for admission with graduate
standing in the School should be made to
the Director of Admissions of the Univer-
sity; applications are reviewed by the appro-
priate department of the School before ad-
mission is authorized. Inquiries may be ad-
dressed 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, phys-
ics, or mathematics (see, for example, the
Four-Two program described under “Mas-
ter of Science”).

GRADUATE REGISTRATION

New graduate students should follow pro-
cedures for registration as listed in the Time
Schedule. Adviser assignments can be ob-
tained from the Department office.

GRADUATE PROGRAMS OF STUDY

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

AERONAUTICS AND ASTRONAUTICS

Aerodynamics
Aerelasticity
Aerophysics
Aerospace Systems Design
Aircraft, Missile, and Spacecraft Struc-
tures
Astrodynamics
Dynamics and Vibrations
Elastic and Inelastic Solids
Experimental Methods
Guidance and Control
Life Sciences-Biomechanical Engineering
Physical Gas Dynamics
Plasma Dynamics and Magnetoaerodynamics
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

BIOENGINEERING
(See Master of Science and Doctor of Philosophy programs.)

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 Engineering
Hydraulic Engineering
Hydromechanics
Hydrology

Nuclear Civil Engineering
Sanitary Engineering
Soil Mechanics and Foundations
Structural Engineering
Urban Planning

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
Intersystem Relationships
Decision Analysis
System Analysis
Automation
Simulation
Long Range Planning

HYDROLOGY
(See separate section in this bulletin.)

INDUSTRIAL ENGINEERING
Computer Utilization
Economic Systems Planning
Management Systems Design
Systems Analysis and Synthesis

MATERIALS SCIENCE
Physical Metallurgy
Physical Ceramics
Photoelectronic Properties of Solids
Defects in Crystalline Solids and Their Effects on Electronics, Magnetic and Mechanical Properties
Magnetic Behavior of Solids
Mechanical Behavior of Solids and Structures
Thermodynamics of Solids
Reaction Kinetics in Solids
Phase Transformation in Solids
Crystal Growth
X-ray and Electron Diffraction and Spectroscopy Applied to the Study of Solids

MECHANICAL ENGINEERING
Thermodynamics
Heat Transfer
Fluid Mechanics
Engineering Design
Product Design
Nuclear Engineering

OPERATIONS RESEARCH
Mathematical Programming
Probabilistic Models

SPACE SCIENCE
(See separate section in this bulletin.)
For further details see the department sections following.

Related aspects of particular areas of graduate study are commonly covered in the offerings of several departments and divisions. Graduate students are encouraged, with the approval of their departmental advisers, to select courses in departments other than their own to achieve a broader appreciation of their field of study. For example, most departments in the School offer courses concerned with properties of materials, and a student interested in an aspect of materials engineering can often gain appreciable benefit from the related courses given by departments other than his own.

MASTER OF SCIENCE
The degree of Master of Science (M.S.) is conferred on graduate students in engineering according to the University regulations stated elsewhere. A minimum of 45 units is usually required in M.S. programs in the School of Engineering. However, the presentation of a thesis is not a School requirement in Engineering.

Four-Two program — Superior students who hold baccalaureate degrees in physical science with adequate physics and mathematics may complete the requirements for an M.S. in engineering at Stanford (in most of the curricula above) in two academic years (six quarters). Programs will be worked out in consultation with an adviser from the department in which the student wishes to study. Further information may be obtained from the department in which the student is interested.

Engineering Science — The degree of Master of Science is available to those who wish to follow a program of study emphasizing the scientific background of some aspect of engineering (e.g., Bioengineering, Nuclear Engineering) and which does not conform to a normal graduate program in a department. Such programs usually combine work in several engineering departments, or contain an unusual amount of mathematics, physics, chemistry, statistics, etc. Application for admission to Engineering Science should be made to the Dean of Engineering. Only students with superior academic records will be accepted for this type of program.

ENGINEER
The degree of Engineer is awarded at the completion of a comprehensive two-year program of graduate study. It is intended for those who desire more graduate training than can be obtained in a Master of Science program but who do not wish to undertake a Ph.D. program. The program of study must satisfy the student’s department and usually includes 90 units of which at least 60 must be devoted to advanced or graduate study in the major subject or intimately allied subjects. The presentation of a thesis is required. The University regulations for the Engineer degree are stated in the section “Degrees” in this bulletin, and further information will be found in the department sections following.

DOCTOR OF PHILOSOPHY
Programs leading to the degree of Doctor of Philosophy are offered in each of the departments and divisions of the School. Special Ph.D. programs which may be interdepartmental in nature (e.g., Bioengineering, Nuclear Engineering) can be arranged. See “Graduate Division Special Programs” section in this bulletin. University regulations are given in the section “Degrees” in this bulletin, and further information will be found in the department sections following. Inquiries concerning programs in Bioengineering should be addressed to the Dean of the School of Engineering or the Dean of the School of Medicine.

FELLOWSHIPS AND ASSISTANTSHIPS
Each department and division of the School of Engineering awards a number of
fellowships, research assistantships, and teaching assistantships each year. Information and application blanks may be obtained from the head of the appropriate department or division.

**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: Arthur I. Bienenstock, Frederick W. Crawford, Paul Kruger, Bruce B. Lusignan, William D. Nix, William Weaver, Jr.

Assistant Professor: Craig R. Barrett

The "Engineering" courses deal with subject areas within the basic sciences of engineering which are, in their essential nature, broader than the confines of any particular branch of engineering. 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 (Staff) TTh 11 and T 1:15-3:05

5. Introduction to Programming—(Enroll in Computer Science 5.) This course is an introduction to a specific procedure-oriented language for describing computational processes. There will be practice in solving elementary problems on Stanford's automatic digital computers. The course is limited to freshman and sophomore students. Prerequisites: Mathematics 0 or equivalent.
   - 3 units, Aut (—) MWF 11
   - Win (Oakford) TTh 2:15–3:30
   - Spr (——) MWF 11

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. Prerequisites: Mathematics 42 and Physics 51.
   - 4 units, Aut (Weaver, Staff) MWF 9;
   - 2 hour problem session
   - Win (Weaver, Staff) MWF 9;
   - 2 hour problem session
   - Spr (Weaver, Staff) MWF 9;
   - 2 hour problem session

   - 4 units, Aut (Weaver, Staff) MWF 11;
   - 2 hour problem session
   - Win (Weaver, Staff) MWF 11;
   - 2 hour problem session
   - Spr (Weaver, Staff) MWF 11;
   - 2 hour problem session

18. Continuum Mechanics — Analysis of stresses and deformations in elastic materials: statics, equilibrium, and statically determinate solids under load; simple indeterminate systems; tensorial description of stress and strain; small strains and generalized Hooke's law; strain energy; equations of linear elasticity; examples, including torsion of bars and simple flexure. Prerequisites: 11 and Mathematics 43.
   - 3 units, Aut (Ashley) MWF 10

21. Mechanics of Fluids — Statics and dynamics of incompressible ideal fluids; viscosity, fluid friction, laminar and turbulent
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
Sum (Reynolds, Staff) MTWF 9; lab. one afternoon by arrangement


41. 4 units, Aut (Staff) MWF 9;
   2 hour problem session
   Win (Staff) MWF 10;
   2 hour problem session
   Spr (Staff) MWF 9;
   2 hour problem session
42. 4 units, Aut (Staff) MWF 10;
   2 hour problem session
   Win (Staff) MWF 9;
   2 hour problem session
   Spr (Staff) MWF 10;
   2 hour problem session
   Sum (Staff) MTWF 9, and one hour by arrangement

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

42A. Laboratory II—To accompany 42.
   1 unit, Aut, Win, Spr, Sum (Lusignan) one 3 hour lab. by arrangement

50. Introductory Science of Materials—Introduction to the physical basis of the mechanical, electrical, and magnetic behavior of solids. Electron theory, imperfections in solids. Relations between structural features and properties. Prerequisite: Mathematics 23 or 43.

3 units, Aut (Barrett, Nix, Bienenstock) MWF 9
Win (Barrett, Nix, Bube) MWF 11
Spr (Barrett, Nix, Shyne) MWF 10
Sum (———) MTWF 11

101. Engineering Casewriting — Students examine the engineering practices of a local company (contacts arranged by instructor), becoming acquainted with adventures of one or more engineers in order to tell the story of a real engineering project in the form of a written case which may be published for study by other students.

3 units, Win (Staff) by arrangement

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 (Cannon) MWF 11
Win (Staff) MWF 11

105. Control System Analysis and Design—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: 104 or Electrical Engineering 102.

3 units, Aut, Win, Spr (Franklin)


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

161. Engineering Economy—Economic decision making for engineering alternatives. Use of compound interest and depreciation calculations to compare the relative economy of both technical investments and plant operating procedures before and after Federal income taxes. Simple decision making in the face of uncertainty as to possible damage or economic obsolescence. May be taken by freshmen. Recommended for sophomores.

3 units, Aut, Win (Ireson) TTh 10, and one hour by arrangement


3 units, Win (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 57.

3 units, Aut (P. Kruger) TTh 9

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 171, or 172, or consent of instructor.

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

176. Radioisotope Methods—Nuclear reactions, radioisotope production, radioactivity genetics and separations, radio-tracer methods in laboratory and engineering practices. Prerequisite: 171, 172, or 175, or consent of instructor.

3 units, Win (Staff) Th 1:15 and one lab. 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.

2 units, Spr (P. Kruger) TTh 11

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

207. Introduction to Astrophysics I: Solar-Terrestrial Relations—Origin and characteristics of the solar wind. Magnetosphere and bow wave; radiation belts; aurorae. Phenomena caused by solar flares: interplanetary shock waves; geomagnetic storms; Forbush effect. Prerequisite: Physics 220, or Electrical Engineering 243B, or Aeronautics and Astronautics 285A, or equivalent.

3 units, Aut (Sturrock) MWF 11


3 units, Win (Sturrock) MWF 11

209. Introduction to Astrophysics III: Stars and Galaxies—Radiative and convective energy transport; equation of state; opacity; nuclear processes. Hertzsprung-Russell diagram; stellar evolution. Galactic morphol-
ology; structure of our galaxy; spiral arms. Radio galaxies; quasi-stellar radio sources; cosmic rays. Prerequisite: Physics 220, or Electrical Engineering 243B, or Aeronautics and Astronautics 285A, or equivalent. Physics 132 desirable.

3 units, Spr (Sturrock) MWF 11

210. Space Science and Astrophysics Seminar—Discussion of research problems and current literature in space science and astrophysics with contributions by faculty, students and outside specialists.

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

211. The Laboratory Plasma — Methods of forming laboratory plasmas. 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, Aut (F. Crawford) alternate years, given 1970-71

214. Plasma Physics Seminar — Discussion of research problems and current literature in plasma physics is offered by faculty, students, and outside specialists.

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

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 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 to provide educational TV to developing countries; and ocean systems to develop the sea’s 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

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 preceed 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. Ph.D. and En-
engineer candidates 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

AERONAUTICS and ASTRONAUTICS

Emeriti: Irmgard Flügge-Lotz, Alfred S. Niles (Professors)

Chairman: Nicholas J. Hoff

Vice Chairmen: Daniel Bershader (on leave Autumn quarter), R. H. Cannon, Jr., Jean Mayer (on leave 1969–70)


Associate Professors: Max Anliker, I-Dee Chang, Benjamin O. Lange, Charles R. Steele

Assistant Professors: Donald Baganoff, Acting: Sotiris Koutsoyannis, Samuel C. McIntosh

Senior Research Associate and Lecturer: Daniel B. DeBra


OFFERINGS AND FACILITIES

This Department prepares the student for a professional career in aeronautics and astronautics by offering a comprehensive program of graduate teaching and research. Particular emphasis is given to structural, aerodynamic, guidance and control, and propulsion problems of aircraft, missiles and spacecraft. The teaching program provides courses leading to the degrees of Master of Science, Engineer, and Doctor of Philosophy. The Department of Aeronautics and Astronautics offers two curricula for the Master of Science and Doctor of Philosophy—one oriented toward the sciences, the other emphasizing engineering. Specific programs are available in the following areas:

- Aerodynamics
- Aeroelasticity
- 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 Magnetoaerodynamics
- Propulsion
- Solid Mechanics and Wave Propagation
- Structures and Materials

Requirements for all degrees include courses on basic topics in aeronautics and astronautics, as well as in mathematics, physics and applied mechanics.

The current research activities cover a number of advanced fields, with special emphasis on:

- Thermal Effects in Structures—Structural Problems of Reentry
- Creep Effects in Structures
- Stability and Postbuckling Behavior of Thin Shells
- Maximum Strength Analysis of Structures
- Static and Dynamic Behavior of Sandwich and Composite Structures
- Continuum Mechanics—Viscoelasticity
- Dynamic Response—Wave Propagation
- Unsteady Aerodynamic Theory
- Aerospace Vehicle Dynamics—Aeroelastic Phenomena
- Viscous Flow—Boundary-Layer Theory
- Hypersonics—Mathematical Methods of Fluid Mechanics
- High Temperature Gas Dynamics—Nonequilibrium Flow
- Plasma Dynamics and Magnetoaerodynamics
- Attitude Control and Instrumentation for Space Vehicles
- Astrodynamics—Orbit Perturbations
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.

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 spectro-interferometric laboratory is being outfitted to study resonant refractivity in shocked heated gasses to obtain information on kinetic 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. Now under design 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 in-
clude a 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 also sponsors a student branch of the American Institute of Aeronautics and Astronautics which holds periodic meetings and conducts visits to nearby research, military, and industrial facilities.

ADMISSION AND REGISTRATION

To be eligible for registration in the Department a student must have received the Bachelor's degree in engineering, physical science, mathematics, or an acceptable equivalent. Students with an aeronautical engineering background should be able to qualify for the Master's degree in three quarters of work at Stanford. Students with a Bachelor's degree in physical science, mathematics, or other areas of engineering may find it necessary to take certain prerequisite courses, which 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 Magnetoe aerodynamics, (g) Experimental Methods, (h) Propulsion; (2) 15 units of Engineer's Thesis; and (3) 6 units of free electives. A list of courses currently accepted as approved electives can be obtained upon request to
the Department. Candidates for the degree of Engineer will be expected to have a minimum grade point average of 3.00 for work in courses beyond those required for the Master's degree.

**Doctor of Philosophy**

The University's basic requirements for the Ph.D. degree are outlined in the section “Degrees” in this bulletin. The following are Departmental requirements.

Qualification for candidacy for the Doctor's degree is contingent on the passing of an examination given by the Department. This examination is given twice a year (autumn and spring) and should be taken as soon as possible in the second graduate year. A general list of subject matter for which the candidate is held responsible in the examination is available from the Department. Research on the doctoral dissertation may not be started formally prior to passing the examination. The candidate's study program must fulfill the requirements for the Master's degree or their substantial equivalent. Beyond the Master's degree, a total of 90 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, McDonnell-Douglas Aircraft Company, Stanford University, and Affiliates of Stanford University in Aeronautics and Astronautics carry grants up to $4,000 for the nine-month academic year. NSF and NASA training grants have been allocated for students who plan to become doctoral candidates in the aerospace sciences. Students who already have a Master of Science degree or equivalent may qualify for half-time research assistantships. The minimum stipend for half-time research assistants, on the basis of 20 hours of work per week, is $250 per month, plus tuition for 9 units per quarter. Research assistants are normally given the opportunity of full-time summer employment 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 36 units of electives to constitute the engineering depth requirement for the B.S. degree.

**Courses**

100. *Introduction to Aeronautics and Astronautics* — Explanation of principles of flight and propulsion. Concise discussion of aerodynamic performance, trajectories outside the atmosphere, and the problems of reentry. Remarks on the history of aeronautics and astronautics.

3 units, Aut (Hoff) TTh 11:00–12:15


3 units, Aut (Cannon) MWF 11

Win (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.

2 units, Win (Ogden,Billingham,Feller,Klein,Young) W 2:15-4:05

131. Experimentation in Aeronautics and Astronautics — Introductory treatment of principles of experimentation; importance of experiment in aeronautics and astronautics; theory of measurements, scaling problems, dynamic response, and evaluation and reporting of results; laboratory experiments selected from the various fields of aeronautics and astronautics.

3 to 4 units, Win (Bershader,Baganoff) lec. Th 1:15-2:05; lab. Th 2:15-5:05 or T 1:15-4:05

188. Experimental Plasma Physics 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 consideration of currently interesting examples of flight vehicle analysis, with emphasis on derivation of the associated theory and on the role of digital computation. Cases treated might include, but not be limited to, the following: subsonic cruising performance, supersonic transport drag and noise reduction; booster trajectory optimization, interceptor dynamics, lifting reentry, variable geometry, and problems of flight at very low speed. Prerequisite: 200B.

3 units, Spr (Ashley) MWF 9


3 units, Aut (Spreiter) TTh 2:15–3:30

206B. Mathematical Hydro- and Aerodynamics—(Enroll in Applied Mechanics 243.) Continuation of 206A: 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, waves, and flows of rotating and stratified fluids with applications to problems of engineering, geophysical, and astronomical interest. Prerequisite: 206A.

3 units, Win (Spreiter) TTh 2:15–3:30


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 with application to phenomena of aerodynamic and astronomical interest. Analysis of one-dimensional flow in a streamtube of variable cross section, including effects of external body forces such as gravity and heat addition or subtraction. Application to nozzles, the solar wind in interplanetary space, and the accretion and mass loss of stars. Derivation of the small disturbance nonlinear equations of two- and three-dimensional transonic flow theory. Discussion of fundamental mathematical properties and difficulties of solution arising from the mixed elliptic-hyperbolic type of the governing equations. Transonic similarity rules for thin wings and slender bodies of revolution. Local Mach number invariance principle. Area rule for drag and equivalence rule transonic flow past slender wing-body combinations. Derivation of several simple exact solutions including those for flows through two-dimensional and axisymmetric nozzles, simple wave flows along a curved wall, and for shock waves in transonic flows. Introduction to hodograph method for two-dimensional flow, Tricomi’s equation, methods for solution, and principal results. Introduction to Green’s theorem methods and their specialization to obtain iteration, integral equation, and local linearization methods. Application to flows past thin airfoils, bodies of revolution, and wings of finite span. Discussion of shockwave boundary-layer interaction, and of wind-tunnel wall interference effects in transonic testing. Prerequisites: 206A, and either 206B or 210A.

2 units, Spr (Spreiter) TTh 9, alternate years, given 1969–70


3 units, Aut (Chang) MWF 10

210A. Fundamentals of Compressible Flow—Fundamentals of the flow of a perfect gas from the standpoint of the aerospace engineer; basic thermodynamics; steady and unsteady one-dimensional flow; shock waves; simple expansion waves.

3 units, Aut (Vincenti) MWF 10

3 units, Win (Staff) MWF 8

3 units, Spr (Spreiter) TTh 2:15–3:30

206A. Mathematical Hydro- and Aerodynamics—(Enroll in Applied Mechanics 243.) Continuation of 206A: 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, waves, and flows of rotating and stratified fluids with applications to problems of engineering, geophysical, and astronomical interest. Prerequisite: 206A.

3 units, Win (Spreiter) TTh 2:15–3:30


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 with application to phenomena of aerodynamic and astronomical interest. Analysis of one-dimensional flow in a streamtube of variable cross section, including effects of external body forces such as gravity and heat addition or subtraction. Application to nozzles, the solar wind in interplanetary space, and the accretion and mass loss of stars. Derivation of the small disturbance nonlinear equations of two- and three-dimensional transonic flow theory. Discussion of fundamental mathematical properties and difficulties of solution arising from the mixed elliptic-hyperbolic type of the governing equations. Transonic similarity rules for thin wings and slender bodies of revolution. Local Mach number invariance principle. Area rule for drag and equivalence rule transonic flow past slender wing-body combinations. Derivation of several simple exact solutions including those for flows through two-dimensional and axisymmetric nozzles, simple wave flows along a curved wall, and for shock waves in transonic flows. Introduction to hodograph method for two-dimensional flow, Tricomi’s equation, methods for solution, and principal results. Introduction to Green’s theorem methods and their specialization to obtain iteration, integral equation, and local linearization methods. Application to flows past thin airfoils, bodies of revolution, and wings of finite span. Discussion of shockwave boundary-layer interaction, and of wind-tunnel wall interference effects in transonic testing. Prerequisites: 206A, and either 206B or 210A.

2 units, Spr (Spreiter) TTh 9, alternate years, given 1969–70


3 units, Aut (Chang) MWF 10

210A. Fundamentals of Compressible Flow—Fundamentals of the flow of a perfect gas from the standpoint of the aerospace engineer; basic thermodynamics; steady and unsteady one-dimensional flow; shock waves; simple expansion waves.

3 units, Aut (Vincenti) MWF 10

3 units, Win (Staff) 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: 210A (or Mechanical Engineering 131B) and 192.

3 units, Win (Karamcheti) MWF 1:15

210C. Fundamentals of Compressible Flow — Continuation of 210B: Slender body of revolution in steady subsonic and supersonic motion; introduction to higher approximations; similarity rules; hodograph method; method of characteristics. Prerequisite: 210B.

3 units, Spr (Karamcheti) MWF 2:15

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 (Bershader) 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 (Karamcheti, Koutsoyannis) 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 1969–70

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; solution of simple flow problems. Prerequisite: 211A or consent of instructor.

3 units, Win (Vincenti) MWF 2:15

216. Hypersonic Flow Theory — Aerodynamics at supersonic speeds so great that nonlinearities are essential: improvements on linearized theory; Newtonian, shock-layer, and other methods for blunt bodies; blast-wave theory and self-similar solutions; viscous interaction; numerical methods. Prerequisite: completion of or concurrent registration in 210C.

3 units, Spr (Van Dyke) MWF 8, alternate years, given 1970–71

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. T 2:15-3:05; lab. Th 1:15-4:05

221. Introductory Reentry Aerophysics — Description of the high temperature airflow environment surrounding hypervelocity vehicles. Application of equilibrium thermodynamics and thermostatistics to the analysis of dissociating and ionizing shock waves. Introduction to boundary layer flows, leading to a formulation of the hypersonic stagnation-point heat transfer problem. Concepts of gaskinetic collision phenomena as the basis for determination of transport properties. Fundamentals of thermal radiation in gases, with discussion of the absorption coefficient for air, and simple examples of radiative transport.

3 units, Aut (Bershader) T 2:15-3:05 and Th 2:15-4:05, alternate years, given 1969-70

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 ob-
jects in the solar system. Prerequisites: Physics 55 and familiarity with vector analysis.

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

228. Interplanetary Gasdynamics—(Enroll in Applied Mechanics 249.) Review of pertinent observations supporting the use of continuum fluid models to represent conditions in the interplanetary medium. Physical concepts and equations of gasdynamics and magnetohydrodynamics of a perfect dissipationless gas. Fundamental properties of solutions for hydromagnetic flow, waves, and discontinuities of finite amplitude including shock waves, and their simplification for weak magnetic fields. Concept of a hot extended solar corona and the impossibility of static equilibrium. Theory of an ideal spherically symmetric steady solar wind, and extensions to allow for the Sun’s rotation and for blast waves and driver gas clouds ejected by solar flares. Theory of interaction of the solar wind with the geomagnetic field to form the magnetosphere and the Earth’s bow wave. Transient effects and relation to geomagnetic storms and related solar-terrestrial phenomena. Interaction of the solar wind with the Moon, Mars, Venus, and comets. Implications regarding mass loss and accretion of stars, and interactions with the interstellar medium. Prerequisites: 206A, and either 206B or 210A.

2 units, Win (Spreiter) TTh 9, alternate years, given 1969–70

229A. Physiology for Engineers and Physical Scientists — Bioenergetics, circulation, renal function, gaseous exchanges. Neuro-muscular system, central nervous system, special senses and endocrine system. Emphasis will be placed on a quantitative approach and aspects of current interest in biomedical engineering. Prerequisite: graduate standing or consent of instructor.

5 units, Win (Sapirstein) MWF 4:30–6:00

229B. Cardiovascular Dynamics and Respiration — Generation and transmission of pulse waves and sounds in cardiovascular systems. Pulsatile flow in arteries. Dispersion, stability and reflection phenomena in blood vessels. Regional blood flow, flow measurements, radiologic, isotropic and other techniques. Discussion of problems and experiments pertaining to manned space flight. Prerequisite: 229A or consent of instructors.

3 units, Spr (Anliker, Chang, Ogden, Sapirstein) MWF 5

230. VTOL Aircraft—Various VTOL configurations are examined and evaluated as regards their appropriate mission application. Dynamic and aerodynamic characteristics of the classical rotor, as the optimum hovering device, are considered. Combinations of rotor-wing and direct thrust-wing configurations are analyzed for high speed VTOL aircraft.

2 units, Spr (Carlson) S 10–12

235A,B. Space Systems Engineering—(Enroll in Engineering 235A,B.) 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) TTh 1:15–3:05 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 (Kalman) TTh 11:00–12:15

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

239C. Dynamic Optimization (Deterministic)—(Enroll in Operations Research 348.)
Mathematical theory of optimization problems with respect to dynamical systems: unified treatment of necessary conditions via convexity methods, Pontryagin's theorem, theory of the second variation. Prerequisites: 239A, B or equivalent, or consent of instructor.

3 units, Aut (Kalman) TTh 2:45-4:00, alternate years, given 1970-71

239D. Dynamic Optimization (Stochastic) — (Enroll in Operations Research 349.) Optimal prediction and filtering theory of linear systems; realization of theory of random processes, nonlinear prediction, plus some recent research results. Prerequisites: 239A, B or equivalent, or consent of instructor.

3 units, Aut (Kalman) TTh 2:45-4:00, alternate years, given 1970-71

240A. Aircraft and Missile Structural Analysis — Elements of one- and two-dimensional linear and nonlinear elasticity theory; reductions to strength of materials theory; strength of thin-walled structures in bending, shear, torsion; introduction to shear lag and diagonal tension behavior; potential energy principle, direct and indirect methods of the calculus of variations, deflection analysis of straight and curved beams, effects of nonuniformity of loading and sectional properties. Prerequisite: Civil Engineering 114.

3 units, Aut (Staff) MWF 11

240B. Aircraft and Missile Structural Analysis — Potential energy principle applied to elastically restrained beams and plates, stability of plates in compression and shear; Galerkin procedure and applications; complementary energy principle, redundant structures, bending and torsion of nonuniform plates, shear lag; Reissner's variational principle and applications. Prerequisite: 240A.

3 units, Win (Staff) MWF 2:15

240C. Aircraft and Missile Structural Analysis — Further applications of the variational principles to nonlinear behavior of beams, plates and shells; thermal effects; orthotropic and sandwich structures; dynamic behavior of structural elements in bending and torsion. Influence coefficients; use of finite difference, finite-element, and matrix methods. Prerequisite: 240B.

3 units, Spr (Staff) MWF 10

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, safety) on design aimed at system optimization; preliminary design philosophy; parametric studies and configuration evolution; environments (cumulative and noncumulative) and basic loads (static, dynamic, aerodynamic and thermal); structural analysis versus stress analysis; weight control; structural materials; factors and margins of safety; allowable stresses; design of experiments; prototype testing; behavior predictions versus experiment; design flexibility and growth factor; reliability and structures. Prerequisite: fundamental knowledge of elementary structures, aerodynamics and vibrations.

3 units, Aut (Wells, Staff) MWF 11

241B, C. Introduction to Aerospace Structural Systems Synthesis and Analysis — Application of the elements of systems synthesis and analysis to the preliminary design of a hypothetical manned aircraft or guided missile system subject to compromise between cost, schedule and performance; utilization of advanced 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 fittings (boundary conditions). Prerequisite: 241A.

241B. 3 units, Win (Wells, Staff) MWF 11

241C. 3 units, Spr (Wells, Staff) MWF 2:15


3 units, Aut (Germain, Staff) MWF 8


3 units, Win (Germain, Staff) MWF 8

242C. 3 units, Spr (Germain, Staff) MWF 8


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

243B. Theory of Vibrations — Eigenvibrations and dynamic response of elastic systems including beams, membranes, plates and shells. Approximate techniques. Parametric resonance, Floquet theory and Hill's equation. Introduction to statistical methods and their application to the dynamic response of linear systems to random excitation. Prerequisite: 243A.

3 units, Win (Anliker) MWF 8

244A. Aeroelasticity — Presentation of the field of aeroelasticity from a unified viewpoint applicable to all types of flight vehicles. Dynamics of continuous elastic structures, with typical examples in one and two dimensions. Normal coordinates. Introduction to aeroelastic operators and unsteady aerodynamics. Forced response, static and dynamic eigenvalues of a simplified system. Prerequisite: 104 or equivalent.

3 units, Win (Ashley) MWF 3:15

244B. Aeroelasticity — Continuation of 244A: Aeroelastic analysis of representative one-dimensional and two-dimensional structures. The unrestrained elastic flight vehicle. Modern unsteady aerodynamic theory. Special topics of current interest, with emphasis on aerodynamic operators. Prerequisite: 244A.

3 units, Spr (Ashley) MWF 3:15


3 units, Win (Chao) MWF 9


3 units, Win (Chao) 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 (Chao) TTh 11


3 units, Win (——) MWF 9


3 units, Spr (——) MWF 9

248A. Spacecraft Structural Analysis—Application of theory for axisymmetric defor-

3 units, Aut (Steele) MWF 1:15


3 units, Win (Steele) MWF 1:15


3 units, Spr (Steele) MWF 1:15, alternate years, given 1970–71

248D. Spacecraft Structural Analysis — Continuation of 248B: Linear and nonlinear stability of shells. Snap-through of shallow domes. Buckling of cylindrical, conical and spherical shells. Recent developments. Prerequisite: 248B.

3 units, Spr (Hoff) MWF 1:15, alternate years, given 1969–70


3 units, Spr (Steele) TTh 11:00–12:15, alternate years, given 1969–70

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

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


2 units, Win (Chao) W 3–5


2 units, Spr (Chao) W 3–5

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, Win (Lee) T 9, lab. TTh 2:15–4:05

260B. Aircraft and Missile Structures Laboratory — Continuation of 260A: Visual and optical techniques, including thermally sensitive paints; strain transfer techniques, photo grid methods, interferometric methods, optical projectors and comparators; brittle lacquers, photoelastic coating tests, analog and model techniques; nondestructive test systems for field use including liquid penetrant, eddy-current, magnetic and ultrasonic tests.

3 units, Win (——) lec. T 9, lab. TTh 2:15–4:05

260C. Aircraft and Missile Structures Laboratory — Continuation of 260B: Radiant, inductive and convective heat systems; automatic test systems for heat problems of
high speed flight and pressure cabin loadings.

3 units, Spr (-----), lec. T 9; lab. TTh 2:15-4:05


3 units, Win (Hetényi) TTh 8 and one lab. by arrangement

271. Automatic Control of Space and Aerospace Vehicles — Basic dynamics of vehicles in three dimensions. The environment of space and aerospace vehicles, and its role in their control. Passive attitude control, such as gravity gradient, magnetic, solar, spinning, etc. Sensors and active control moment devices (jets, reaction wheels, gyros, magnetic devices, etc.). Space vehicle control system synthesis and techniques. Aircraft stability and response. Automatic flight-control-system synthesis. Prerequisites: 242A or Applied Mechanics 222, and Engineering 105.

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


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


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


275A. 3 units, Win (Lange) MWF 8
275B. 3 units, Spr (Lange) MWF 8


3 units, Aut (Bryson) MWF 11


3 units, Win (Bryson) MWF 11


3 units, Spr (Bryson) MWF 11

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.

3 units, Win (Breakwell) MWF 12

279B. Advanced Space Mechanics I — Effects of several centers of attraction; re-
stricted 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.

3 units, Spr (Breakwell) MWF 11

279C. Advanced Space Mechanics II — 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: 279B.

3 units, Aut (Breakwell) MWF 11, given 1970-71

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.

3 units, Win (Seifert) MWF 11

280B. Advanced Chemical Propulsion — Topics selected from hybrid rockets, air-breathing propulsors, combustion, gas-particle flows, ablative heat transfer and thrust vector control. Prerequisite: 280A.

2 units, Spr (Seifert, Staff) TTh 9

280C. Chemical Rocket Design and Technology — Comparative study for liquid and solid rockets of system optimization, liquid propellant feed systems, solid propellant charge design; plus nozzle, heat transfer, structural, thrust control, and ignition design problems of chemical rockets. Prerequisite: 280A.

4 units, Spr (Seifert, Colahan, Frey, Sampson) TTh 11:00-12:15

281. Electric Propulsion — Ballistics of low-thrust, long-duration propulsion. Introductory theory of reaction propulsion by electrostatic, electrothermal, and electromagnetic means. Sources of electrical power in space. Prerequisite: equivalent of 285A or Electrical Engineering 243, or consent of instructor.

3 units, Aut (Seifert) MWF 8, alternate years, given 1970-71

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.

3 units, Aut (Connolly) MWF 8, alternate years, given 1969-70


3 units, Win (Staff) MWF 1:15


3 units, Spr (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) T 9 and Th 9:00–10:40


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


3 units, Win (Lee) TTh 11:00–12:15, alternate years, given 1969–70


3 units, Spr (Lee) MWF 10, alternate years, given 1969–70

295. Seminar in Solid Mechanics— (Enroll in 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. Ph.D. and Engineer candidates 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 (Staff)
   2 to 15 units, any quarter (Staff) by arrangement

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

**APPLIED MECHANICS**


*Chairman:* Miklós Hetényi

*Professors:* Arthur E. Bryson, James N. Goodier, Miklós Hetényi, Thomas R. Kane, Erastus H. Lee, John R. Spreiter

*Affiliated Faculty*


*Associate Professors:* Max Anliker, Byrne Perry, Cedric W. Richards, Robert L. Street

**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 abundant career opportunities in industrial and governmental research establishments, in technical development in industry, and in the universities and institutes of technology. Programs of study are also offered for mechanical, aeronautical, and civil engineers who find that their work involves them in advanced mechanics, and necessitates a year or more of graduate study to acquire a deeper grasp of fundamental concepts and advanced methods.

The Timoshenko Center of Applied Mechanics provides facilities for special experimentation in conjunction with other Laboratories in the School of Engineering. Individual accommodation is provided for the work of each research student. Weekly seminar meetings acquaint the students with a great variety of subjects in their field, and give opportunity to practice speaking on a selected topic.

Government-sponsored research projects are also conducted in Applied Mechanics. Qualified students participate in these as research assistants, engaged in thesis research, in close working association with the faculty director and fellow students. The projects include original experimental and theoretical investigations in the strength and deformability of elastic and anelastic elements of machines and structures, vibrations and nonlinear dynamics, analysis, synthesis, and control of the 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 curriculum of the Department of Civil Engineering and the Department of Mechanical Engineering.

**Master of Science**

The University's basic requirements for the Master's degree are discussed in the section "Degrees" in this bulletin. The following are Applied Mechanics requirements.

To secure the recommendation of Applied Mechanics for the Master's degree, a candidate must include a minimum of 6 graduate units in each of the four sections: (1) Advanced Dynamics, (2) Elasticity and Plasticity, (3) Fluid Mechanics, and (4) Mathematics. (Candidates who have a strong interest in Automatic Control Engineering may be allowed to substitute appropriate courses for one of the sections "(2)" and "(3)." Similarly, candidates strongly interested in the mechanical behavior of materials may be allowed to substitute appropriate Materials Science courses for one of the sections "(1)" and "(3)" above.) In addition to these 24 units of required courses, the program calls for a minimum of 12 units in approved electives and 9 units in free electives, making in all 45 units of course work. No thesis is required. In all of this work a minimum grade point average of 2.75 is required.
The program assumes that, at the time of admission, the student is adequately prepared for graduate study in Applied Mechanics, particularly as to Mechanics of Materials, Ordinary Differential Equations, and Dynamics. Otherwise the student will be required to remedy the deficiency by taking appropriate courses during his graduate study. In this case more than the three quarters of residence normally 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. The requirements of Applied Mechanics include qualifying oral examinations early in the second year of graduate study, and the presentation of a satisfactory program after consultation with the faculty member who will direct the dissertation research. Preparation for research usually requires that this second year be devoted mainly to courses. The requirements for the M.S. degree (see above) must be met. The Departmental language requirement must be fulfilled by either German or Russian.

FELLOWSHIPS AND ASSISTANTSHIPS

University Fellowships are open to all (prospective) graduate students. See "Student Aid Funds" in the Information Bulletin obtainable from the Registrar. In addition, several special fellowships and assistantships are offered. Information and application forms (due March 1) may be obtained through the secretary of the Department of Applied Mechanics.

COURSES

200. Theory of Structures—(Enroll in Civil Engineering 280.) Energy theorems; deflection of structures; analysis of statically indeterminate structures; least work; slope deflection; elastic load method; introduction to matrix methods. Prerequisite: Civil Engineering 114.

3 units, Aut(Shah) MWF 9


3 units, Aut(Chao) MWF 9


3 units, Win(Chao) W 3-5

203A. Stress Waves in Solids—Stress waves in rods, tubes, rings, disks, spheres. Reflection, refraction and diffraction at interfaces and discontinuities. Dispersion, surface waves, waves in layered media. Prerequisites: 202A or equivalents, Mathematics 106 and 131.

2 units, Win(Chao) W 3-5


2 units, Spr(Chao) W 3-5

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(Chao) TTh 11


3 units, Win(Hetényi) TTh 8 and one lab. by arrangement

206A. Elastic-Plastic Instabilities—Instabilities of structural elements under steady or sudden loading. Types of elastic buckling analysis in small and large deformations.
Compressed bars. Dynamic instability within the longitudinal pressure wave. Prerequisites: Civil Engineering 114 and Mathematics 130 or equivalents.

2 units, Aut (Goodier) TTh 11, alternate years, given 1970–71

206B. Elastic-Plastic Instabilities—Continuation of 206A: Lateral and torsional buckling of bars. Frequencies and critical rotational speeds under destabilizing loads. Compressed plates and shells. Prerequisite: 206A.

2 units, Win (Goodier) TTh 11, alternate years, given 1970–71

206C. Elastic-Plastic Instabilities—Continuation of 206B: Relation of dynamic buckling and nonlinear oscillation. Dynamic instabilities from impulsive loading into plastic range. Instability of plane and cylindrical free surfaces of solids in sustained plastic flow. Prerequisite: 206B.

2 units, Spr (Goodier) TTh 11, alternate years, given 1970–71

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 (——) MWF 9


3 units, Spr (——) MWF 9


3 units, Aut (——) MWF 11


3 units, Aut (——) MWF 3:15


3 units, Aut (——) MWF 10


3 units, Win (——) MWF 11

214A. Introduction to Nonlinear Continuum Mechanics—Definitions of general states of stress and deformation of continua. Discussion of constitutive equations, and influence of material symmetries. Applications of the theory with particular reference to finite elasticity. Prerequisite: 210 or 202A.

3 units, Win (Lee) TTh 11:00–12:15, alternate years, given 1969–70

214B. Introduction to Nonlinear Continuum Mechanics—Application of theory of continua to nonlinear viscoelastic materials. Thermodynamic effects including thermoelastic coupling for nonlinear elasticity at finite strain. Prerequisites: 209 and 214A.

3 units, Spr (Lee) MWF 10, alternate years, given 1969–70

215. Mechanical Properties of Materials—(Enroll in Civil Engineering 216.) Elastic, inelastic behavior of structural materials; yield criteria; material damping; viscoelastic behavior; creep; rheological models. Effects of internal structure on properties. Prerequisite: Civil Engineering 114 or equivalent.

3 units, Spr (Richards) TTh 10 and one lab. by arrangement

216A. Mechanical Behavior of Solids—(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) MWF 10

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 or Materials Science 130.

3 units, Win (Nix) MWF 8


3 units, Aut (—) MWF 2:15

218A. Advanced Theory of Viscoelasticity—Equivalent mathematical representations of stress-strain relations for linear response and connections between them. Stress analysis problems for simple boundary conditions, mixed conditions, and consideration of moving boundaries. Temperature effects. Prerequisites: 202A, 217, and 250.

3 units, Win (Lee) MWF 2:15, alternate years, given 1970-71

218B. Advanced Theory of Viscoelasticity—Dynamic problems including wave propagation. Basic mathematical structure of the linear theory, conditions for uniqueness of solution. Variational principles. Prerequisite: 218A.

3 units, Spr (Lee) MWF 2:15, alternate years, given 1970-71

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 1969-70


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


3 units, Spr (Anliker) TTh 7:35-8:50, alternate years, given 1970-71

231. Nonlinear Oscillations—Derivation and classification of nonlinear differential equations governing various phenomena of mechanics. Phase plane trajectories and inte-
grals of the equations of motion of autonomous systems.

2 units, Win (Kane) T 2:15-4:05, alternate years, given 1970-71


2 units, Spr (Kane) T 2:15-4:05, alternate years, given 1970-71


2 units, Win (Kane) T 2:15-4:05, alternate years, given 1969-70


3 units, Aut (Bryson) MWF 11


3 units, Win (Bryson) MWF 11


3 units, Spr (Bryson) MWF 11


239A. 3 units, Aut (Kalman) TTh 11:00-12:15

239B. 3 units, Win (Kalman) TTh 11:00-12:15

239C. Dynamic Optimization (Deterministic)—(Enroll in Operations Research 348.) Mathematical theory of optimization problems with respect to dynamical systems: unified treatment of necessary conditions via convexity methods, Pontryagin's theorem, theory of the second variation. Prerequisites: 347A,B or equivalent, or consent of instructor.

3 units, Aut (Kalman) TTh 2:45-4:00, alternate years, given 1970-71

239D. Dynamic Optimization (Stochastic)—(Enroll in Operations Research 349.) Optimal prediction and filtering theory of linear systems; realization on theory of random processes, nonlinear, plus some recent research results. Prerequisites: 347A,B, or equivalent, or consent of instructor.

3 units, Aut (Kalman) TTh 2:45-4:00, alternate years, given 1969-70

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


Boundary layer control. Introduction to turbulent boundary layer theory. Introduction to effects of compressibility on laminar boundary layers. Energy dissipation in wave motion, with application to damping of sound and surface waves. Prerequisite: 242.

3 units, Spr (Spreiter) TTh 2:15–3:30

245. Transonic Flow Theory—Description and mathematical analysis of flows in which both subsonic and supersonic velocities occur with application to phenomena of aero-dynamic and astronomical interest. Analysis of one-dimensional flow in a streamtube of variable cross section, including effects of external body forces such as gravity, and heat addition or subtraction. Application to nozzles, the solar wind in interplanetary space, and the accretion and mass loss of stars. Derivation of the small disturbance nonlinear equations of two- and three-dimensional transonic flow theory. Discussion of fundamental mathematical properties and difficulties of solution arising from the mixed elliptic-hyperbolic type of the governing equations. Transonic similarity rules for thin wings and slender bodies of revolution. Local Mach number invariance principle. Area rule for drag and equivalence rule for transonic flow past slender wing-body combinations. Derivation of several simple exact solutions including those for flows through two-dimensional and axisymmetric nozzles, simple wave flows along a curved wall, and for shock waves in transonic flows. Introduction to hodograph method for two-dimensional flow, Tricomi’s equation, methods for solution, and principal results. Introduction to Green’s theorem methods and their specialization to obtain iteration, integral equation, and local linearization methods. Application to flows past thin airfoils, bodies of revolution, and wings of finite span. Discussion of shock-wave boundary-layer interaction, and of wind-tunnel wall interference effects in transonic testing. Prerequisites: 242 and 243.

2 units, Spr (Spreiter) TTh 9, alternate years, given 1969–70

246. Applied Hydrodynamics—(Enroll in Civil Engineering 265B.) Theory of ideal fluid flow applied to problems in hydraulic engineering. Nozzles and jets, weirs and spillways, shapes to control cavitation, properties of water waves. Prerequisite: Civil Engineering 265A.

3 units, Win (Perry) MWF 1:15
247. Applied Hydromechanics—(Enroll in Civil Engineering 265C.) Propagation of waves and hydraulic bores, unsteady flow in open channels, breaking of a dam, overland flow, steady and unsteady seepage flow. Prerequisite: Civil Engineering 265B.

3 units, Spr (Perry) MWF 1:15, given 1970–71

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 pertinent observations supporting the use of continuum fluid models to represent conditions in the interplanetary medium. Physical concepts and equations of gasdynamics and magnetohydrodynamics of a perfect dissipationless gas. Fundamental properties of solutions for hydromagnetic flow, waves, and discontinuities of finite amplitude including shock waves and their simplification for weak magnetic fields. Concept of a hot extended solar corona and the impossibility of static equilibrium. Theory of an ideal spherically symmetric steady solar wind, and extensions to allow for the Sun's rotation and for blast waves and driver gas clouds ejected by solar flares. Theory of interaction of the solar wind with the geomagnetic field to form the magnetosphere and the Earth's bow wave. Transient effects and relation to geomagnetic storms and related solar-terrestrial phenomena. Interaction of the solar wind with the Moon, Mars, Venus, and comets. Implications regarding mass loss and accretion of stars, and interactions with the interstellar medium. Prerequisites: 242 and 243.

2 units, Win (Spreiter) TTh 9, alternate years, given 1969–70

250. Mathematical Methods in Applied Mechanics — Development of the basic concepts of analytic functions and conformal mapping, and application to problems in several engineering disciplines. Use of the Laplace transform with particular emphasis on vibration and wave problems. Prerequisite: Mathematics 43 or equivalent.

3 units, Aut (——) MWF 11

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 (Street) MWF 10


2 units, Aut (Hetényi) TTh 10

254. 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 (Goodier, Hetényi, 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, Staff) Th 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. Ph.D. and Engineer candidates 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 Rysselbergh

Assistant Professors: John E. Lind, Jr., Robert J. Madix
Lecturer: John M. Ausman

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

The B.S. Chemical Engineering program, supplemented with courses in chemistry, physics, mathematics, and engineering, provides a broad preparation for design, operation, and management in the chemical, biological, pharmaceutical, or aerospace industries, as well as for postgraduate research in Chemical Engineering leading to research positions in industry and to academic careers.

Transfer to Chemical Engineering from 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>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>English 1, 2, 3. Freshman English</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>History 1, 2, 3. Western Civilization</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Math. 41, 42, 43. Analytical Geometry and Calculus</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Physics 51, 52, 53, 54. Mechanics and Electricity</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Studies</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>15</td>
<td>16</td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

Second Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 4, 5. Chemistry</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Engr. Breadth II</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Engr. Breadth V</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Math. 24 or 44. Calculus</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Physics 55, 56. Light and Heat</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>General Studies</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Electives*</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>15</td>
<td>15</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

* Recommended elective: Math 130 (Win).

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>Ch.E. 115C. Unit Operations: separation processes</td>
<td>-</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ch.E. 116C. Unit Operations Laboratory</td>
<td>-</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ch.E. 120. Equilibrium in Thermo-dynamic Systems</td>
<td>-</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ch.E. 128. Kinetics</td>
<td>-</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engr. Breadth I</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engr. Breadth II</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engr. Breadth VII</td>
<td>-</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chem. 173, 175, 176. Physical Chemistry and Laboratory</td>
<td>3</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electives</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Studies</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>15</td>
<td>15</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

* The curriculum leading to the B.S. degree in Chemistry is described elsewhere in this bulletin.
Fourth Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch.E. 116D</td>
<td>Special Projects</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laboratory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ch.E. 160</td>
<td>Process Design or Ch.E. 190.</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Research</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engr. Breadth IV</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chem. 122, 123. Organic Chemistry and Laboratory</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engr. Breadth IV</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electives*</td>
<td></td>
<td>5</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

* 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 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 lecture courses, should normally take 30 additional units of lecture courses chosen from among the following five areas: (a) chemical engineering, (b) chemistry, (c) mathematics, (d) physics, (e) other engineering subjects. Three courses each in at least two of these areas are required and a grade point average of at least 3.20 or higher in each quarter should be maintained. Undergraduate chemical engineering courses may not be included in fulfilling the 60-unit requirement without approval of the graduate committee.

During the last quarter of his first year of residence, a doctoral candidate is expected to present orally to the chemical engineering faculty a comprehensive review and analysis of a technical paper chosen by him in collaboration with the graduate committee. Upon satisfactory performance in this presentation the candidate will be permitted to proceed with his research and he should be prepared at this time to choose a research topic and research adviser.

A dissertation based on a successful investigation of a fundamental chemical engineering problem is required and the student will ordinarily register in Ch.E. 290 while pursuing his research. It is expected that in three calendar years or less of residence the candidate will have fulfilled all requirements for the Ph.D. degree including submitting his completed dissertation to his research adviser. Permission to continue beyond this period must be obtained by petition to the graduate committee.

Research investigations are currently being carried out in the following fields: applied chemical kinetics; adsorption and catalysis; fluid mechanics; heat and mass transfer; optimization theory; process dynamics and control; surface reactivity. Further detailed descriptions of research programs are available upon request to the Department.

**Fellowships and Assistantships**

Fellowships and assistantships are awarded each year. Application forms may be procured by writing the Department of Chemical Engineering. Applications should be made as early as possible and no later than March preceding the start of the academic year for which the award is to be made. By mutual agreement of the graduate schools of North America, the student need not com-
mit himself to fellowship or scholarship award offers before April 15.

COURSES PRIMARILY FOR UNDERGRADUATE STUDENTS

11. Chemical Computations—Stoichiometry of chemical production. Open only to chemical engineering majors who have not taken Chemistry 4 and 5. Pass/fail.

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

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

115A. Unit Operations: Fluid Flow—The energy balance and fluid friction in laminar and turbulent flow systems; dimensional analysis; flow measurement; pumps and compressors; phase separations based on fluid mechanics.

3 units, Aut (Staff) MWF 9

115B. Unit Operations: Heat and Mass Transfer—Heat transfer in forced and free convection; heat exchange equipment. Theory of molecular diffusion; transfer of material between phases; simultaneous heat and mass transfer; principles of design in processes involving absorption, humidification and drying.

3 units, Win (Lind) MWF 9

115C. Unit Operations: Separation Processes—Application of the equilibrium-stage concept to design of mass-transfer devices; phase relationships; countercurrent multistage extraction and distillation processes, simplified graphical and computer design methods; chromatographic separations, thermal diffusion, reverse osmosis, zone refining.

3 units, Spr (Acrivos) MWF 9

116A. Fluid Mechanics Laboratory—Experiments in fluid mechanics. To be taken concurrently with 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 the instructor.

3 units, Win (Madix) MWF 10


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.

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.

3 units, Win (Mason) TTh 2:15

150. Chemical Reactor Design—Use of chemical rate theory and empirical relationships to develop expressions for use in the design of homogeneous and catalytic static and flow reactors. Characteristics of the batch reactor, steady-state tubular and backmix flow reactor, and semibatch reactor; choice of reactors for product discrimination; optimization of reactor design.

3 unit, Spr (Mason) TTh 2:15

3 units, Aut (Wilde) MWF 1:15

160. Chemical Engineering Process Design — Various topics in the design of chemical processes. Economic goals are developed and used to guide design decisions.

2 units, Win (Ausman) by arrangement

190. Undergraduate Chemical Engineering Research — Laboratory or theoretical work for undergraduate students on assigned chemical engineering problems. It is advisable for National Science Foundation Undergraduate Research Participants to enroll in this course.

(Staff) by arrangement

COURSES PRIMARILY FOR GRADUATE STUDENTS

202. Foundations of Optimization — Finding the optimum values of design or operating variables affecting a given economic objective. Classical indirect methods, constrained derivatives, nonlinear and generalized polynomial optimization, direct elimination and climbing techniques, partial optimization of serial, branching, and cyclic systems.

3 units, Win (Wilde) MWF 11


3 units, Aut (Madix) by arrangement

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)

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

230A. Thermodynamics of Irreversible Processes — A course dealing with the main developments in the thermodynamic treatment of irreversible chemical and electrochemical processes, transport processes, coupling phenomena, etc., with special emphasis on topics and methods of interest to students of chemical engineering, materials science, physical chemistry, biophysics, etc.

3 units, Aut (Van Rysselberghe) by arrangement


2 units, Win (Van Rysselberghe) by arrangement

231. Electrochemical Concepts and Conventions — (Enroll in Chemistry 265.) A sur-
vay of the fundamentals of electrochemistry, sign conventions, etc.

1 unit, Win (Van Rysselberge) by arrangement

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. Ph.D. and Engineering candidates 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, Donovan H. Young (Professors); Eugene V. Ward (Lecturer)

Chairman: James M. Cere

Vice Chairmen: Joseph B. Franzini, Robert L. Street

Professors: Jack R. Benjamin, Rolf Eliassen, John W. Fondahl, Joseph B. Franzini, James M. Cere, Miklos Hetényi, Ray K. Linsley, Perry L. McCarty, Clarkson H. Oglesby, John K. Vennard

Associate Professors: James Douglas, En Y. Hsu, Paul Kruger, Henry W. Parker, Byrne Perry, Vincent J. Roggeveen, Cedric W. Richards, Haresh C. Shah, Robert L. Street, William Weaver, Jr.

Assistant Professors: Kaare Höeg. Acting: George Tchobanoglous, Gene Willeke

Lecturers: John W. Alltucker, John A. Blume, Charles Curione, Paul Eller, Ben C. Gerwick, Jr., Grant P. Gordon, Clarence A. Grubb, Charles J. Heyler, Richard R. Kennedy, Robert R. Matheu, Robert W. Medearis, Bennet L. Raffin

OFFERINGS AND FACILITIES

The undergraduate Civil Engineering program provides a well-balanced program stressing the fundamentals common to all special fields of civil engineering. Elective units permit the student to make a further selection of general courses or, if his interests are well defined, to specialize slightly in a definite branch, such as construction, highways, hydraulics, public works administration, or structures. Well-equipped laboratories are available to supplement the lecture courses. At least one year of graduate study is becoming increasingly important in the preparation of engineers for professional practice and is strongly recommended. Students who contemplate advanced study at Stanford should discuss their plans with advisers early in their senior year.

The Civil Engineering Department, in collaboration with other departments of the University, offers graduate programs with particular strength in:

Civil Engineering Materials
Construction Management
Engineering-Economic Planning
Transportation
Water Resources
Environmental Engineering
Hydraulic Engineering  
Hydromechanics  
Hydrology  
Nuclear Civil Engineering  
Public Works Administration  
Sanitary Engineering  
Soil Mechanics and Foundations  
Structural Engineering  
Urban Planning  

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 laboratory facilities, the materials, laboratory complex that houses the materials, concrete, and soil mechanics laboratories, and the Ryan Nuclear Laboratory. Office space is provided for most of the graduate students who are acting as research or teaching assistants.

The Program in Engineering-Economic Planning is directed toward preparation for planning and management positions in the public works area. One-year internships with the Federal Government are available for students in the advanced stage of a Ph.D. program.

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

In addition to the basic University requirements for the B.S. degree, students in civil engineering must complete the specific course requirements for all engineers and for Civil Engineering. Because of the considerable amount of time allotted to other than civil engineering in the undergraduate program, qualified students should seriously consider graduate study to equip themselves for advanced professional work.

MASTER OF SCIENCE

Programs are available leading to the degree of M.S. in Civil Engineering with special designation on the diploma as follows: Civil Engineering Materials, Construction Management, Engineering-Economic Planning, Environmental Engineering, Hydraulic Engineering, Nuclear Civil Engineering, Public Works Administration, Sanitary Engineering, Soil Mechanics and Foundations, Structural Engineering and Urban Planning. A general M.S. in Civil Engineering without special designation is also given. Detailed statements of the requirements for all Master's degrees and the specific course requirements for a degree with special designation may be secured by request to the Civil Engineering Department.

Students having undergraduate degrees in civil engineering normally can satisfy requirements for the M.S. degree with three quarters of graduate work of satisfactory quality. Students with undergraduate degrees in other fields may need longer residence for the M.S. degree as they will be required to make up specified basic undergraduate civil engineering subjects. A minimum grade point average of 2.75 is required for candidates to be recommended for the M.S. degree.

ENGINEER

A minimum of six quarters of graduate work including a thesis is required for the degree of Engineer in Civil Engineering. This degree is recommended for students planning a career in professional practice. The student normally should start his thesis in the first quarter of graduate work beyond the M.S. degree. Programs leading to the degree of Engineer are offered in the fields of specialization mentioned above. A minimum grade point average of 3.0 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 and to complete a substantial amount of the required foreign language work in order to be admitted to candidacy.

**Financial Assistance**

The Department maintains a large and continuing program of financial aid for graduate students. Fellowship or scholarship awards range from $500 to $5,000. Teaching assistantships (normally awarded only to Engineer and Ph.D. candidates) carry stipends for as much as one-third time work as teaching aides during the academic year. Research assistantships are also available. Engineer and Ph.D. candidates may be able to use research results as a basis for a thesis. Assistantships and other basic support may be supplemented by fellowship and scholarship awards. Continued support is generally available for further study toward the Engineer or Doctor of Philosophy degree subject to performance of 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**

20. 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

3 units, Aut (Vennard) TTh 9; lab. Th 1:15–4:05

4 units, Aut (Richards) MTThF 8

116. Plain Concrete—Physical properties of concrete and its constituents. (Limited to 24 students per section.)  
3 units, Aut (Douglas) W 1:15–5:05 and F 1:15–4:05  
Win (Parker) W 1:15–4:05 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 2.  
3 units, Win (Richards) TTh 10; lab. M 1:15–4:05

121. Advanced Surveying—Additional study of surveying for students who desire it.  
2 or more units, Spr (Staff) by arrangement

138. 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) MWF 10  
Win (Oglesby) MWF 11

144. Construction Estimates and Costs—Estimates, costs from viewpoint of contractor, construction engineer; details of estimating, emphasis on labor, material, equipment, overhead costs.  
3 units, Aut (Douglas) MWF 10  
Win (Parker) TTh 8 and M 1:15

145. Construction Equipment and Methods—Construction procedures, equipment; job
planning and scheduling, selection and efficient use of excavation and hauling equipment, related problems. (May be taken concurrently with 151.)

3 units, Aut (Douglas) TTh 8;
lab. M 1:15-4:05
Spr (Parker) TTh 9;
lab. M 1:15-4:05

150. Transportation Engineering — Basic principles of planning and design of highways, airports, railroads, mass transit, etc. Trip generation, desires, capacity, geometric design, pavements, tracks, finance, economy, relationships with land use, interrelationships between modes, systems analysis. Prerequisite: junior standing.

3 units, Aut (Roggeveen) MWF 11

151. Highway Engineering — Soils, soil conditioners, asphalts, and concrete as highway materials; design and construction procedures for highway embankments, undercourses, and pavements. Prerequisite: junior standing.

3 units, Spr (Oglesby) TTh 8;
lab. M 1:15-4:05

160. Water-Resources Engineering — Introduction to hydrologic measurements, runoff computations, groundwater, water law, reservoir design, frequency analysis, dams, spillways, conduits, economy of water-resources development. Prerequisite: 107.

4 units, Win (Franzini) MWF 9 and T 2:15-4:05


2 units, Win (Vennard) TTh 11

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, (2 to 4 units, by arrangement)
Win (Eliassen) MWF 10
Spr (Eliassen) MWF 8


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 57.

3 units, Aut (P. Kruger) TTh 10

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, Win (Staff) and lab. one afternoon by arrangement

176. Radioisotope Methods — (Enroll in Engineering 176.) Nuclear reactions, radioisotope production, radioactivity genetics and separations, radiotracer methods in laboratory and engineering practices. Prerequisite: Engineering 171, 172, or 175 or consent of instructor.

3 units, Win (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.

2 units, Spr (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, Spr (Shah) MTWF 10

181. Design of Steel Structures — Elastic and plastic design of steel beams, girders,
columns, trusses, frames; design of riveted, bolted, welded connections; design of steel buildings and bridges. Prerequisite: 180.

3 units, Aut (Shah) 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, Win (Shah) MWF 10

183. Design of Timber Structures — Loads, structural elements, fastenings, connectors; design of timber trusses, glued-laminated frames and arches, plywood shell roofs; lateral analysis using sheathed diaphragms. Prerequisites: 180 and 181.

2 units, Spr (Staff) TTh 11, given 1970–71

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, Spr (Staff) TTh 11

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. Hydromechanics of Real Fluids — Boundary layer theory for incompressible flows, approximate solutions for boundary layer equations. Prerequisite: 107.

3 units, Win (Hsu) TTh 10 and one hour by arrangement

206. Advanced Hydraulic Laboratory — Prerequisite: 207 or equivalent. Enrollment is limited.

2 units, Spr (Vennard) by arrangement

207. Advanced Hydraulics—Steady flow in pipes, in open channels, and through porous media. Similitude and dimensional analysis. Prerequisite: Engineering 21 or equivalent.

3 units, Aut (Vennard) MWF 11

208. Hydraulics of Pipe Lines—Mainly unsteady flow problems featuring surge and water hammer. Prerequisite: 207.

3 units, Win (Vennard) MWF 11

209. Hydraulics of Open Channels—Uniform, gradually-varied, and rapidly-varied flow. Prerequisite: 207.

3 units, Spr (Vennard) MWF 8


3 units, Win (Hetényi) TTh 8 and one lab. 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

217A. Concrete Seminar — Structure and properties of fresh and hardened concrete.

1 unit, Win (Richards, Staff) T 4:15
217B. Concrete Seminar — Continuation of 217A.
1 unit, Spr (Richards, Staff) T 4:15

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: Engineering-Economic Systems 211 or consent of instructor.
3 units, Spr (Linsley) TF 2:15-3:30

223. Highway Planning—A study of the decision process in highway planning as influenced by engineering, economic, political and social problems. Prerequisite: Engineering-Economic Systems 211 or consent of instructor.
3 units, Spr (Oglesby) MWF 9

3 units, Spr (Roggeveen) MWF 10

225. The Institutional Setting for Public Works Planning—The role of administrative organization, interest groups, legislative bodies and technical experts in democratic decision-making.
3 units, Win (Roggeveen) TTh 11

231. Problems in Engineering Economy — Independent study or research of a selected problem in engineering economy of public utilities or public works. Prerequisite: consent of instructor.
2 or more units, Aut, Win, Spr (Staff) by arrangement

232. Maintenance Management — Policy, level, identification, reception, planning, performance, evaluation, and analysis of maintenance work. Contract administration, legal or claim implications, and typical maintenance contracts included. Course designed for civil engineering management of public works or construction activities in industry or government. Prerequisite: senior standing.
2 units, Spr (Grubb) by arrangement

233. Statistical Models in Civil Engineering—Applications of probability and statistical analysis to civil engineering; model construction from probability theory; descriptive statistics; estimation with small samples; recognition of variation including professional elements; models for reliability studies of civil engineering designs; construction of complex models. Prerequisite: graduate standing.
3 to 4 units, Win (Benjamin) MWF 8

234. Decision Making in Civil Engineering—Applications of statistical decision theory in civil engineering practice; decision theory; value; prior, posterior; expected value; model of engineering office practice; formulation of problems; economic analysis. Prerequisite: 233.
3 units, Spr (Benjamin) MWF 8

235. Stochastic Process Models in Civil Engineering—Introductory course in applications of stochastic processes to problems in Civil Engineering; the traffic model; generalized transportation models; structural dynamics models; creep and one-cycle problems; diffusion models; fitting of data to models and the estimation problem. Prerequisite: 233, 234, or equivalent.
2 units, Aut (Benjamin) T 2:15-4:05

240. Operations Analysis for Work Improvement in Construction—Application of crew balance, process charts, time-lapse motion pictures, and operations research techniques to construction operations. Accident prevention. Prerequisite: graduate standing.
2 units, Aut (Oglesby) TTh 2:15-3:05; lab. T or Th 1:15-2:05 and 3:15-4:05

241. Concrete Construction—Economy and procedures in plant and equipment selection, form design, and field operations. Special techniques in forming and handling concrete.
3 units, Aut (Fondahl) TTh 10 and one evening by arrangement

242. Construction Equipment Policy—Application of sound management principles in establishing equipment policy; treats depreciation and obsolescence, standardization, preventive maintenance, and fiscal as-
pects of equipment ownership; includes use of computer for economic analysis of equipment problems. Prerequisites: 243, Engineering 161, and computer programming.

3 units, Win (Douglas) TTh 9 and one hour by arrangement


4 units, Win (Fondahl) MWF 10 and one evening by arrangement

244. Construction Planning and Scheduling — Planning, scheduling, and progress control of construction operations. Emphasis on the Critical Path Method including network diagramming, calculations based on time data, and scheduling variations to optimize cost. Manpower and equipment leveling. Course includes both non-computer and computer techniques. Prerequisite: graduate standing.

3 units, Aut (Fondahl) MWF 9
Spr (Fondahl) MWF 8 and one evening by arrangement

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: 138 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

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

249A. 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

249B. Construction Problems — Analysis of individually selected problem in construction techniques, equipment, or management, followed by preparation of oral and written report. Students are expected to consult specialists from construction industry as well as make use of University facilities. Prerequisites: 240, 241, and 243.

3 units, Spr (Staff) by arrangement

251. Transportation Problems — Individual investigation. Prerequisite: consent of instructor.

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

260A. Advanced Hydrology — Meteorology, climatic data, precipitation, evapotranspiration, and streamflow, techniques of measurement and interpretation. Enrollment limited. Must be taken with 260B.

4 units, Aut (Staff) MWF 9; lab. T 1:15-4:05

260B. Advanced Hydrology — Methods of applied hydrology: runoff relationships, unit hydrographs, flood routing, frequency analysis, etc. Prerequisite: 260A.

4 units, Win (Linsley) MWF 10; lab. T 2:15-5:05
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 (Kruger) TTh 9

263. Sedimentation Problems — Erosion, character of sediments, sediment transport and deposition. Regimen of rivers, reservoir sedimentation. Effects of watershed management and engineering control works. Prerequisite: 107 or equivalent.

3 units, Spr (Faznini) MWF 9

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, and coastal processes. Effects of waves on structures. Application of hydraulic models and computer simulation in the design of offshore towers, floating platforms, breakwaters, protection against coastal erosion, etc. Prerequisite: knowledge of fundamental concepts of fluid mechanics.

3 units, Spr (Street) MWF 11

265A. Flow in Permeable Media — Fluid mechanics of subsurface flow. Basic concepts, Darcy's law, potential flow theory with application to groundwater and seepage flow. Formulation of boundary-value problems and solution by analytical and computer techniques. Prerequisite: knowledge of ordinary differential equations.

4 units, Aut (Perry) MTThF 10

265B. Applied Hydromechanics—Theory of ideal fluid flow applied to problems in hydraulic engineering. Nozzles and jets, weirs and spillways, shapes to control cavitation, properties of water waves. Prerequisite: 265A.

3 units, Win (Perry) MWF 1:15

265C. Applied Hydromechanics—Propagation of waves and hydraulic bores, unsteady flow in open channels, breaking of a dam, overland flow, steady and unsteady seepage flow. Prerequisite: 265B.

3 units, Spr (Perry) by arrangement, given 1970–71

266. Engineering Hydrology—Elements of the hydrologic cycle; runoff relations, unit hydrographs, flood routing, frequency analysis; applications to engineering problems.

4 units, Aut (Franzini) MWF 9; lab. T 2:15–4:05

268. Mechanics of Flow through Soils—Capillarity and hysteresis; relation between hydraulic conductivity, capillary suction and moisture content; unsteady flow in unsaturated soils; experimental procedures, numerical methods; application to infiltration and other phases of the hydrologic cycle. Prerequisite: 107 or equivalent.

3 units, Spr (Faznini) MWF 10

269. Water-Resources Engineering Seminar —Discussions on all phases of water-resources engineering including reports on current research at Stanford.

1 unit, Win, Spr (Staff) T 4:15–6:05

270. Water Quality Control I—Natural and man-made characteristics of water quality; effect of quality on the use of water; unit operations and processes of water quality control, including desalination, for municipal and industrial use. Prerequisite: 170 or equivalent.

3 units, Win (Eliassen) MWF 9

271. Water Quality Control II—Characteristics of waste waters; chemical and biological unit processes for the treatment of sewage and industrial wastes; water quality requirements in stream pollution control. Prerequisite: 270.

3 units, Win (Eliassen) MWF 9

272. Design of Water Quality Control Systems — Application of physical, biological, and chemical unit operations and unit processes to the functional design of treatment plants for water, sewage, and industrial wastes. Prerequisites: 270 and 271.

2 units, Spr (Eliassen) W 1:15–5:05

273. Water Resources Chemistry—Application of basic principles of analytical, physical, and organic chemistry to the analysis and treatment of water, sewage, and industrial wastes.

3 units, Aut (McCarty) TTh 8; lab. M 1:15–4:05

274. Water Resources Microbiology — The ecology of streams, lakes and other water resources; identification and control of microorganisms in water and wastes; fundamental aspects of microbiology and biochemistry as
related to stream pollution and water quality control. Prerequisite: 273.

3 units, Win (McCarty) TTh 10; lab.
W 1:15-4:05

275. Water Quality Control Processes — Laboratory and pilot plant studies of physical, chemical, and biological processes for the treatment of water, sewage, and industrial wastes. Prerequisite: 274.

3 units, Spr (McCarty) M 1:15-5:05 and Th 1:15-4:05


2 units, Spr (McCarty) TTh 8


2 units, Win (P. Kruger) TTh 4:15

278. Environmental Radioactivity — Review of the sources of radioactivity in man's environment from space, nature, fallout, nuclear power, etc.; the transport of radioactivity throughout the biosphere; and the means of controlling the radiation hazard to man. Prerequisites: 170, or Chemistry 3, or Physics 57, or equivalent with consent of instructor.

3 units, Aut (P. Kruger) TTh 11

279. Water Quality Control Seminar — Discussions on all phases of sanitary engineering including reports on current research at Stanford.

1 unit, Win, Spr (Staff) W 4:15-6:05

280. Theory of Structures — Energy theorems; deflection of structures; analysis of statically indeterminate structures; least work; slope deflection; elastic load method; introduction to matrix methods. Prerequisite: 114.

3 units, Aut (Shah) MWF 9

281. Matrix Analysis of Structures — Introduction to matrix algebra; use of matrix methods in the analysis of statically and kinematically indeterminate structures; flexibility and stiffness methods. Prerequisite: 114.

3 units, Aut (Gere) MWF 11

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 (McCarty) MWF 11


3 units, Spr (Weaver) MWF 11

284. Design of Prestressed Concrete Structures — Analysis and design of prestressed slabs, beams, and columns; special problems; design and testing of beam in laboratory. Prerequisite: 182.

2 units, Aut (Staff) TTh 10, given 1970-71

285. Advanced Structural Design — Structural geometry; analysis of structures by deflected structures, statics; structural models; bridge analysis, design; bridge types, characteristics; design problems.

4 units, Aut (Benjamin) TTh 8; lab. W 1:15-4:05


4 units, Win (Benjamin) TTh 9; lab. W 1:15-4:05

287. Advanced Structural Design — Continuation of 286: Design of buildings in steel, timber; lateral load analysis, design; shear walls; diagonal sheathing; framing problems. Prerequisites: 285 and 286.

4 units, Spr (Benjamin) TTh 8; lab. W 1:15-4:05

288. Structural Engineering Seminar — Problems in all phases of structural engineering.

1 unit, Aut, Win, Spr (Staff) alternate W 4:15
290. Soil Mechanics—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) MWF10

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 (Höeg) 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 (Höeg) by arrangement

295. Harbor Structures—Wharves and piers of timber and concrete; sea walls, bulkheads, mole and groins; dredging and channel construction; factors affecting design, construction of waterfront facilities. Prerequisite: 190.

3 units, Win (Douglas) MWF 9

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

297A. Random Vibrations—Introduction of stochastic process; characterization of random vibrations; transmission of random vibrations; failure due to random vibrations; introduction to analog computer measurements; response of structures to random excitations.

3 units, Win (Shah) MWF 11

297B. Random Vibrations—Continuation of 297A: Response of multidegree freedom system to random excitations; non-stationary random inputs and responses; random excitation nonlinear systems; response of space vehicles to noise; generation of random excitations. Prerequisite: 297A.

3 units, Spr (Shah) MWF 11

298. Stability Problems—Beam-columns; elastic buckling of columns; non-prismatic columns; inelastic bending and buckling of bars; torsion of bars of open section; lateral buckling of beams; buckling of frames. Prerequisites: 114 and ordinary differential equations.

3 units, Spr (Gere) MWF 10

299. Directed Reading and Special Studies in Civil Engineering—Graduate students by special permission.

Aut, Win, Spr (Staff) by arrangement

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

323. Transportation Planning—Planning of facilities for all modes of transportation with emphasis on current developments, particularly systems analysis and urban land use—transportation models.

3 units, Spr (Roggeveen) MWF 1:15, alternate years, given 1969-70

385. Special Problems in Structural Mechanics—General theory of linear structural problems. Energy theorems, reciprocal the-
orems, normal functions. Applications to spatial deformation of skeletal structures. Extensions of nonlinear aspects. Prerequisite: 280.

2 units, Aut (Hetényi) TTh 10

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. Ph.D. and Engineer candidates 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 graduate students with interests in special fields will also take appropriate courses in other schools and departments of the University including the Graduate School of Business, Applied Mechanics, Electrical Engineering, Engineering-Economic Systems, Industrial Engineering, Materials Science, Mechanical Engineering, Art and Architecture, Biological Sciences, Chemistry, Mathematics, Political Science, Statistics, Geology and Geophysics.

ELECTRICAL ENGINEERING

Emeriti: Leland H. Brown, Joseph S. Carroll, Frederick E. Terman (Professors)
Chairman: John G. Linvill
Vice Chairman: Ralph J. Smith
Vice Chairman (Admissions): Robert L. Pritchard


Assistant Professors: Michael A. Arbib, Edward S. Davidson. Acting: Noel P. Thompson


Instructors: Gilbert M. Masters, Robert Nowak, Lawrence E. Sweeney

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 strongly recommended. For those who plan to work in highly technical development or fundamental research, additional graduate study is desirable.

The Electrical Engineering Department offers graduate courses in the following areas:

- Bioelectronics
- Computers and Control
- Electromagnetic Theory and Microwaves
- Electronic Circuits and Devices
- Network Theory
- Plasmas
- Quantum Theory
- Radioscience
- Solid State Materials and Properties
- Systems Theory

Descriptions of courses will be found in the following pages.

A one-year program of graduate study in electrical engineering may lead to the degree of Master of Science. A two-year program, offering wider selection of engineering course work, more opportunity for study in the related fields of physics, mathematics, and engineering, and in particular more independent work and individual guidance, may lead to the degree of Engineer.

The degree of Doctor of Philosophy is offered under the general regulations of the University. The doctoral program, requiring a minimum of three years (nine quarters) of graduate study, is recommended for those with the desire and ability to make a life work of research or teaching.

MASTER OF SCIENCE

University regulations governing the degree of Master of Science are described in the "Degrees" section in this bulletin; note that this Department has waived the thesis requirement. Applications for admission with graduate standing in Electrical Engineering are made to the Director of Admissions of the University and are reviewed by this Department. Inquiries may be addressed to the Vice Chairman for Admissions, Department of Electrical Engineering.

Modern electrical engineering is a broad and diverse field, and graduate education in this Department may satisfy a great variety of objectives. Students with undergraduate degrees in physics, mathematics, or related sciences, as well as in various branches of engineering, are invited to apply for admission. Such students will ordinarily be able to complete the Master's degree in one calendar year. Students with undergraduate degrees in other fields may also be admitted for graduate study (see below).

The Master's degree program may provide advanced preparation for professional practice, or it may serve as the first step in graduate work leading to the degree of Engineer or Doctor of Philosophy. The faculty does not prescribe specific courses to be taken. Each student with the help of his program adviser prepares his own program and submits it to the faculty for approval. This is done before completion of the first 12 units of graduate study (modifications may be made later). A Supplementary Information Sheet providing detailed instructions, and including a worksheet for preparing a program proposal, is available in the Department Office.

Programs of at least 42 quarter units that meet the following guidelines will normally be approved:

1. A sequence of three or more electrical engineering courses numbered above 200, to provide depth in one area. (See preceding list of graduate course areas.)

2. At least one electrical engineering course numbered above 200 in each of three additional areas, outside of the area selected under item 1, to provide breadth.

3. At least 9 units of electrical engineering courses numbered above 300 and additional courses in electrical engineering numbered above 200 to bring the total units under guidelines 1, 2, and 3 to 21.

4. At least three courses in departments other than electrical engineering.

5. At least three quarters of Electrical Engineering 200 or 201, Seminar (unless there is a schedule conflict).

6. Additional courses to bring the total to 42 or more quarter units, at least 36 units of which must be courses in which letter grades are given.

It is emphasized, however, that any properly prepared student with a specific objective in mind may submit for approval a pro-
gram 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.

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 passing an examination of reading knowledge of one foreign language.

Not later than the first autumn quarter after receiving the Master of Science degree the student should submit an application to take the Department qualifying examination (given each Winter quarter).

Requirements may be summarized as follows: The student is to complete successfully (1) a minimum of three years of residence with graduate standing, one year of which must be in residence at Stanford; (2) one or more qualifying examinations given by the faculty of the Electrical Engineering Department; (3) an examination to show reading knowledge of a foreign language (usually French, German, or Russian, although another language may be substituted if it is of greater value in the student's research); (4) an approved program of courses in electrical engineering and allied subjects; (5) an oral examination near the completion of the doctoral program; (6) a dissertation, based on research, which must be a contribution to knowledge.

About one-fourth of the program of graduate study should be in departments other than Electrical Engineering. Courses shall be selected to form an integrated program, to be approved by the Department. A student wishing to fulfill the requirements for a formal minor may elect to do so.

Ph.D. Minor—For a minor in Electrical Engineering the candidate will take 15 quarter units of course work in the Electrical Engineering Department following a program to be approved by the Department committee on doctoral candidates. He will take and pass a specified portion of the qualifying examination.

Special Programs

Medical Electronics Program—The Master of Science degree carrying the designation "Electrical Engineering: Medical Electronics" on the diploma may be conferred upon students who wish to combine training in biological or medical sciences with an electronics program in the Department of Electrical Engineering. Such a student should so indicate when he submits his application for candidacy for the degree. His proposed program of study for the degree should show at least 42 units of work.

The minimum amount of time required to obtain this degree is one academic year. Candidates with inadequate preparation in mathematics, physics, and electrical engineering will require more time. A candidate with a Bachelor of Science degree in electrical engineering would normally devote approximately half his time to graduate courses in electrical engineering and the balance of his time to courses in biology or medicine. A candidate for the Doctor of Medicine degree who plans to apply his academic year of "University Time" toward this Master's degree would devote about half of his time to undergraduate courses in electrical engineering, mathematics or physics, and the other half to graduate courses in Electrical Engineering.

E.E. 202 Medical Electronics, E.E. 204 Brains, Machines, and Mathematics, E.E. 206 Man-Machine Systems, E.E. 288 Biological Information Processing, and E.E. 304 Neurocybernetics should prove of especial interest to students in this area. These courses provide preparation for doctoral research in various topics in Biological Systems.

Electrical Engineering Administration—By a special arrangement, graduate students of engineering may take courses in the Graduate School of Business. This may be done to an extent that depends on the interests of the student, and three arrangements may be distinguished.

While working toward the degree of Master of Science in electrical engineering, it is possible to take about one course each term in the School of Business without interfering with completion of the technical studies necessary for the degree. Industrial engineering courses are also useful. (Please note that classes in the School of Business have different times from those in the rest of the University and are often difficult to schedule.)

The Master's degree carrying the 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.

**Fellowships, Scholarships, and Assistantships**

The Department each year awards a number of fellowships, traineeships, and assistantships that are available to graduate students. Inquiries concerning these should be addressed to Vice Chairman for Admissions, Electrical Engineering Department.

**Areas of Research**

Candidates for advanced degrees participate in the research activities of the department as paid research assistants or as students of individual faculty members. At any one time, certain areas of research will have more openings than others. A new applicant should express a second choice of research interest in the event that there are no vacancies in his primary area of interest. At present faculty members and students are actively engaged in research in the following areas.

**Radioscience**
- Radiation and Refraction of Radio Waves by Ionized Media
- Solar-Terrestrial Interactions
- Radio Astronomy and Radio Telescopes
- Radar Astronomy
- Space Science and Engineering (also see Index)

**Solid State**
- Semiconductor and Solid State Physics
- Electronic, Magnetic, and Optical Properties of Solids
- Crystal Preparation: Epitaxy and Ion Implantations
- Solid State Devices
- Integrated Circuits
- Applications to Medical Electronics

**Systems Techniques**
- Electronic Systems Engineering: Video through Microwave
- Signal Synthesis and Analysis
- Advanced Receiver Techniques
- Electro-Optics: Coherent Imaging, Laser Applications
- Propagation: Microwave through Optical Data Processing and Pattern Recognition
- Instructional Television Systems

**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

**Systems Theory**
- Statistical Communication Theory
- Pattern Recognition
- Control Theory and Optimization
- 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
SCHOOL OF ENGINEERING

300-399 first graduate year
400-499 second or third graduate year
700-799 special summer courses

COURSES FOR UNDERGRADUATE STUDENTS

41, 42. Circuits, Electronics, and Electromechanics—(Enroll in Engineering 41, 42.)
41A, 42A. Laboratory I and II—(Enroll in Engineering 41A, 42A.)

101. Circuits I—Analysis of simple circuit models, with a view to discovering their fundamental characteristics as transmission networks. Forced and natural components of response, natural frequencies, the complex-frequency plane, resonance; transfer functions and the roles of their poles and zeros. Introduction to the use of analog and digital computers in circuit analysis. Elementary signal-flow graphs. Impulse response: its calculation and its use in obtaining response to other excitations; the superposition (convolution) integral. Prerequisites: Engineering 41 and Mathematics 44.

3 units, Aut (---) MWF 10
Win (---) MWF 8

102. Circuits II—The Laplace transformation, development and application of Fourier series. Sampling and bandwidth concepts. The sinusoidal steady state: plots, charts and loci that exhibit frequency dependence, impedance matching, transformers. Circuit theorems and analytical techniques, including the use of digital computers. Prerequisites: 101 (or, by consent, Engineering 104 plus supplementary reading) and Computer Science 136 or equivalent.

3 units, Win (---) MWF 10
Spr (---) MWF 8


4 units, Aut (---) MTThF 9
Spr (---) MTWF 10

111, 112, 113. Electronics—Basic electronic devices and circuits and an introduction to their applications in electronic systems. Physical principles of charge motion in conductors, semiconductors, vacua and plasmas, and their application to the development of the operating principles and terminal characteristics of electronic devices, particularly semiconductor diodes and transistors. Development of various modeling techniques which are useful in electronic circuit theory (piecewise-linear, graphical, and analytical). Applications of electronic devices in rectification, detection, modulation, amplification, oscillation, switching, and wave-shaping circuits. Prerequisite: previous or concurrent registration in 101 (or consent of the instructor, in special cases).

111. 3 units, Aut (---) MWF 8
Win (---) MWF 11

112. 3 units, Win (---) MWF 8
Spr (---) MWF 11

113. 3 units, Aut (---) MWF 11
Spr (---) MWF 8

121, 122. Laboratory—Measurement techniques, 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

124. Computer Circuit Laboratory—Laboratory projects in digital-computer circuits and applications. Logic design with integrated circuits, analog-to-digital conversion, use of digital computers for the control and testing of external devices. Prerequisite: senior standing.

3 units, Win, Spr (---) 1 lecture and 2 labs. weekly by arrangement

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 various media; reflection and refraction, wave guides, cavities, transmission lines, standing waves, antennas, radiation. Prerequisites: 141 and 103 (103 may be taken concurrently).

3 units, Win (- -) MWF 8
Spr (- -) MWF 9

143. Radio Propagation and Antennas—Propagation through the atmosphere and reflection from the ionosphere. Elementary antenna theory. Consideration of the overall radio system as a communication link. Prerequisite: 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 System Design — Design projects to provide experience in a diversity of engineering problems and decisions. Students work in teams on the definition and description of an engineering problem, plan and conduct a project, and make appropriate reports and presentations. Topics from previous years include: utilization of the radio spectrum, evaluation of an electronic navigation system, development of electronic instruments. Limited to 12 students, with priority to seniors (and first-year graduate students).

3 units, Spr (-)

190. Special Studies 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 (Pritchard, Staff) Th 11

200B. 0 units, Win (Pritchard, Staff)

200C. 0 units, Spr (Pritchard, Staff)

201A,B,C. Seminar — Weekly discussion of special topics of current interest in electrical engineering. Speakers from faculty and from outside the University. Normally taken by graduate students each quarter for 3 quarters.
201A. 1 unit, Aut (Pritchard, Staff) Th 11
201B. 1 unit, Win (Pritchard, Staff)
201C. 1 unit, Spr (Pritchard, Staff)

202. Medical Electronics—This course is an introduction to physiology for engineers, with discussions of problems unique to biomedical instrumentation. Various medical, electrical, and chemical transducer systems and the accompanying electronics are briefly considered. Prerequisite: familiarity with electrical instrumentation techniques.

2 units, Aut (Thompson)


3 units, Aut (Arbib)

206. Man-Machine Systems—The study of systems that require a quantitative analysis of the human component in the system. Emphasis on the quantitative modeling of this human component. Specific system areas considered include: control, monitoring, decision-making, automated instruction, and medical diagnosis. Dependence of future systems on the man-machine relationship. Co-requisites: Statistics 116 or Engineering-Economic Systems 221 or equivalent, or consent of instructor.

3 units, Aut (Smallwood)

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)

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

Spr (Kincheloe) MWF 10

213. Electron Tubes and Associated Circuits—Problems and requirements in modern applications of electron tubes in high-frequency and high-power systems. Short review of fundamentals of vacuum triodes and tetrodes; introduction to electron guns and beams. Tuned power amplifier circuits; klystron amplifiers, reflex klystrons, and traveling-wave tubes. Prerequisites: 103 and 113 (may be concurrent).

3 units, Aut (Rambo) MWF 8, alternate years, given 1970–71


3 units, Aut, Win (Angell, J. Linvill, Meindl)

216. Principles and Models of Semiconductor Devices—Quantitative description and modeling of the physical processes of transport, storage, generation and recombination of carriers in semiconductors. Development, based on the models of the physical processes, of circuit or functional models of transistors and diodes, with emphasis on forms appropriate to integrated circuits. Emphasis is placed on lumped models applicable to small- and large-signal cases. Prerequisite: 113 or graduate standing in electrical engineering.

3 units, Aut, Win (Angell, J. Linvill, Meindl)

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, Staff)


3 units, Spr (McWhorter, Staff)

231, 232. Introduction to Lasers and Masers — Introduction to laser and maser devices, their principles of operation, and their practical applications. Approach based on classical concepts, simple electrical engineering analogies, and classroom demonstrations; no quantum mechanics background required. Independent laboratory work in connection with the course can be arranged. 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

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, Win (Eshleman, Staff)


3 units, Aut, Win (Eshleman, Staff)


3 units, Win, Spr (Eshleman, Staff)

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 (Bracewell) MWF 2:15

Spr (Staff) 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. (The study of network synthesis is continued in 366 for those interested in advanced work in the subject.) Prerequisite: 103 and ability to use digital computation facilities.

3 units, Aut (Tuttle)


271. 3 units, Win (Tuttle)

272. 3 units, Spr (Tuttle)

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 (Cumming) MWF 8

278. Random Signals and Noise—Introduction to the random process model for undetermined signals and noise waveforms, statistical descriptions of signals, power spectral density and autocorrelation function, analysis of linear networks with random inputs, some elementary results with nonlinear elements, physical sources of noise, noise figure. Prerequisites: 102 and Statistics 116 or equivalent.

3 units, Win (——) MWF 2:15


280A,B,C. 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 bloodpressure control using a computer-simulated model of an animal reaction to a pressure-elevating drug. Projects developed in cooperation with electrical engineering and other research laboratories. Should be taken for two consecutive quarters. Prerequisite: Computer Science 136 or some programming experience.

3 units, Aut, Win, Spr (Staff)

281. Theory of Switching—Analysis and synthesis of digital circuits with emphasis on basic design techniques and general concepts. Boolean algebra; simplification of switching functions; sequential circuits; simplification of sequential machines.

3 units, Aut, Win (McCluskey, Peterson)

282. Logic Design and Digital Systems—Characteristics of switching and memory elements. Comparison of integrated-circuit logic modules. Logic design of shift registers, counters, arithmetic circuitry, correlators, analog-digital conversion circuits. Design of representative systems such as radar signal processor, stored program computer, desk calculator, digital differential analyzer. Prerequisite: 281.

3 units, Win, Spr (Peterson, Staff)


3 units, Spr (Peterson)


3 units, Win (Staff)

287. Computer Organization and Information Structures—(Enroll in Computer Science 139.)

289. Theory of Automata—(Enroll in Philosophy 162.)

COURSES FOR GRADUATE STUDENTS

300. Topics and Methods in Solid State Research—Discussion of technical topics in solid state electronics and related mental processes and thinking tools.

Aut, Win, Spr (Shockley) by arrangement

304. Neurocybernetics—Detailed mathematical treatment of such brain modeling problems as control of movement, reliability in neural networks, statistical interaction patterns in the brain. Prerequisites: 363A or equivalent mathematical background; 204 or equivalent background in biology or psychology.

3 units, Win (Arbib) alternate years, given 1970–71

312. Integrated Circuits—A combination laboratory and lecture course in the fundamentals of semiconductor monolithic integrated circuits: guidelines for design of integrated circuits and components, actual cir-
cuit design project including use of computer-aided design techniques, and laboratory instruction in photolithographic techniques; minimum of report preparation. Registration by permission of instructor. Prerequisite: general familiarity with p-n junction devices, e.g., 216; working knowledge of chemistry and/or photographic laboratory techniques is desirable.

3 units, Aut, Spr (Pritchard)

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 (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, Spr (Angell, Meindl)

317. Integrated Circuit Analysis and Design—Analysis and design of linear and digital integrated circuits based on the limitations imposed by device physics, network theory, and fabrication technology. Emphasis on monolithic integrated circuits. Prerequisites: 214 and either 216 or 312.

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, Aut, Win, Spr (Spicer, Moll)

321. Magnetic Phenomena in Solids—Physical basis of magnetic phenomena in solids. Emphasis on the microscopic and atomic origin of the magnetic parameters characterizing magnetic materials, with special attention to ferromagnetic and ferrimagnetic materials. Prerequisite: 238, or Materials Science 152, 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 (Staff)

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 (Staff)

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 (Staff)

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 (Staff)

326A. Wave Phenomena in Active Media I —(Enroll in Applied Physics 250.)

326B. Wave Phenomena in Active Media II —(Enroll in Applied Physics 251.)
328A. Semiconductor Theory — Physical basis for band structure in solids and application to semiconductors. Conduction mechanisms in metals and semiconductors. Extrinsic and intrinsic semiconductors. Static and dynamic behavior of p-n junctions and junction transistors. Prerequisites: 322A or 338A, Physics 57 and Mathematics 130.

3 units, Win (Moll)

328B. Semiconductor Theory — Physical basis for carrier mobility in semiconductors as limited by lattice and impurity scattering, nonlinear high field mobility, negative differential mobility, secondary ionization, and avalanche breakdown of junctions and the theory of tunnel or Zener breakdown and Esaki diodes, semiconductor surfaces. Prerequisite: 328A.

3 units, Spr (Moll)

329A,B,C. Solid State Electronics Laboratory—Experimental projects on semiconductor crystal growth, gaseous diffusion of impurities, Hall effect, minority-carrier diffusion and drift mobility, thermoelectricity, electroluminescence, Gunn effect, optical absorption, plasma reflection, etc. Registration by permission of instructor. Prerequisite: 328A or Physics 172, or Materials Science 122.

3 units, Aut, Win, Spr (Pearson)

332. Optical Properties of Solids — Basic theory with emphasis on the relationship between electronic structure and optical properties of solids. Representative semiconductors, insulators, and metals will be discussed, including Ge, GaAs, CdS, NaCl, ruby, Cu, and Al. Prerequisites: One group of the following: 322A and 322B (may be concurrent); Physics 230 and 231 (may be concurrent); or Materials Science 233 (338A).

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 (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. Photoelectronic 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) 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 guides filled with 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; parametric interaction in active media. Optical resonators and waveguides. 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. Topics treated include diffraction, lenses, coherent and incoherent imaging, optical data processing and holography. Prerequisite: 261 or equivalent.

3 units, Spr (Goodman)

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 1969–70

350. Radioscience Seminar — Student-faculty discussion of research problems in the fields of ionospheric and magnetospheric
physic; 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 (Thomassen) alternate years, given 1969–70

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 the theory of systems as applied to control, communication, and computation by faculty, students, and outside specialists. Prerequisite: 363A or equivalent.

1 unit, Aut, Win, Spr (Bryson, Franklin)


4 units, Aut, Win, Spr (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 (Staff)


3 units, Spr (Luenberger, Staff)

365. Network Theory Seminar—Discussion of recent results in network theory. Prerequisite: 366 or consent of instructor.

1 unit, Spr (Newcomb)

366. Advanced Network Theory — A study in depth of topics in modern network analysis and synthesis: n-ports and properties; positive and bounded-real matrices; topological methods; scattering and immitance matrix synthesis; distributed, active, variable parameter, and equivalent networks. Prerequisites: 266 and 363A.

3 units, Win (Newcomb) alternate years, given 1970–71

367. Active Integrated Network Synthesis — Investigation of synthesis techniques for linear microelectronic structures: Thin film and integrated circuit characteristics; active-passive, lumped-distributed RC structures; operational and feedback amplifier, gyrator, and negative-impedance converter synthesis. Research topics as pertinent. Some lectures are joint with 312. Prerequisite: 366 or consent of instructor.

3 units, Spr (Newcomb) alternate years, given 1970–71

Prerequisites: 163 or equivalent, and 363A.

3 units, Win (Franklin)


3 units, Spr (Widrow)

374A,B. Optimal Trajectories and Control Logic — (Enroll in Applied Mechanics 235 A,B.)

374C. Optimal Estimation and Control Logic in the Presence of Noise—(Enroll in Applied Mechanics 235C.)

375. Information Theory Seminar — Student-faculty discussion of research problems in the general field of information theory, communication theory, pattern recognition, coding theory.

1 unit, Spr (Cover)

376. Information Theory — Information sources. The measure of entropy, information, and mutual information properties of codes; coding information sources; Huffman coding. Information channels; reliable messages through unreliable channels; Shannon's noiseless and noisy coding theorems; channel capacity; restricted primarily to discrete channels.

3 units, Aut (Cover)


3 units, Win (Cover)


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 (Staff)

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 (Staff)

380. Seminar on Digital Systems — Discussion of current research in the area of digital systems including logic design, switching theory, and machine organization.

1 unit, Aut, Win, Spr (McCluskey, Peterson)

381A,B. Systems Programming and the Theory of Formal Languages — (Enroll in Computer Science 236A,B.)

382. Structure of Digital Computers—(Enroll in Computer Science 231.)

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, 284 or equivalent.

3 units, Spr (McCluskey)

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 (Staff)

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.

   1 unit, by invitation

400. Thesis and Thesis Research—Limited to students who have established candidacy for the degree of Engineer or Ph.D. A grade of + indicates satisfactory work; no letter grade is assigned.

   By arrangement


430. Band Structure and Photoemission Seminar—Groups of articles will be selected from the literature and discussed. The more advanced students will assume responsibility for presenting the material for discussion.

   1 unit, Aut, Win, Spr (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 1969–70

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

scanning theory. Prerequisites: 261 or equivalent, and 244.

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 laminas, of small and large size. Propagation through planetary atmospheres and scattering from planetary surfaces. Emphasis on physical descriptions and on applications to communications, radar astronomy, and space probes. Prerequisite: 244 or consent of instructor.

3 units, Aut (Eshleman) alternate years, given 1969-70

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. Space Science and Astrophysics Seminar — (Enroll in Engineering 210.)

456A. Introduction to Astrophysics I: Solar-Terrestrial Relations — (Enroll in Engineering 207.)

456B. Introduction to Astrophysics II: The Sun — (Enroll in Engineering 208.)

456C. Introduction to Astrophysics III: Stars and Galaxies — (Enroll in Engineering 209.)


464C. Dynamic Optimization (Deterministic) — (Enroll in Operations Research 348.)

464D. Dynamic Optimization (Stochastic) — (Enroll in Operations Research 349.)


479. Topics in Statistical System Theory — Study of related problems in statistical communication, stochastic control, statistical data processing, network and system realization 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)

ENGINEERING-ECONOMIC SYSTEMS

Chairman: William K. Linvill

Professors: Willis W. Harman, Ronald A. Howard, William K. Linvill, Julius Margolis

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, Iram J. Weinstein

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: core system courses and foundation courses. The core 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 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 fountainhead of methodology that sustains the core systems courses.

**BACKGROUND REQUIRED**

Students admitted for graduate study in Engineering-Economic Systems must have a background of undergraduate work that indicates a level of mathematical maturity customarily found in an intensive undergraduate engineering or physical science program. Although not a requirement, most students entering the Department will have completed a Master's degree in engineering, science, or business. Undergraduate coursework in economics is not required, but will prove helpful in graduate study in this field.

**PROGRAMS OF STUDY**

There are three programs of study, all at the graduate level, leading to the degrees of Master of Science, Engineer, and Doctor of Philosophy in Engineering-Economic Systems.

**MASTER OF SCIENCE**

University regulations governing the degree of Master of Science are described in the “Degrees” section of this bulletin. Department requirements provide great flexibility for meeting individual objectives. The Master's degree may be viewed as a terminal degree program to provide a professional focus, or it may be used as an exploratory vehicle to formulate and select a more advanced graduate school program. Course programs are approved individually by Engineering-Economic Systems faculty. In addition to meeting university requirements, programs must involve at least six core courses in Engineering-Economic Systems. Internships are not required in Master’s degree programs.

**ENGINEER**

Graduate work to this level is the minimum for adequate qualification as a “System Engineer.” In addition to the University's basic requirements as described in the “Degrees” section of this bulletin, all Engineer degree candidates must demonstrate their proficiency in solving practical problems by either the completion of a field project or the equivalent experience outside the University.

**DOCTOR OF PHILOSOPHY**

The doctoral program in Engineering-Economic Systems involves more academic breadth and deeper research activity than the Engineer degree. The “Degrees” section of this bulletin discusses the University’s basic requirements for the Ph.D. degree. To be admitted to the Engineering-Economic Systems doctoral program, students must pass an examination given during the winter quarter of the first graduate year. Later, in addition to the University oral examination, comprehensive area examinations are given covering the candidate's graduate systems courses.

**MINORS IN ENGINEERING-ECONOMIC SYSTEMS**

Doctoral students throughout the University may complete a minor in Engineering-Economic Systems by taking 15 units of core systems courses selected from the list below. The selection must be approved by the student's department adviser and by the Engineering-Economic Systems faculty. The primary aim of this minor is to develop system analysis and decision-making capabilities for graduate students who anticipate careers associated with system problems. Candidates for a minor in Engineering-Economic Systems will be required to pass an examination on the material they have taken in the core course program. The standard of achievement in these examinations is the same for minor as for major candidates.

**SYSTEM INTERNSHIPS**

Since system problems cannot be captured within a university, internships are offered to help the student develop his ability to solve system problems in the field environment. Those students who have not had adequate previous experience typically serve one or more internships under the
general supervision of the Engineering-Economic Systems staff.

Problems of broad scope requiring a system viewpoint and thus suitable for the internship experience are found in large industrial firms, in companies and research groups concerned with the design and operation of civilian and military systems, and in government agencies planning and executing public works and economic development projects. Opportunities also exist to participate in economic and industrial planning in developing countries.

The duration of internship will normally be between six and twelve months, but depends upon the time required to complete each project successfully. While interning, the student will live on location and work as an employee responsible to the company or agency concerned. The Engineering-Economic Systems faculty will locate and screen suitable internship opportunities in a variety of areas, but the student bears the responsibility for selecting an appropriate problem and for arranging conditions of employment. The faculty will review each proposed project to verify its educational value.

The student's internship work in the field is mainly directed toward the successful solution of a real-world problem. Consequently, the student will gain an appreciation for the approximations and compromises with rigor that characterize applied research. After returning to the University, the student will complete a given casework phase of his program by reexamining his field work in the light of the fundamental principles of system analysis, pointing out the shortcomings of the existing theory in this application, and abstracting from his experience the general insight that he expects to be useful in future studies.

One internship project or equivalent practical experience is standard in both degree programs. There is wide flexibility in the Ph.D. program to accommodate the particular interest of the student. The internship experience develops the student's appreciation for the relation between general and applied work and guides him in selecting a meaningful research topic.

The variety of internships available will vary in time as new problem areas become of interest. The aim is to undertake projects that are technically challenging, practically significant, and theoretically enlightening.

### AREAS OF APPLICATION

Although system concepts are portable and their generality must be emphasized, 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 four categories of courses: (1) foundation courses from physical sciences, social sciences, and mathematics; (2) general core courses in engineering-economic systems; (3) casework courses for the various practical areas; and (4) other elective courses.

FOUNDATION COURSES

System analysis is a young discipline that draws many of its models and methods from mathematics, physical science, and social science. Future developments in system analysis will often be an outgrowth of concepts born in these foundation fields. The course program includes a selection of foundation material from the offerings of many departments so that the system student will have the breadth to contribute to the growth of his profession both now and for years to come. The stronger a student's background in foundation courses, the greater will be his flexibility to move from area to area as career opportunities develop. The list of relevant foundation courses is very long, including a wide variety of mathematics as well as the basic material of the physical and social sciences. A partial list includes:

**MATHEMATICS**

113, 114. Linear Algebra
115, 116. Analysis
120, 121. Modern Algebra
137, 138. Numerical Analysis
205A,B,C. Real Variables
206A,B,C. Complex Variables
220A,B,C. Methods of Mathematical Physics

**PHYSICS**

210, 211, 212. Introductory Theoretical Physics

**ECONOMICS**

202. Price and Allocation Theory
241. Public Finance and Taxation

BUSINESS

200, 201. Business Economics

CORE COURSES IN SYSTEMS

Engineering is distinguished from science by its emphasis on decisions concerning commitment of resources. The engineering-economic systems profession is characterized by its broad concern with the physical, economic, social, and political implications of systems decisions. The central focus of graduate study in systems is a set of portable concepts or tools of thought that apply to a broad spectrum of system problems. The three primary aspects in system work are: (1) intersystem relationships—how system planning decisions depend on a system’s relationship to other systems at the same and other levels of the systems hierarchy; (2) decision analysis—logical balancing of the factors that affect a decision; and (3) system analysis—development of the models for structuring and procedures for optimizing that formalize the selection among systems alternatives. Core concept courses are divided into these categories. Although students are not required to take any specific courses, material relevant to these categories is covered in comprehensive area examinations and will be found in the following courses:

1. Intersystem Relationships: E.E.S. 210, 211, 212A,B, 260.
2. Decision Analysis: E.E.S. 231A,B.
3. System Analysis—
   a) Modeling—
      1) Introductory System Analysis: E.E.S. 201A,B,C.
      2) Probabilistic Models for Problems of Uncertainty: E.E.S. 221, 251A,B.
   b) Optimization—
      1) Concepts of Optimization: E.E.S. 243, 263A,B.
   c) Laboratory and Applications—
      1) System Analysis Laboratory: E.E.S. 220.

FINANCIAL ASSISTANCE AND ADMISSION

A limited number of fellowships and research assistantships are awarded annually. The fellowships are usually awarded to
newly entering students; the assistantship is used primarily for advanced graduate students. Applicants for all forms of assistance may obtain the necessary application forms from the University Admissions Office. Applications for fellowships must be made by the fifteenth of January preceding the fall quarter that admission is desired and must be accompanied by application for admission. Research Assistantships, however, are awarded by the individual faculty research supervisors, not by the Department, and have no such deadline. Applicants, because of the individual nature of these awards, are advised to contact directly the faculty member under whom they wish to work. Formal applications to the Department for research assistantships will be referred to the individual faculty research supervisors. Research assistants can, and normally do, carry out their thesis work and write their theses as an integral part of the commitments of their assistantship.

Except in unusual circumstances, admission to the Department of newly entering graduate students is confined to the fall quarter because the course offerings are arranged sequentially with basic courses and prerequisites falling early in the academic year.

COURSES

CORE COURSES

INTERSYSTEM RELATIONSHIPS


3 units, Aut (Staff) MW 11:00-12:15

211. Economics of Public Works—Analysis of government production of services, criteria for investment, price and non-price rationing of services, financing of services, particular attention to resources development, transportation and public planning. Prerequisite: 210 or consent of instructor.

3 units, Win (Staff) 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 3:15–4:30

260. Economic Analysis of Governmental Behavior — (Enroll in Economics 243.) Development of a set of models to characterize the behavior of governmental bodies. Economic analysis (allocation theory and strategic analysis) will be the principal tools. Units to be studied include administrative, legislative, executive, and judicial bodies. Processes to be studied include budgetary, electoral, functional changes, political leadership, centralization, information, political exchanges, and corruption. Criteria to evaluate structural changes suggested by welfare economics and political philosophy will be considered.

3 units, Win (Margolis) MW 11:00–12:15

DECISION ANALYSIS

231A,B. Decision Analysis — Development of a normative rationale for action in the face of uncertainty and of the procedures necessary to reduce the rationale to practice. Encoding of uncertainty, values, and criteria. Discussion of utility measures of risk preference and discounting measures of time preference. Analysis of problems using decision trees that include risk and time preference. Determination of the economic value of perfect and imperfect information on one of several variables in a decision problem. Design of economic information-gathering experiments. Relationship of this approach to classical procedures. Presentation of examples that range from design change to competitive bidding. Applications drawn from private and public sectors of the economy. First quarter self-contained; second quarter emphasizes project in which teams of students analyze current decision problems drawn from a variety of sources. Prerequisite: 221 or equivalent.

3 units, Win, Spr (Howard) TTh 9:30–10:45
SYSTEM ANALYSIS

MODELING

201A,B,C. Introductory System Analysis — Introduction to analytical concepts of modeling and optimization necessary for system engineering. Static equilibrium models, least squares and data analysis, static allocation problems, constraints and Lagrange multipliers, primal and dual problems. Introduction to linear dynamic system concepts. The superposition concept, Fourier and Laplace transforms, the Z-transform. State variable concepts, flow-graph manipulation, eigenvalue analysis and normal coordinates. Resorvents and functions of matrices. Comparison of discrete and continuous systems, iterative procedures for solving simultaneous equations, numerical solution to differential equations. Applications. Concurrent registration in Mathematics 113 and 114 desirable. This sequence includes the material formerly in 240 and 250A,B.

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 (Howard) TTh 9:30-10:45

251A,B. Dynamic Probabilistic Systems — Analysis of linear probabilistic systems. 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

CONCEPTS OF OPTIMIZATION


3 units, Spr (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. Mathematics 115 is recommended but not required.

3 units, Aut (Luenberger) MWF 2:15

263B. System Optimization — Linear operators; inverses; adjoints, pseudo-inverses. Minimization of functionals; calculus of variations, Feuchel duality. Constrained optimization: Lagrange multipliers, Kuhn-Tucker theorem, duality, optimal control theory. Iterative techniques of optimization. Prerequisite: 263A.

3 units, Win (Luenberger) MWF 2:15

LABORATORY AND APPLICATIONS

220. System Analysis Laboratory—A laboratory course to develop practical judgment and physical insight prerequisite to the successful application of the formal models and mathematical methods of system analysis. The student is presented a simulated real world problem and asked to plan an approach to the problem, formulate the problem in quantitative terms, model the physical processes relevant to the problem, design experiments consistent with the economics of the problem, and finally to write a report that describes his solution in a manner help-
ful 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. Specific system areas considered include: manual control, monitoring, decision making, automated instruction, and medical diagnosis. Discussion of the paramount importance of this area to future systems. Prerequisite: 221 or equivalent. Recommended: familiarity with Laplace transforms.

3 units, Aut (Smallwood) TTh 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, Aut (Margolis)

CASEWORK, SEMINARS, RESEARCH

290. Applications Workshop — Student participation in an ongoing program applying the complementary knowledge of University faculty, graduate assistants, and visiting fellows to a problem of importance to society. Lectures by faculty and visiting fellows survey the substantive issues, the approach being taken, and the research in progress. Class discussion defines additional studies that can contribute to the program. Sample topics are: health systems planning, educational systems planning, regional development, energy resource development, and transportation planning. Prerequisite: consent of instructor.

Aut, Win, Spr (Staff)

291. System Research Seminar — Group study of an area of current system research. Topics may include areas of optimization theory, decision theory, economies, numerical analysis, etc. Topics will be announced on a quarterly basis.

1 unit, Aut, Win, Spr (Staff)

292. Directed Reading and Research in Engineering-Economic Systems — Directed study and research on subject of mutual interest to student and staff member.

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

300. Thesis and Thesis Research — Limited to students who have established candidacy for the degree of Engineer or Ph.D. A grade of + indicates satisfactory work; no letter grade is assigned.

Any quarter (Staff) by arrangement

341A,B,C. Seminar in Public Finance — (Enroll in Economics 341A,B,C.)


INDUSTRIAL ENGINEERING

Emeritus: Eugene L. Grant (Professor)
Chairman: W. Grant Ireson
Associate Professors: Roy E. Lave, Jr., David A. Thompson
Assistant Professor: Hugo A. DiGiulio. Acting: George Bozoki, Robert A. Hemmes

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.

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 the following courses or their equivalents:

Physics 51, 53, 54, 55 and 56,
and Mathematics 41, 42, 43 and 44.

In addition, the student must have successfully completed or must take whatever courses are required as prerequisites for the courses listed on his program for the M.S. degree.

ENGINEER

The Engineer degree normally requires two years of academic work beyond the Bachelor's degree. Normally a program of study for the Engineer degree will include the courses required for the M.S. plus approximately 30 units of additional courses of a more advanced level and a dissertation. Up to 15 units may be allowed for the dissertation. The purpose of the dissertation is to prove the professional competence of the candidate and not necessarily to make an original contribution to knowledge.

DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is offered under the general regulations of the University. The program requires a minimum of three years (nine quarters) of graduate study, at least one year of which must be at Stanford. The first year is represented by the M.S. program. The completion of an acceptable dissertation may occupy most of the third year of study.

The program of study will be arranged by the candidate with the advice of a 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 $3,500 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, Aut, Spr (Thompson) M 2:15-4:05

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 (——) MTWF 8

Win (——) MWF 11

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 (Thompson) 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 10

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: Engineering 5 or Computer Science 50A or 136.

3 units, Aut (——) MWF 9

Win (——) MWF 1:15

Spr (DiGiulio) MWF 8

141A. Utilization of Computers—Same 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


3 units, Win (Veinott) MW 4:15-5:30

crete 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 enroll in 252. Prerequisites: 152 and Statistics 27, or 110, or 116.

3 units, Spr (Iglehart) 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, and Statistics 110.

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 (Thompson) 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. 25–Sept. 19 (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 (DiGiulio) MWF 3:15

211. Systems Analysis and Synthesis II — Course is designed to develop an understanding of the fundamental methods and applications of analysis and synthesis. Covers the basic concepts of scheduling; transportation algorithms; network flow; games, bidding and pricing; Markov processes and chains; optimal (S,s) inventory policy, single stage queues; elements of decision theory, forecasting and smoothing of discrete data.

3 units, Win (DiGiulio) 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 (DiGiulio) 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 10; lab. Th 1:15–4:05 alternate years, given 1970–71


3 units, Spr (Veinott) MWF 2:15


2 units, Aut (——) TTh 3:15

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 (Oakford) MWF 1:15

231. Problems in Engineering Economy—Independent study of selected problem 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, benefit/cost studies, income tax, leases vs. ownerships, 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 (——) 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 (——) TTh 1:15–3:05 and one hour 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 (DiGiulio) MWF 2:15

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

250. Deterministic Models in Operations Research — (Enroll in Operations Research 250.) Formulation, solution, and analysis of mathematical programming models in operations research, including those of integer programming, nonlinear programming, network flow theory, dynamic programming, and game theory. Prerequisite: linear programming.

3 units, Win (——) TTh 4:15–5:30

251. Stochastic Models in Operations Research — (Enroll in Operations Research 251.) Formulation, solution, and analysis of stochastic models in operations research, including those of queueing theory, inventory theory, Markov processes simulation, re-
liability theory. Prerequisites: 250 and Statistics 116 (concurrently).

3 units, Spr (——) MW 4:15–5:30

252. Operations Research — (Enroll in Operations Research 252.) For graduate students who have not had the equivalent of 152 and 153. See 152 and 153 for course content. Prerequisites: Calculus and Statistics 27 or 110 or 116. (May be taken concurrently.)

4 units, Aut (——) MW 3:15–5:05
Win (——) 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 136 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, 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 (Ireson) TTh 9 and Th 1:15–4:05

263. The Engineering and Organization of Small Businesses — A laboratory for the development of a technical idea, embodied in a specific product, into an economic enterprise. Includes product selection, market analysis, pricing, engineering design, production design, economic analysis, establishment of marketing organization, financing and financial planning, design of management organization. Inputs from practicing small businessmen are obtained. Students, including qualified undergraduates, from all appropriate disciplines are encouraged to enroll. May serve as an orientation for a summer economic development project. Prerequisite: consent of instructor.

3 units, 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

265. Readings in Systems Analysis and Synthesis — Assuming a background in the techniques of analysis (operations research, decision theory, etc.) this course is designed to provide a vehicle for discussing general systems concepts with emphasis on the planning of systems with economic, social and technological aspects. The Process of Systems Studies, Modeling, Decomposition Techniques, Future Technologies, Frameworks for Planning, Characteristics of the Systems Analyst and Examples of Systems Studies. This course will consist of a great deal of reading and interactive meetings. Limited enrollment. Prerequisites: several quantitative technique courses, intention of pursuing a degree in Industrial Engineering beyond the M.S., graduate standing, and consent of instructor.

3 units, Spr (Lave) MWF 9

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.

3 units, Win (Thompson) Th 2:15–4:05

281. Individual Study in Biotechnology — Directed reading and research in man-machine systems. Prerequisite: consent of instructor.

2 or more units, any quarter (Thompson) by arrangement

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 (Rice, Lave)
MW 11:00-12:15

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

3 units, Spr (———) by arrangement

345. Finite Graphs and Network Flows — (Enroll in Operations Research 345.) Graph theory with emphasis on related optimization problems and applications. Matroid theory; the max-flow min cut theorem; out-of-kilter algorithm. Matching, covering, applied combinatorial problems. Prerequisite: 240.

3 units, Win (Dantzig) TTh 2:45-4:00


3 units, Aut, Spr (Veinott, Iglehart)
TTh 9-11


3 units, Aut (Iglehart) TTh 8-10

MATERIALS SCIENCE
Emeriti: Welton J. Crook, O. Cutler Shepard (Professors)
Chairman: William A. Tiller
Associate Professors: Arthur I. Bienenstock, William D. Nix, David A. Stevenson
Assistant Professor: Craig R. Barrett
Lecturers: Claus G. Goetz, R. Hiskes, B. 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 and George A. Parks.

OFFERINGS AND FACILITIES
Materials science is concerned with the relation between the structure and properties of materials, factors which control the internal structure of solids, and processes for altering the structure and properties of solids. It brings together in a unified discipline the developments in physical metallurgy, ceramics, and the physics and chemistry of solids. The undergraduate program of the Department, described under School of Engineering, provides training for the physical metallurgist or materials engineer and also preparatory training for graduate work in materials science. Able students are encouraged to take at least one year of graduate
study to extend their course work and to obtain training in research. Graduate programs lead to the degrees of Master of Science, Engineer, and Doctor of Philosophy.

FACILITIES FOR INSTRUCTION AND RESEARCH

The Materials Science Department occupies an area of 30,000 square feet in the Thomas F. Peterson Engineering Laboratory building. The laboratory includes modern facilities for teaching and research in physical metallurgy and materials science. Ordinary melting and heat treating furnaces are included as well as furnaces for vacuum melting, zone refining, and crystal growing. Mechanical testing equipment includes hardness measuring devices, variable strain rate machines for mechanical deformation studies, creep machines and equipment for dynamic elastic modulus and internal friction measurements. For studying the structure of solids, there are optical and electron microscopes as well as X-ray and electron diffraction machines, X-ray fluorescent equipment, gamma ray spectrometer, electron probe microanalyzer, nuclear magnetic resonance spectrometer and equipment for standard electrical, magnetic, and optical measurements.

The Department, together with Physics, Chemistry, and Solid State Electronics, participates in an interdisciplinary Center for Materials Research that has been established at Stanford by funds from the Advanced Research Projects Agency. The Center, with a budget of a million dollars a year, provides equipment, service facilities, and funds for faculty and student research. In addition the Center provides 35,000 square feet of space for materials research in the McCullough Building.

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

The undergraduate Materials Science program provides training in solid state fundamentals and in physical metallurgy. In addition to the General Studies requirements, the curriculum includes the "Courses Normally Taken by All Engineering Students" and the Materials Science supplementary requirements. Electives are available so that students with broad interests can combine Materials Science with work in another science or engineering department.

ADVANCED DEGREES

Graduate students can specialize in any of the areas of Materials Science. In collaboration with other departments of the University, additional special programs are available. For example:

- Materials Science—Electronic Materials
- Materials Science—Applied Mechanics and Structures

MASTER OF SCIENCE

The University's basic requirements for the Master of Science degree are discussed in the section "Degrees" in this bulletin. The following are Departmental requirements:

1. Completion of the equivalent of the requirements for the B.S. degree in Materials Science. Deficiencies in previous training should be made up and not more than 15 units of such work may be counted as part of the minimum total of 45 units.

2. Completion of 45 units of an approved program. A minimum grade point average of 2.75 for course work is expected. The program should contain the following:

   a) A minimum of 20 units of advanced courses in the general area of Materials Science (excluding research and special problems), including 3 of the following:
      - 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 30 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. 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 54 course units beyond the B.S. degree requirements must be included in the program.

COURSES

50. Introductory Science of Materials—(Enroll in Engineering 50.) Introduction to the physical basis of the mechanical, electrical, and magnetic behavior of solids. Electron theory, imperfections in solids. Relations between structural features and properties. Prerequisite: Mathematics 23 or 43.

   3 units, Aut (Barrett, Nix, Bienenstock)
   MWF 9
   Win (Barrett, Nix) MWF 11
   Spr (Barrett, Nix) MWF 10
   Sum (——) MTWTh 11

106. Extractive Metallurgy Processes—(Enroll in Mineral Engineering 105.) Introduction to metallurgical thermodynamics, and fundamentals of the processes used in the production and refining of metals. May be taken as an introduction to metallurgical thermodynamics by enrolling for 2 units. Prerequisite: Chemistry 5. Recommended: Chemistry 171.

   2 to 3 units, Aut (Parlee) by arrangement

107. High Temperature Laboratory—(Enroll in Mineral Engineering 107.) Lectures and laboratory experiments relating to high temperature processes, atmosphere control and vacuum technology; thermodynamic and kinetic measurements. Prerequisite: Mineral Engineering 105 or Chemistry 173.

   2 units, Win (Staff) TTh 1:15–4:05

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 (Tiller) 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, Staff) 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 5.
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: 190 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

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

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, Spr (Staff) MWF 1:15

205. Mechanical Behavior of Solids — (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) MWF 10

207. Physical Chemistry of Metal Purification — (Enroll in Mineral Engineering 207.) Refining processes and the physical chemistry underlying them. A systematic treatment of unit processes based on types of impurity phases, deals effectively with fundamentals of such widely different methods as the zone refining of semiconductors, the industrial refining of copper, steel making and the vacuum refining of high temperature alloys. Prerequisite: Mineral Engineering 105 or Chemistry 173 or equivalent.
3 units, Win (Parlee) by arrangement

208. Environmental Radioactivity — (Enroll in Mineral Engineering 278.) 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: Civil Engineering 170, or Chemistry 3, or Physics 57, or equivalent with consent of instructor.
3 units, Aut (P. Kruger) TTh 11

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

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, Spr (Staff) MWF 10, alternate years, given 1969–70

222. Statistical Thermodynamics — Systematic development of the methods of statistical mechanics. Applications to problems in Materials Science. Prerequisite: 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. No absolute prerequisites, but prior exposure to thermodynamics is recommended.

3 units, Win (Hutchinson, Staff) by arrangement

225B. Surfaces and Interfaces — (Enroll in Mineral Engineering 225B.) Advanced treatment of selected topics in Surface Chemistry with emphasis on inorganic colloidal systems and adsorption. Independent study, lectures, and discussions. Term paper. Prerequisites: 225A or equivalent and 122 or 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 energy conversion cells. Prerequisite: Chemistry 173.

3 units, Win (Staff) MWF 10

230. Materials Science Colloquium.

1 unit, Aut (Sherby) M 4:15
Win (Nix) M 4:15
Spr (Stevenson) M 4:15
Sum (Bube) 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, Win (Staff)

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, Aut (Staff) MWF 1:15


3 units, Win (Staff) MWF 1:15, alternate years, given 1969–70

235. Photoelectronic Properties of Solids—Seminar on selected topics in photoelectric properties of solids, including photoconductivity, luminescence, photovoltaic effects, and techniques and methods of photovoltaic analysis of imperfections in crystals. Prerequisite: 234.

3 units, Win (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
line broadening, strain measurements, effect of stacking faults, diffuse scattering, low angle scattering, diffraction from noncrystalline materials. Prerequisite: 180.

3 units, Aut (Bienenstock) TTh 9; lab. by arrangement


3 units, Win (Staff) MWF 1:15


3 units, Win (Nix) MWF 8

239. Seminar in Advanced Mechanical Metallurgy—Prerequisite: 238.

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


3 units, Spr (Pound) MWF 11


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

246. Crystalline Anisotropy — Seminar on the application of tensor notation to the description and analysis of the properties of crystalline materials.

2 units, Spr (Staff) 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).

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. Prerequisite: Physics 57 and 111, and Mathematics 131, or equivalent.

3 units, Aut (Staff)

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 (Staff)

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, Aut (Tiller) TTh 3:15-4:35, alternate years, given 1969–70


3 units, Win (Pound) TTh 1:15-2:45

266. The Redistribution of Solute During Phase Transformations — Mathematical analysis of the solute distributions in a solid after a phase transformation. Consideration of diffusion in only one or both phases, applied electric field, shape of solid, time dependence of transformation velocity, dendritic interface, multi-phase interface, and fluid motion in one phase. Prerequisites: 240 and Mathematics 131.

3 units, Aut (Tiller) TTh 3:15-4:35, alternate years, given 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 (Tiller) 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: Stephen J. Kline (Thermosciences), Thomas J. Connolly (Nuclear), Peter Z. Bulkeley (Design)
Assistant Professor: John R. Manning
Lecturers: Frank R. Arnold, Richard J. L. Martin, Carl G. A. Rosen

OFFERINGS AND FACILITIES

The courses and degrees offered in Mechanical Engineering provide a background for careers in research, development, design, and manufacture in a wide variety of industries concerned with the handling of mechanical, thermal and nuclear energy (generation, transmission, conversion, metering, control, utilization), the handling of fluids, the construction of mechanical devices (tools, mechanisms, machines, mechanical instruments, control systems), and the conception of systems involving mechanical and thermal components together with electrical, chemical, and human components. Graduates at all degree levels typically go into the product manufacturing industries, aerospace industries (especially in propulsion systems), nuclear power industry, gas
turbine and internal combustion systems industries, and to a lesser extent into the chemical and petroleum process, and transportation.

The Department is organized into three divisions — Thermosciences, Design, and Nuclear, each of which maintains its own laboratory, shops, and secretarial services. The Thermosciences Division offers courses and specialized work in the areas of thermodynamics, thermal power systems, energy conversion, fluid mechanics, and heat transfer. The Design Division is concerned with comprehensive systems design, product design, mechanical analysis and 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 Laboratories are equipped with representative power, fluid handling, refrigeration and heat and mass transfer equipment, a magneto-hydrodynamic power conversion system, shock tube, gasdynamics facility, and extensive special facilities for convective heat transfer and boundary layer research. A wide variety of instrumentation, extensive shop facilities, utilities, and research space are all available within the laboratories.

The Design Division maintains shops for both student instruction and construction of research apparatus, drafting rooms, an analog computer, and instrumentation and space for instruction and graduate research work in stress analysis, dynamics, mechanics, and control systems.

The Nuclear Division laboratories include a 10 KW pool-type research reactor, a neutron accelerator, a sub-critical assembly, a radiochemistry laboratory, a reactor heat transfer laboratory, an analog computer, and a machine shop.

In addition each Division maintains its own small library and reading room, and office space for a substantial number of graduate research students.

PROGRAMS OF STUDY

BACHELOR OF SCIENCE

Students desiring to specialize in mechanical engineering during their undergraduate period may do so by following the curriculum outlined earlier under School of Engineering. The University's basic requirements for the Bachelor's degree are discussed in the section "Degrees" in this bulletin.

A program for Product Design is offered by the Design Division and leads to the degree of Bachelor of Science in General Engineering. It is recommended, however, that this should not be considered a terminal degree and that all students who elect this program continue on through the Master's degree in this field.

MASTER OF SCIENCE

Admission and Registration — The basic University requirements for the Master's degree are discussed in the section "Degrees" in this bulletin.

To be eligible for registration as a graduate student in the Department a student must have received a B.S. degree in engineering, physics, or some comparable science program. His undergraduate record and personal recommendations must demonstrate that he is capable of handling graduate level work and will be able to complete the requirements for the M.S. degree. Students whose undergraduate backgrounds are entirely devoid of some of the major subject disciplines of engineering (for example, fluid mechanics, applied thermodynamics, applied mechanics, circuit theory) may find it desirable to take some undergraduate courses to fill in obvious gaps and prepare themselves to take graduate courses in these areas. Such students may require more than three quarters to fulfill the Master's degree requirements, as the make-up courses may not be used for other than the free electives (see item 4 below) in the M.S. degree program. However, it is not the pol-
icy to require fulfillment of mechanical engineering B.S. degree requirements in order to obtain an M.S. degree, and furthermore students who have already fulfilled certain categories of the M.S. degree requirements as a result of their undergraduate work may find they have sufficient time under item 3 below to obtain the M.S. degree in the normal three quarters.

Graduate Program—The Master's degree program requires 45 units of course work. No thesis is required, although many students include some research work in their course program. The program is designed to provide considerable breadth in applied mathematics and the engineering sciences which are used in the professional practice of engineering. Although considerable depth may be attained in a few areas, a high degree of specialization can only be attained by continuing toward the degrees of Engineer or Doctor of Philosophy, or by including more than 45 units in the M.S. degree program.

The Departmental requirements which must be met for the degree of Master of Science are:

1. 6 units of mathematics from Applied Mechanics 250, 251 (or Computer Science 137), Mathematics 106, 113, 131, 132. (Ordinary differential equations, e.g., Mathematics 130, may not be used to fulfill this requirement; it may be taken as a free elective, item 5 below.)

2. Two courses in each of two of the following three categories, or two courses in one category and one course in each of the other two categories (11 to 13 units total).
   a) Design and Solid Body Mechanics
   b) Nuclear Engineering and Physics
      Mechanical Engineering 271A, 175, 282, 285; Physics 130
   c) Thermosciences
      Mechanical Engineering 211A, 231A (or 231B or 230), 233A, 237A, 238A, 251; Applied Mechanics 242

3. 21 units of approved electives (approved by adviser); these should ordinarily be in mathematics, physics, chemistry, or engineering, and may include any courses in the above lists not used to satisfy area minimum requirements. Courses in this category should be graduate level courses or, if in another department, they should be at least junior level courses with a minimum of introductory courses; specific exceptions to the graduate level rule are Engineering 104, 171, 172, 175; 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.

Students who have already fulfilled in full, or in part, any of the area requirements as a result of their undergraduate work, or work elsewhere, may place the released units in the approved elective category.

4. Included in the above courses must be a minimum of work in Engineering Experimentation and in Engineering Synthesis. This requirement can be fulfilled as outlined below:
   a) In Experimental Engineering, a minimum of 3 units of 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, 217A, 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.

Although it is possible to fulfill most of the above requirements with courses taken outside of the Department, or transferred from elsewhere, it is the policy of the Department that a student must present for the degree at least 15 units of course work in courses presented in the Department.
Candidates for the degree of Master of Science will be expected to have 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 48 units of work specified below are all that is required. For students with other undergraduate backgrounds, one or two years may have to be spent in removing undergraduate deficiencies before starting the graduate program. A special program is available in cooperation with the Art Department of the School of Humanities and Sciences for students who have a Bachelor of Arts in Fine Arts. They will register with the Art Department and, while they will take many of the courses listed below, they will receive the degree of Master of Arts in Art.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.E. 214</td>
<td>Philosophy of Design</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 215A,B,C</td>
<td>Design Seminar</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 219A</td>
<td>Advanced Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>M.E. 219C</td>
<td>Experimental Development</td>
<td>2</td>
</tr>
<tr>
<td>M.E. 299A,B,C</td>
<td>Master's Project</td>
<td>12</td>
</tr>
<tr>
<td>Art 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>CS 208</td>
<td>Biotechnology</td>
<td>3</td>
</tr>
<tr>
<td>GSB 240</td>
<td>Marketing</td>
<td>3</td>
</tr>
<tr>
<td>Free Electives</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

Total. ........................................... 48

The grade point average requirements for this program are the same as for the ordinary Mechanical Engineering Master's Degree.

Degree of Engineer

The basic University requirements for the degree of Engineer are discussed in the section "Degrees" in this bulletin.

This degree represents nominally an additional year of study beyond the Master of Science degree, and includes a research thesis. This program is designed for students who desire to do professional engineering work upon graduation, and who desire an opportunity to engage in more specialized study than is afforded by the Master's degree alone.

The admission standards for this program are substantially the same as indicated under the Master's degree. However, since thesis supervision is required, and the availability of thesis supervisors is strictly limited, the Department cannot admit a student to candidacy until he has personally arranged with some member of the faculty to supervise a research project. This will frequently involve a paid research assistantship, and research assistantships are awarded by individual faculty members (usually from the funds of sponsored research projects under the direction of individual faculty members) and not by the Department, so again a personal arrangement is necessary. Students studying for their Master's degree at Stanford and desiring to continue to the Engineer degree ordinarily make such arrangements during their M.S. degree year. Students holding Master's degrees at other universities will be admitted and allowed to register if they are sufficiently well qualified. However, the Department cannot guarantee thesis supervision or financial assistance, and the student must make such arrangements himself during his first quarter or two of residence.

The Departmental requirements for the degree include an acceptable thesis; up to 15 units credit will be allowed for thesis work. In addition to the thesis, 30 units of approved advanced course work in mathematics, science, and engineering are expected beyond the requirements for the Master of Science degree; the choice of courses is subject to the approval of the adviser. Students who have not fulfilled the Stanford M.S. de-
gree 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 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 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 fulfill University residence requirements, but they are not required to do so if they would prefer to fulfill residence by formal course work, and there is no minimum limit on registered thesis units.

It is the policy of the Department that students engaged in faculty supervised research and special study are obligated to provide the faculty member with a minimum of 20 hours per quarter of reading and grading assistance in the faculty member’s other courses, if the faculty member asks for this assistance. The student will be paid for this assistance unless he holds a fellowship that precludes such payment.

**FINANCIAL ASSISTANCE**

The Department annually awards a number of fellowships, teaching assistantships, and research assistantships to graduate students. The fellowships are usually awarded to first-year graduate students, with the assistantship used primarily for post-Master’s degree students. Preference for the teaching assistantships is generally given to students who obtain their Master’s degree at Stanford. Research assistantships are awarded by the individual faculty research supervisors and not by the Department as a whole.

Applicants for all three forms of assistance may obtain the necessary application forms from the University Admissions Office. However, post-Master’s degree applicants for research assistantships are advised to contact directly the faculty member under whom they would like to work, because of the individual nature of these awards, and if they are successful they need not apply to the Department for assistance. Formal applications to the Department for research assistantships will be referred to the individual faculty research supervisors.

Research assistants can, and normally do, carry out their thesis research work and write their thesis as an integral part of the commitments of their assistantship.

**UNDERGRADUATE COURSES**

Note.—Laboratory sections in experimental engineering will be assigned in groups. Insofar as the laboratory schedule permits, students will be allowed, with due regard to priority of application, to arrange their own sections and laboratory periods. Enrollment with the instructor concerned, on registration day or the first day of University instruction, is essential in order that the laboratory schedule may be prepared. Enrollment later than the first week will not be permitted under any circumstances.

101. Manufacturing Technology—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 (Bulkeley) 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 (Martin) MW 2:15–5:05


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

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.)

3 units, Aut (Adams) Lec. TTh 2:15–3:05; lab. Th 3:15–5:05


3 units, Win (Fuchs) T 10–12, Th 11

113. Engineering Design—Individual or team effort on design projects under the supervision of a faculty team. Projects are selected by the students in consultation with the instructors from a list of problems of current interest to industry, government, and the universities. Emphasis is placed on the simultaneous application to complex real design situations of various analytical techniques learned in engineering science courses. Final presentation to a professional jury. Prerequisites: knowledge of the material in 101, 102, 107, 111.

3 units, Win, Spr (Manning, Staff) TTh 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: 102.

3 units, Win (Staff) 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 (Staff) TTh 12:00–2:05

116C. Advanced Product Design—Summary project utilizing knowledge, methodology, and skills obtained in 102, 113, 115A,B and 116A,B. Final presentation to professional jury. Prerequisite: 116B.

3 units, Spr (Staff) 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 thermo-
sciences 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. Pre-requisites: Familiarity with basic principles of thermodynamics, and some elementary knowledge of fluid mechanics. 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

135. Heat, Mass, and Momentum Transfer
—(This course is now 230.)

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.)

2 units, Aut (C. Kruger) TTh 11


3 units, Spr (Bulkeley) MWF 11

191. Engineering Problems and Experimental Investigation — Directed study and research for the undergraduate student on a subject of mutual interest to student and staff member. Student must find faculty sponsor and have approval of his adviser.

1 to 5 units, any quarter (Staff) by arrangement

COURSES PRIMARILY FOR GRADUATES

ENGINEERING DESIGN

201. Case Work in Engineering Design—Design projects undertaken by local industry will be studied by examination of 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 (Fuchs) 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 (Staff) 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.

215A. 1 unit, Aut (Staff) W 4:15
215B. 1 unit, Win (Staff) W 4:15
215C. 1 unit, Spr (Staff) W 4:15


217B.
Project analyzing hardware of student's choice.

3 units, Aut (Bulkeley) MWF 2:15


3 units, Spr (Bulkeley) MWF 8

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 (Fuchs) 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.

2 units, Spr (Adams, Fuchs) lab. MW 1:15-4:05

220. Space Mechanisms — Constraints and pairing in three-dimensional mechanisms; spatial velocity and acceleration analysis. The spherical 4-bar. The spatial 4-bar. Synthesis of spatial mechanisms for path and function generation. Prerequisite: 107.

3 units, Aut (Roth) MWF 12

221. Kinematic Analysis—The relative motion between links in a mechanism is studied in terms of rolling centroids. The kinematical forms of the Euler-Savary equation are derived and the path curvature of points on a moving link are rigorously determined. The properties of the coupler curves are analyzed in terms of the theory of higher plane curves. Prerequisite: 107.

3 units, Win (Roth) MWF 12

222. Kinematic Synthesis—The problem of determining linkage proportions from prescribed input-output conditions is considered for both path and function generating mechanisms. Critical comparison of graphical, analytical, and computer oriented methods. The techniques are applied to the synthesis of various machines and computers. Prerequisite: 107.

3 units, Spr (Roth) MWF 12


3 units, Spr (J. Manning) T 8-10 Th 11

228. Fluidics—Introduction to fluidic components and systems. Behavior and modeling of bistable and proportional jet devices, vortex amplifiers and sensors, passive elements, transmission lines. System synthesis, coupling effects. Survey of current applications and research. Prerequisite: Engineering 105 (may be taken concurrently).

3 units, Aut (J. Manning) MW 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. 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 gov-
ernment and industry and publishes a final report on the system.

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

235B. 3 to 5 units, Spr (Staff) TTh 1:15 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—(Enroll in Aeronautics and Astronautics 211A.) The fundamentals of high-speed, high-temperature flow of a gas from the molecular point of view; molecular concepts and simple kinetic theory; equilibrium properties of gases and gas mixtures as obtained from kinetic theory, chemical thermodynamics, and statistical mechanics.

3 units, Win (Bershader) MWF 2:15

211B. Physical Gas Dynamics—(Enroll in Aeronautics and Astronautics 211B.) High-speed, high-temperature flows of gas mixture in local thermodynamic and chemical equilibrium; physical and chemical basis of rate equations; flows with vibrational and chemical nonequilibrium. Prerequisites: 211A and Aeronautics and Astronautics 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: 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

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 velocity compressible boundary layer; design of heat and mass transfer sys-
tems. 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

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) MWF 9

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 11 and one hour by arrangement

238A. Continuum Fluid Mechanics — Development of the basic mathematical models for the kinematics and dynamics of the fluid continuum. Integral theorems for mass, momentum and energy. The Newtonian fluid and Navier-Stokes equations. Fractional analysis of basic equations and boundary conditions to obtain simplified models: one-dimensional flow, two-dimensional potential flow of an incompressible fluid, the boundary layer. Applications to engineering problems by exact and approximate methods. Prerequisite: graduate standing.

3 units, Aut (Staff) MWF 8

238B. Continuum Fluid Mechanics — Continuation of 238A: Exact solutions to Navier-Stokes equations. Low Reynolds number flows. Introduction to lubrication. The laminar boundary and free shear layers (wakes and jets). Concepts of stability of fluid flows and introduction to hydrodynamic stability theory. Prerequisite: 238A.

3 units, Win (Staff) MWF 11


3 units, Spr (Staff) MWF 9

239A. Fluid Dynamics of Turbomachinery —Analysis of the fluid dynamics and thermodynamics of flow in turbomachinery. Basic equations for flow in rotating coordinates. Effects of Coriolis and centrifugal forces on boundary layers. Flow in, and design problems of, the centrifugal compressor stage used as vehicle for discussions of concepts and general methods. Prerequisite: 238A. Recommended: 238B,C.

3 units, Win (Johnston) MWF 9, alternate years, given 1969–70


3 units, Win (Reynolds) MWF 8, alternate years, given 1969–70

240. Current Topics in Fluid Mechanics—This course will consist of a series of lectures by invited experts from outside the University on a topic of current interest in the general area of fluid mechanics. The topic chosen will be announced in the Summer Session Bulletin.

2 or 3 units, Sum (———) by arrangement
242A. Experimental Methods in the Thermostosciences — 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) MWF10 and one 3-hour lab. by arrangement

242B. Experimental Methods in the Thermostosciences—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.) 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

248. Plasma Physics Seminar — (Enroll in Engineering 214.) Discussion of research problems and current literature in plasma physics is offered by faculty, students and outside specialists.

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


3 units, Win (Staff) MWF 1:15

252. Magnetofluidmechanics — Interaction of conducting fluids with electric and magnetic fields. MHD one-dimensional channel flow, boundary layers, power generation and fluid acceleration. Calculations of electrical conductivity of equilibrium and nonequilibrium partially ionized gases. Prerequisite: 251 or consent of instructor.

3 units, Spr (Staff) MWF 10

253. Kinetic Theory of Partially Ionized Gases—Collisions between charged particles, Debye shielding. The Fokker-Planck equation and its relation to the Boltzmann equation. Application of the spherical harmonic expansion to the calculation of electrical and thermal conductivities and thermal-diffusion coefficients of partially ionized gases in a magnetic field. The effect of strong electric fields on the electron velocity distribution and on the values of the transport coefficients; the electron energy equation. Rate equations for the population of excited atomic states and the degree of ionization. Nonequilibrium as a result of relaxation and radiation escape. Prerequisites: 251 and 211A, or consent of instructor.

3 units, Spr (C. Kruger) MWF 1:15, alternate years, given 1969–70

254. Physics of Atomic and Radiative Processes in Partially Ionized Gases — This course will be primarily concerned with providing an introduction to fundamental concepts of electromagnetic theory of radiation and in quantum mechanics. Topics to be covered will include radiation from an accelerated charge, bremsstrahlung, blackbody radiation, deficiencies of classical theory, de Broglie waves, the uncertainty principle, Schrödinger’s equation and its solutions, scattering theory, Ramsauer effect. Emphasis will be placed on atomic collision
processes of interest in high temperature gas-dynamics. Prerequisite: Mathematics 132 concurrently or equivalent.

3 units, Spr (Mitchner) MWF 3:15, alternate years, given 1970–71


3 units, Spr (Staff) MWF 11

260. 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 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. Ph.D. and Engineer candidates 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
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.

Graduate Program — To secure the recommendation of the Division for the Master's degree, a candidate must complete 45 units of course work distributed as follows: 6 units of mathematics, 33 units of restricted electives which will include several of the courses described below as well as other engineering or science courses, and 6 units of free electives.

DEGREE OF ENGINEER

The basic University requirements for the degree of Engineer are discussed in the section "Degrees" in this bulletin. This degree represents nominally an additional year of study beyond the Master of Science degree, and includes a research thesis. This program is designed for students who desire to do professional engineering work upon graduation, and who desire an opportunity to engage in more specialized study than is afforded by the Master's degree alone.

DOCTOR OF PHILOSOPHY

The basic University requirements are discussed in the section "Degrees" in this bulletin. The Doctor's degree is intended primarily for students who desire to pursue a career in research, advanced development, or teaching, where a broad background in mathematics and the engineering sciences, together with intensive study and research experience in a specialized area, are the necessary requisites.

The Division of Nuclear Engineering is administered within the Department of Mechanical Engineering; a Ph.D. candidate is enrolled in this Department. A student may elect a minor field of study if he wishes, but it is not required that he do so. A Ph.D. program should, however, show some breadth of training outside of a student's research field.

A student studying for the Ph.D. degree ordinarily will not take an Engineer degree, although this is not precluded. Although a Master's degree is not technically required, a student will usually have fulfilled M.S. degree requirements before becoming a candidate for the Ph.D.

Prior to being formally admitted to candidacy for the Ph.D. degree the student must demonstrate his knowledge of the fundamentals of nuclear engineering by passing a qualifying oral examination. The examination covers the subjects of mathematics, physics, nuclear reactor theory, and two other engineering science subjects (e.g., control theory, heat transfer) selected from a list of seven. The academic level of this examination corresponds to the M.S. degree program. A student must have the approval of his adviser, and at least a tentative arrangement for research supervision, in order to take the examination. The examination is offered during the winter quarter and may in addition be offered at other times as the need arises. Normally the examination will be taken during the first post-Master's year.

FINANCIAL ASSISTANCE

A number of fellowships and research assistantships are awarded annually to graduate students. The fellowships are usually
awarded to first-year graduate students, with the assistantship used primarily for post-Master's degree students. Research assistantships are awarded by the individual faculty research supervisors and not by the Division as a whole.

Applicants for all forms of assistance may obtain the necessary application forms from the University Admissions Office. However, post-Master's degree applicants for research assistantships, because of the individual nature of these awards, are advised to contact directly the faculty member under whom they would like to work. Formal applications to the Division for research assistantships will be referred to the individual faculty research supervisors.

Research assistants can, and normally do, carry out their thesis work and write their thesis as an integral part of the commitments of their assistantship.

COURSES


3 units, Win (Staff) MWF 9

172. Nuclear 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, activation analysis, and their applications. Prerequisites: Chemistry 3, Mathematics 23, and Physics 57.

3 units, Aut (P. Kruger) TTh 9

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, Win (Staff) lab. one afternoon by arrangement

176. Radioisotope Methods—(Enroll in Engineering 176.) Nuclear reactions, radioisotope production, radioactivity genetics and separations, radiotracer methods in laboratory and engineering practices. Prerequisites: 171, 172, or 175, or consent of instructor.

3 units, Win (Staff) Th 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 1969–70

277. Neutron Thermalization—Calculation of thermal neutron spectra; space-dependent spectra in reactors, time-dependent spectra in pulse systems. Calculation of scattering kernels from the dynamics of the scattering system: the Zemach-Glauber and Van Hove formalisms, application to scattering from an ideal gas, Einstein and Debye crystals, and molecules; approximate treatments of liquids, real gases and crystals. Prerequisites: 271C and Physics 132.

3 units, Spr (Ferziger) MWF, 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 1969–70


3 units, Win (Staff) MWF 1:15
is designed to prepare individuals for high-level professional work in applying operations research. Thus, the emphasis is on providing a solid foundation for a life-long professional career involving the formulation, solution, and implementation of operations research models for analyzing complex systems problems in business or government.

In addition to the University's basic requirement for the Master's degree discussed in the section "Degrees" in this bulletin, a candidate is expected to complete an approved course program of 45 units. This program normally can be completed in one academic year (three academic quarters) of full-time work. A number of operations research workers in local industry also attend part-time, taking one or two daytime classes per quarter, under the Honors Cooperative Program. Each student will normally fulfill the following requirements for the Master of Science degree:

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math. 113</td>
<td>Linear Algebra and Matrix Theory</td>
<td>3</td>
</tr>
<tr>
<td>Math. 115</td>
<td>Fundamental Concepts of Analysis</td>
<td>3</td>
</tr>
<tr>
<td>Stat. 116</td>
<td>Theory of Probability</td>
<td>4</td>
</tr>
<tr>
<td>Stat. 219</td>
<td>Elementary Statistical Inference</td>
<td>3</td>
</tr>
<tr>
<td>Stat. 220</td>
<td>Statistical Inference</td>
<td>3</td>
</tr>
<tr>
<td>Stat. 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></td>
</tr>
<tr>
<td>Op. Res. 240</td>
<td>Linear Programming</td>
<td>3</td>
</tr>
<tr>
<td>Electives from the offerings of the Department of Operations Research or from authorized courses in other departments</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

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, queueing models of congestion, modeling and control of dynamical systems arising in physical, economic, or management contexts, discrete selection models for routing and pattern cutting, policy decisions for production and inventory control, and models for conflict resolution, and

(b) the development of the mathematical theory, including the theory of optimization, necessary for the solution of these models.

Examples of the applied mathematical disciplines studied include mathematical programming, dynamic programming, optimal control theory, structure and identification of dynamical systems, stochastic processes, optimal prediction and filtering, network and combinatorial theory, reliability, queueing theory, inventory theory, and game theory.

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.


3. **Requirements in other departments:** Statistics 217H, 218H, and three 200-level quarter courses in either Computer Science, Economics, Mathematics, or Statistics.

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. A few additional research assistantships are awarded with duties assigned at the Stanford Research Institute. Supplementary financial aid can sometimes be obtained by grading, assisting in special projects, or University loans.

All applicants for financial assistance are required to take the Aptitude Test and the Advanced Test (in the field of the applicant's choosing) of the Graduate Record Examination.

Applications for fellowships and assistantships should be made to the Financial Aids Office by March 1.

**Courses**

152. Introduction to Operations Research I—Introduction to deterministic models in operations research. Linear, nonlinear, and dynamic programming. Network analysis, inventory theory, simplex method, transportation problem, dual theorem, convex programming, integer programming, structure of deterministic dynamic programming problems, minimax theorem. Matrix notation will be introduced. Graduate students enroll in 252. Prerequisite: differential calculus.

3 units, Win (Veinott) MW 4:15-5:30


3 units, Spr (Iglehart) TTh 4:15-5:30

240. Linear Programming—This course will survey linear programming, emphasizing standard model formulation, fundamental theorems, variations of the simplex method and parametric programming. Students will solve a linear programming problem on the computer. Corequisite: Mathematics 113.

3 units, Aut (Manne) TTh 1:15-2:45

241. Economics of Industry — (Enroll in 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.

5 units, Aut (Manne)

250. Deterministic Models in Operations Research—Formulation, solution, and analysis of mathematical programming models in operations research, including those of integer programming, nonlinear programming, network flow theory, dynamic programming, and game theory. Prerequisite: 240.

3 units, Win (——) TTh 4:15-5:30


3 units, Spring (——) MW 4:15-5:30

252. Operations Research — For graduate students who have not had the equivalent of 152 and 153. Prerequisites: Calculus and Statistics 27, or 110, or 116. May be taken concurrently.

4 units, Aut (——) MW 3:15-5:05
Win (——) 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 136 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


3 units, Win (Cottle, 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 (Cottle) TTh 1:15-2:30

341. Large Scale Systems in Mathematical Programming — (Enroll in Computer Science 341.) Specializes the methods of 340. Development of efficient solution methods for optimizing special large-scale linear inequality systems such as those encountered in control theory, programming in a Markov chain, investment and economic planning, multi-commodity network flows, multi-item production and distribution models; and those that arise as a solution procedure for nonlinear, integer, and stochastic programming problems. The decomposition principle, partitioning proposals, compact inverse schemes will be developed and applied to various special structures. The role of flexible computer languages to assist in the experimental development will be discussed. Prerequisite: 340C.

3 units, Aut (Dantzig) by arrangement


3 units, Win (Cottle, Dantzig) TTh 2:45-4:00


347A. 3 units, Aut (Kalman) TTh 11:00-12:15
347B. 3 units, Win (Kalman) TTh 11:00-12:15

348. Dynamic Optimization (Deterministic)—Mathematical theory of optimization problems with respect to dynamical systems: unified treatment of necessary conditions via convexity methods, Pontryagin's theorem, theory of the second variation. Prerequisite: 347A,B or equivalent or consent of instructor.

3 units, Aut (Kalman) TTh 2:45-4:00, alternate years, given 1970-71

349. Dynamic Optimization (Stochastic)—Optimal prediction and filtering theory of linear systems; realization of theory of random processes, nonlinear prediction, plus some recent research results. Prerequisites: 347A,B or equivalent or consent of instructor.

3 units, Aut (Kalman) TTh 2:45-4:00, alternate years, given 1970-71

3 units, Win (Kalman) TTh 9–11


3 units, Aut, Spr (Veinott, Iglehart) TTh 9–11


3 units, Win (——) TTh 11:00–12:15

356. Inventory Theory—Characterization and computation of optimal inventory policies for single and multi-item dynamic inventory models with convex or concave cost functions and known or uncertain requirements. Myopic policies. Bayes and minimax policies. Multi-echelon models. Prerequisites: 351 and Statistics 218.

3 units, Aut (Iglehart) TTh 8–10, given 1970–71


3 units, Aut (Iglehart) TTh 8–10


3 units, Aut (——) TTh 9–11, given 1970–71

370. Seminar in Mathematical Programming—Advanced topics. Prerequisite: 341.

3 units, given 1970–71

371. Seminar in Combinatorial Analysis and Integer Programming—Advanced topics. Prerequisite: 341.

3 units, given 1970–71

372. Seminar in Nonlinear Programming—Advanced topics. Prerequisite: 340C.

3 units, Aut (Cottle) by arrangement

375. Seminar in Network Theory—Advanced topics. Prerequisite: 345.

3 units, given 1970–71

378. Seminar on Mathematical System Theory—Advanced topics. Prerequisite: 348.

3 units, given 1970–71

381. Seminar in Dynamic Programming—Advanced topics. Prerequisite: 351 and Mathematics 205A.

3 units, Spr (Veinott) TTh 8–10

385. Seminar in Reliability Theory—Advanced topics. Prerequisite: 355.

3 units, Spr (——) by arrangement

386. Seminar in Inventory Theory—Advanced topics. Prerequisite: 356.

3 units, given 1970–71

388. Seminar in Queueing Theory—Advanced topics. Prerequisite: 358.

3 units, given 1970–71

389. Seminar in Applied Probability—Advanced topics. The subject for 1969–70 will be limit theorems for stochastic processes
which arise in applications. Prerequisites: Mathematics 205A or Statistics 230A.
3 units, Win (Iglehart) by arrangement

   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

Associate Dean: Lawrence V. Ryan
Assistant Dean: Donald R. Price


Organization

The School of Humanities and Sciences includes all members with the rank of instructor or above of the Departments of Aerospace Studies, Anthropology, Applied Physics, Art and Architecture, Asian Languages, Biological Sciences, Chemistry, Classics, Communication, Computer Science, Economics, English, French and Italian, German, History, Humanities Special Programs, Mathematics, Military Science, Music, Naval Science, Philosophy, Physics, Political Science, Psychology, Slavic Languages and Literatures, Sociology, Spanish and Portuguese, Speech and Drama, and Statistics, together with appointees to the Faculty at Large.

Members of the School of Humanities and Sciences are listed under their respective departments, or under the staff for Special Interdepartmental Programs.

Undergraduate Programs

A student wishing to take a departmental major leading to the degree of Bachelor of Arts should consult appropriate sections of the announcements following. Further information concerning requirements may be obtained from the department concerned.

A student desiring to fulfill the requirements for the degree of Bachelor of Arts or Bachelor of Science in one of the special interdepartmental programs (see Humanities Special Programs, Physical Sciences General Program, and Social Sciences Special Program in following sections of this bulletin) should consult the Director of Special Programs in the Humanities, the Chairman of the General Program in the Physical Sciences, or the chairman of the interdepartmental program in the Social Sciences. For general statements of the requirements for the degree of Bachelor of Arts or Bachelor of Science in these programs, students should see appropriate sections of the announcements following.

The School of Humanities and Sciences offers several survey courses in Geography which are listed separately in this publication. It is not possible, however, for a student to elect Geography as a major or minor field.

ROTC—Reserve Officers’ Training Corps are maintained at Stanford by the Army, the Navy, and the Air Force (see Aerospace Studies, Military Science, and Naval Science in this bulletin). Students enrolled in Chemistry or Physics who are also enrolled in an ROTC program will usually require more than the usual four years (twelve quarters) in the University to obtain a baccalaureate degree. Because of the 36 units of credit required for the Aerospace Studies, Military Science, and Naval Science, the Chemistry or Physics courses require additional time for graduation which will vary from one to three quarters depending upon the circumstances in each case.

Graduate Programs

Candidates for the degree of Master of Arts, Master of Science, or Doctor of Philosophy should consult appropriate sections of the announcements following and should also consult the department in which they intend to specialize.

For regional, area studies, or other special graduate programs leading to the degree of Doctor of Philosophy, see listing under Graduate Division Special Programs.

Aerospace Studies

Chairman: Leon C. Heinle (Lieutenant Colonel, USAF)
SCHOOL OF HUMANITIES AND SCIENCES

Professor: Leon C. Heinle (Lieutenant Colonel, USAF)
Assistant Professors: Thomas J. Bagley III (Captain, USAF), Carl R. Oliver (Captain, USAF)

GENERAL

The Department of Aerospace Studies offers a program of Air Force ROTC instruction and pre-commissioning training which, in conjunction with a baccalaureate degree, qualifies a student for a commission in the United States Air Force. This program can be completed in either a two- or a four-year configuration.

CURRICULUM

TWO-YEAR PROGRAM (GRADUATE OR UNDERGRADUATE)

It is now possible for a student with two years remaining at Stanford University to participate in the AFROTC Program. Graduate students are especially invited to apply. The Professional Officer Course covers the development of aerospace power from man's early attempts to fly through our current space programs. Included is a detailed study of the military as a profession with particular emphasis on leadership and management training.

Throughout the AFROTC curriculum, major emphasis is placed on the development of the student's communicative skills. All classes are taught by the seminar method, with active student participation required. All cadets attend one hour of Leadership Laboratory each week.

Students will attend a six-week Field Training Course during the summer preceding their enrollment. This Field Training Course replaces the General Military Course required in the four-year program and satisfies all Field Training requirements. Each student will experience living on an Air Force base and virtually become a part of the Air Force. He will learn about modern air and space weapons, participate in orientation flying, train in the use of weapons, gain leadership experience and discipline, and experience Air Force life through actual exposure.

FOUR-YEAR PROGRAM

This program consists of the General Military Course offered during the freshman and sophomore years and the Professional Officer Course during the junior and senior years.

The General Military Course includes an introductory course exploring the causes of the present world conflict as they affect the security of the United States, an introduction to the United States Air Force and a comparative study of the Free and Communist world military forces. The Professional Officer Course is the same as that described in the two-year program.

Students will attend a four-week Field Training Course on an Air Force base during the summer preceding their junior or senior year.

ACTIVITIES

In addition to the academic curriculum the AFROTC program offers many activities which help the student develop the qualities of an Air Force officer. Leadership training is held once each week and enables the cadet to practice skills he studied in the seminar. Tours of Air Force installations acquaint cadets with the facilities and operations required to accomplish the Air Force missions. Orientation flights, often in jet aircraft, are offered to selected students. The Arnold Air Society, an honorary professional organization, sponsors social activities, service projects, and inter-ROTC competition.

DEFERMENT-DELAY

Active participation in the AFROTC program authorizes deferment from selective service induction. This deferment can insure completion of undergraduate or graduate courses of study. Upon graduation and commissioning, education delays (postponement of active duty) may be granted to students pursuing graduate studies.

DISTINGUISHED GRADUATE PROGRAM

The Air Force ROTC Distinguished Graduate Program provides an opportunity for highly qualified cadets to be selected for appointment in the Regular Air Force. The Professor of Aerospace Studies may designate as Distinguished Graduates those
seniors who possess outstanding qualities of leadership and have demonstrated these qualities both in military classwork and other campus activities. They must also maintain high academic standings in their military and University studies. These distinguished graduates become eligible to compete for regular commissions.

**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 prior to entering the Two-Year Professional Officer Course. Students enrolled in the Four-Year Program receive approximately $190 while attending the four-week Field Training Course.

**FLIGHT INSTRUCTION PROGRAM**

A light plane pilot training program is offered during the final year to cadets who plan to enter the USAF pilot training program following commissioning. Cadets may obtain a private license through this program.

**COURSES**

Course numbers are assigned by the Air Force and do not correspond to the general University plan for numbering, i.e., none are graduate courses.

**FIRST YEAR**

101, 102, 103. National Security—An introductory course exploring the causes of present world conflict as they affect the security of the United States. National power, the United States Air Force and Department of Defense are studied as instruments of national policy.

101. 1 unit, Aut (Heinle) Th 1:15
102. 1 unit, Win (Heinle) Th 1:15
103. 1 unit, Spr (Heinle) Th 1:15
Leadership lab. M 4:30-5:20

**SECOND YEAR**

201, 202, 203. World Military Systems—A study of world military forces (Air, Land, and Naval), to include trends in the development of military equipment and changing concepts of employment. International security organization and the rationale of contemporary peace proposals.

201. 1 unit, Aut (Staff) Th 10
202. 1 unit, Win (Staff) Th 10
203. 1 unit, Spr (Staff) Th 10
Leadership lab. M 4:30-5:20

**THIRD YEAR**

401. The Professional Officer—The foundations of the military profession. The channels of communications. Human relations as they apply to the leadership situation, and the theory of leadership.

3 units, Aut (Bagley) MW 3:15-4:30;
Leadership lab. M 4:30-5:20


3 units, Win (Bagley) MW 3:15-4:30;
Leadership lab. M 4:30-5:20

403. The Professional Officer—Air Force management, principles, and functions. The command and staff team. Data processing and controls. Performance standards. The junior officer as an administrator.

3 units, Spr (Bagley) MW 3:15-4:30;
Leadership lab. M 4:30-5:20

**FOURTH YEAR**


301. 3 units, Aut (Oliver) MW 11:00-12:15; Leadership lab. M 4:30-5:20
302. 3 units, Win (Oliver) MW 11:00-12:15; Leadership lab. M 4:30-5:20


3 units, Spr (Oliver) MW 11:00-12:15;
Leadership lab. M 4:30-5:20
ADVANCED LABORATORY

199. Corps Training—Open to the AFROTC cadet staff and selected cadets. One hour each week.

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

ANTHROPOLOGY

Chairman: Benjamin D. Paul


Lecturers: Peggy J. Golde, Louise Spindler

Research Associate: Gene McN. Stirling

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, 172, 175, 177. To be recommended for the Bachelor's degree, the student must have an average grade of C or higher for work in the major field.

The Department offers an Honors Program in Anthropology to give Department majors with superior scholastic records and outstanding ability in anthropology an opportunity to undertake more independent and creative work along the lines of their special interests. Honors work, when undertaken, is part of the student's junior and senior year program, and culminates in the presentation of an honors thesis in the final quarter of the senior year. A student completing the program will graduate "with Departmental Honors."

To qualify for admission to the Honors Program the student must have a grade point average of B or better (normally based on 15 units of work) in courses within the anthropology major sequence, and an overall grade average of B or better in general University work. Candidates for admission should apply to the departmental adviser for majors by the second quarter of the junior year. A student may be admitted in the third quarter of the junior year and, in exceptional cases, at the beginning of the first quarter of the senior year. The departmental adviser will assist the student with the selection of a faculty member to act as his honors adviser. Each student will prepare a proposed program of study, including his thesis topic, in consultation with his adviser and any other faculty member whose interests relate to his own. Topics for the honors thesis may consist of empirical field studies, where feasible; problems in the history of anthropological theory; or the manipulation of data from the literature bearing upon some problem of special interest to the student.

The honors student may apply 12 units of the 45 units required for the departmental major to a special study program. These 12 units will be distributed as appropriate between (a) courses in or outside the department which bear directly on the preparation of the honors thesis and (b) a special independent study course for honors. The honors thesis will be presented to his adviser.
at least two weeks before the end of the final quarter of the senior year.

Anthropology majors are invited to apply for admission to the seminar for undergraduate majors (192) and to graduate-level seminars of special 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, plus a thesis, unless the thesis requirement is waived by action of the Department. Course requirements are to be determined by the Department, depending on the student’s program.

**DOCTOR OF PHILOSOPHY**

The Doctor of Philosophy degree is earned by fulfilling the following requirements:

1. 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 Autumn and Winter Quarters of the first year, at an acceptable level: 227, 293, 255, 290.

3. satisfactorily complete course 283 in the Spring Quarter of the first year.

4. pass the following courses, by the end of the second year, at an acceptable graduate level:
   a) General Linguistics and Language Behavior (169)
   b) Introduction to Mathematical Anthropology (285)
   c) Prehistoric Archaeology (170 or 172)
   d) Physical Anthropology (175 or 177)

Students who submit satisfactory evidence of having had previous training in any of these fields are urged to take more advanced courses in the same topic areas, or to submit to the faculty a proposal to substitute courses in other fields.

5. pass a Special Examination, normally given at the end of the Autumn Quarter of the third year, covering the candidate’s major topic of specialization and one major ethnological area of the world.

6. present a dissertation based upon independent research.

7. pass the University Oral Examination, normally given in defense of the dissertation.

The Department of Anthropology maintains a graduate summer field training program in Oaxaca, Mexico. Normally graduate students will be given directed training in field research (course 288) during the summer after the first academic year, either at the Oaxaca field site or in another area where directed field training is available.

Students are expected to serve, and gain experience, as teaching 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 (G. and L. Spindler) MTWThF 1:15
5 units, Spr (Wolf) MTWThF 1:15
4 units, Sum (G. and L. Spindler) 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, Aut (Gerow) MTWThF 11

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

(Except where prerequisites are specified, courses are open to all students. With consent of the instructor, one or more extra units may be added by undertaking special project work.)

#102. Indians of North America—History, cultural background, and contemporary situation of major tribes in North America.
5 units, Win (Gerow) MWF 9

#103. Peoples of Middle America—Cultural development culminating in the high, pre-conquest civilizations and post-conquest changes in Indian peasant traditions are surveyed. Emphasis is given on the analysis of the institutions of contemporary small rural communities, using modern village studies as source materials. Prerequisite: 1 or consent of instructor.
5 units, Aut (——) MWF 9

108. Peoples of Europe—A review of anthropological materials on rural (peasant) societies in Europe, with emphasis on Ireland, France, Spain, Italy, and Greece. Prerequisite: 1 or consent of instructor.
4 units, given 1970–71

#109. Peoples of Africa—Social organization and cultural institutions of traditional Sub-Saharan societies and their modification in response to changing conditions.
5 units, Spr (Greenberg) MWF 10

#116. Peoples of Japan—Emphasis on Japan and relationship with other peoples of East Asia. Racial, linguistic, cultural backgrounds and characteristics; opportunities to read on special areas. Prerequisite: 1 or consent of instructor.
4 units (Befu) given 1970–71

117. Traditional Chinese Society—The society, polity, economy, and religion of late traditional China analyzed as a total system. Secondary attention is given to the nature of pre–modern social change. Prerequisite: 1 or Sociology 1 or consent of instructor. Not open to freshmen or sophomores.
5 units, Win (Wolf) MWF 10

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 (Skinner) given 1970–71

#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 instructor.
4 units (Frake) given 1970–71

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.
4 units (Befu) given 1970–71

126. Culture Change—Long and short range processes of sociocultural growth and change, including independent development, diffusion, culture contact, and technical aid programs. Prerequisite: 1 or consent of instructor.
4 units, Win (Paul) MWF 11

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.

4 units (Siegel) given 1970–71

143. Anthropological Approaches to Religion—This course will approach religion in a behavioral, non-evaluative manner, utilizing selected theoretical approaches and emphasizing ethnographic techniques of observation and verification. Prerequisite: 1 or consent of instructor.

4 units, Win (Textor) MWF 2:15

144. Mythology and Folklore—Anthropological contributions to understanding these fields of human activity; comparisons with Western literature.

4 units (Gerow) given 1970–71

151. Economic Anthropology—Data on economic systems of primitive and peasant societies and problems in its conceptualization will be reviewed. Prerequisite: 1 or consent of instructor.

4 units, Aut (Cancian) MWF 10

158. Culture and Personality—Anthropological contributions to understanding the role of culture in personality development; comparative studies; present status of problem. Prerequisites: 1 and Psychology 1 or consent of instructor.

4 units, given 1970–71

159. Cognitive Anthropology—Investigation of the relation between cognitive process and cultural behavior. Selected topics from the fields of perception, language, and belief will be considered. Prerequisite: 1 or consent of instructor.

4 units, given 1970–71

167. Language and Culture—The relevance of linguistic theory, semantic analysis, and the study of speech as social behavior to problems of anthropology, sociology, and psychology. Prerequisite: 1 or consent of instructor.

4 units, Spr (Frake) MWF 1:15


5 units, Win (Diebold) MWF 1:15–2:05

169. Introduction to Special Linguistic Topics—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, Aut (Diebold) MWF 1:15–2:05

170. Prehistoric Archaeology—Methods, findings in this field; correlations of prehistory of Europe and Near East with that of other zones over the world. Prerequisite: 1 or consent of instructor.

4 units (Gerow) given 1970–71

172. Prehistoric Archaeology of the New World—Current methods and findings in this field, with special emphasis on the prehistory of Western North America (United States and Mexico).

4 units, Spr (Gerow) MWF 11

175. Physical Anthropology—Methods, findings relating to human evolution, fossil man, and racial differences.

5 units, Win (——) TTh 1:15–3:05

177. Primate Social Behavior—A Survey of the social behavior of monkeys and apes based on observation of natural, semi-natural, and captive colonies with emphasis on the implications of these observations for reconstructing the evolution of human behavior.

4 units, Spr (——) by arrangement

180. Archaeological Field Methods—Studies, excavations of local archaeological sites, and related work in the Department archaeological laboratory. Prerequisite: 5 or consent of instructor.

4 units, Spr (Gerow) by arrangement

182. Museum Methods—Directed work on anthropological collections. Can be taken for
SCHOOL OF HUMANITIES AND SCIENCES

one or two quarters with consent of instructor.

1 to 4 units, Aut, Win (Gerow) by arrangement

190. Directed Individual Study — For undergraduate students with special needs, and showing capacity to do independent work. Prerequisite: 1 or consent of instructor.

Any quarter (Staff) by arrangement

192. Seminar on Selected Topics in Anthropology — Normally open to anthropology majors. Registration limited. Prerequisite: consent of instructor.

2 to 4 units, Aut (Cancian) by arrangement
2 to 4 units, Win (Siegel) by arrangement
2 to 4 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

203. Middle American Research — Problems on social organization in Middle America. Students may utilize materials from current staff research projects. This seminar may also serve as a follow-up of work done by summer field trainees. Prerequisite: graduate standing or consent of instructor.

5 units, given 1970–71

207. Latin American Peasantry — Seminar treating selected topics in the study of agrarian based societies of Latin America. Emphasis in 1969–70 is on plantation systems and relations between local communities and larger political units. Prerequisite: consent of instructor.

5 units, Win (Siegel) T 3:15–6:05

209. African Law — Seminar analyzing the traditional legal systems of Sub-Saharan Africa, the relationship of legal beliefs and practices to other areas of culture and to other means of social control. Special attention to the changing role of law under colonialism and since independence. Prerequisite: graduate standing or consent of instructor.

5 units (Gibbs) given 1970–71

224. Problems in the Study of Art and Culture — Consideration of concepts of art and aesthetics, the nature and development of art style; critical review of studies relating graphic art to social structure, values or personality; use of ethnographic materials for illustrative and research purposes. Prerequisite: graduate standing or consent of instructor.

5 units (Golde) given 1970–71

227. Theories of Cultural and Social Change — Consideration of sources and characteristics of new alternatives, the reorganization of choice behavior in relation to prevailing social structure, technology and cultural orientations. Prerequisite: graduate standing or consent of instructor.

5 units, Aut (Siegel) Th 2:15–5:05

228. Culture and Education in Developing Nations — (Same as Education 306A.) This course will examine education as a means of fostering modernization in Asia, Africa, and Latin America, utilizing anthropological theories and relating them to relevant theories drawn from neighboring disciplines. Prerequisite: graduate standing or consent of instructor.

2 to 5 units, Aut (Textor) T 3:15–6:05

233. Social Organization — Examination of theories and findings in the area of culturally defined interpersonal relations, focusing on kinship and local group organization. Prerequisite: graduate standing or consent of the instructor.

5 units, Aut, given 1970–71

234. Comparative Peasant Societies — Seminar treating selected topics in the comparative analysis of traditional agrarian societies. The focus is on systems of governance and the political process. Cases may be drawn from any of the historical or contemporary peasant societies in Asia, the Middle East, Africa, Europe, or Latin America. Prerequisite: graduate standing or consent of instructor.

5 units, given 1970–71

235. Kinship and Social Behavior — Seminar in selected topics in the study of kinship and social interaction, emphasizing research applications. Prerequisite: graduate standing or consent of instructor.

5 units, given 1970–71

245. Advanced Political Anthropology — (Same as Political Science 218.) Seminar treating the political process in traditional and modernizing societies, both simple and
complex, and in their various subsystems. Analysis will proceed in connection with a rethinking of relevant theory from political science, anthropology, sociology, and related disciplines.

5 units, given 1970-71

254. Cultural Ecology—Seminar on problems of cultural adaptations of human societies to their environments. Prerequisite: graduate standing or consent of instructor.

5 units (Frake) given 1970-71

255. Psychological Anthropology—Analysis of selected psychocultural processes, including attention to group and individual adaptations to rapid cultural change and urbanization. Prerequisite: graduate standing or consent of the instructor.

5 units, Win (Wolf) 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.

3 units, Aut (Warren) M 7-10 p.m.

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

258. Psychocultural Dynamics — Exploration of relationships between persons and culture systems; of psychological process and culture change; and of research methods and theory appropriate to these concerns.

5 units (Spindler) given 1970-71

260. Languages of the Pacific — Comparative Austronesian linguistics, structural characteristics of Oceanic languages, sociolinguistics in the Pacific and Insular Southeast Asia.

5 units, Win (Frake) Th 3:15-6:05

261. Linguistic Field Methods — Introduction to articulatory phonetics and intensive training in phonetic transcription; introduction to techniques of phonological, grammatical, and semantic analysis. Practice in elicitation procedures and the collection and collation of linguistic data. Emphasis will be placed on the contrastive analysis between English and the foreign target language spoken by the linguistic informants who will participate in the course. Prerequisite: graduate standing or consent of instructor.

5 units, Spr (——) Th 9:00-11:50

263. Grammatical Theory — 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 (Greenberg) TTh 2:15-4:05

264. Typology and Universals of Language — The methodology of structural comparisons of languages; the connection between typological analyses and generalizations about language; universals of language in phonology, grammar and semantics; problems concerning deductive explanation of universals. Prerequisite: elementary linguistic course or consent of instructor.

5 units, Win (Greenberg) given 1970-71

265. Introduction to Linguistics — General theory of language including basic problems of descriptive and historical linguistics. Prerequisite: graduate standing or consent of instructor.

5 units, given 1970-71

266. Seminar: Linguistic Ways to Prehistory—The application of historical-comparative linguistic techniques to problems of culture 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, Spr (Diebold) MW 4:15-6:05

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, Win (Greenberg) MW 3:15-5:05

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 De-
partments of Preventive Medicine, Pediatrics and Division of Clinical Social Work) by arrangement

277. Medical Anthropology—Seminar, analyzing theories of disease and therapy in selected societies, the relation of medical beliefs to other areas of culture, and similar problems of medical-anthropological interest. Prerequisite: graduate standing or consent of instructor.

5 units, Spr (Golde) TTh 4:15-6:05

278. Advanced Medical Anthropology—Seminar devoted to examination in depth of research problems requiring medical and behavioral science collaboration. Prerequisite: 277 and consent of instructor.

5 units, given 1970-71

279. The Hospital as a Socio-Cultural System—Students will carry out field studies of the structure and functioning of the Stanford University Medical Center after review of the relevant literature and demonstration of research interviewing and participant observation techniques. Open to Year I and II medical students, graduate students in anthropology and sociology, and advanced nursing students.

3 units, Aut (Barnett) M 4:15-6:05 and 3 lab. hours by arrangement

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 1970-71

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

285. Introduction to Mathematical Anthropology—Application of mathematics to social and cultural data. Examples will be taken from probability theory, statistics, algebra and logic. Prerequisite: graduate standing or consent of instructor.

5 units, Aut (——) MWF11

286. Computer Applications in Social Anthropology—Seminar in the use of digital computers in social anthropology, including both data manipulation and simulation techniques. Familiarity with Algol or a similar computer language is required.

5 units, Spr (——) given 1970-71

288. Field Training in Cultural Anthropology—Instruction and practice in data gathering methods and analyses in native community settings at one of three field stations in the United States and Mexico. Required of all first-year students in the Department's Ph.D. program. Open to other graduate students with permission of instructor.

15 units, Sum (Frake, Staff) by arrangement

290. History of Anthropological Theory—A historical treatment of the chief theoretical trends in anthropology. Prerequisite: 1 or graduate standing.

5 units, given 1970-71

293. Ethnographic Theory and Method—Consideration of the relations between ethnography and cultural theory through investigation of the criteria for the adequacy of ethnographic descriptions and of methods for producing descriptions that meet these criteria. Special attention will be given to kinship and other aspects of social structure and to ecological adaptation. Prerequisite: graduate standing or consent of instructor.

5 units, Aut (Frake) TTh 9:00-10:50

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

308. Teaching Apprenticeship—Supervised experience as assistant in one undergraduate course.

5 units, any quarter (Staff) by arrangement

309. Directed Graduate Research—Re-
search “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: Marvin Chodorow

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 Professor: Robert L. Byer

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, 1970. 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, 172, 220 (or Electrical Engineering 342), Physics 230, 231, 232 (or Electrical Engineering 322A, 322B, Applied Physics 237), Applied Physics 213, 214, 215 (or Physics 210, 211, 212), 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, examination, etc.) are discussed in the section “Degrees” in this bulletin. The Departmental requirements include a good reading knowledge in any one of the three languages: French, German, or Russian. Each candidate for this degree will be required to pass the written comprehensive examination on undergraduate-level physics and, in addition, an oral qualifying examination before his candidacy for the Ph.D. degree is accepted. This examination will consist of a seminar given by the candidate on a suitable technical topic, and questioning by a faculty
committee on that topic and related material.

Minimum subject matter requirements for the Ph.D. degree include: Physics 210, 211, 212 (or Applied Physics 213, 214, 215); Physics 221; Physics 230, 231, 232 (or Electrical Engineering 322A, 322B); Physics 220 (or Electrical Engineering 322); and two quarters of advanced laboratory (chosen from Physics 200, 201, 202, Applied Physics 351, 353, 355, Electrical Engineering 329A, B, C, or Engineering 212A, 213A). Additional course requirements will be arranged in consultation with the major professor. Typically, these will include enough units (course work and research) either in applied physics, physics, mathematics, or specialized courses in engineering to total approximately 80 units beyond the B.S. degree. A minimum grade average of B during the last five quarters is required in the courses taken toward the Ph.D. degree.

SPACE SCIENCE AND ASTROPHYSICS

A small number of students may by arrangement pursue a program of study of space science (see “Space Science and Related Opportunities”) or astrophysics. Under the general provisions of the Graduate Division Special Programs, an approved program may lead to a Ph.D. degree in Space Science or Astrophysics.

FELLOWSHIPS AND ASSISTANTSHIPS

Besides the University fellowships open to all students, there are available in the Department several special fellowships and a number of assistantships involving research. Applications for fellowships, scholarships, and assistantships are made to the Office of Financial Aid and must be completed by January 15, 1970.

COURSES

213, 214, 215. Methods of Theoretical Physics—A course designed to illustrate mathematical methods in physics and engineering with emphasis on applications rather than formal mathematical development. Topics include boundary value problems, eigenvalues and eigenfunctions, linear operators, vector spaces, matrices, integral transforms, Green’s functions, integral equations, special functions, complex variable, variational methods, perturbation theory and group theory. Prerequisite: Mathematics 130.

213. 3 units, Aut (Doniach) TTh 11:00–12:15
214. 3 units, Win (Doniach) TTh 11:00–12:15
215. 3 units, Spr (Doniach) TTh 11:00–12:15

232, 233. 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 Schrödinger formulations, multiplet structure by Racah methods, Hartree-Fock calculations, hyperfine couplings, vibrational-rotational structure, molecular orbitals, ligand-field theory as well as the physical content of various experimental methods. Prerequisite: Physics 132 or Electrical Engineering 322B.

232. 3 units, Aut (Weissbluth) MWF 11
233. 3 units, Win (Weissbluth) MWF 11

237. Quantum Mechanics of Atomic Systems—Directed toward application to solid state, magnetics, quantum electronics, etc. Includes the density matrix; quantization of the EM field; second quantization; interaction of EM radiation and matter; multiple-quantum effects. Prerequisite: Electrical Engineering 322B or Physics 231.

3 units, Spr (Heffner) given 1970–71

250. Wave Phenomena in Active Media I—Theory of wave interactions in various active media. Space charge waves in electron beams, plasmas and semiconductors. Instability criteria for growing waves. Applications 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 (Kino) 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 (Kino) 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 magnetostriiction, 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 1969-70

253. Microwave Semiconducting Devices and Related Transport Theory—This course will consist of a series of lectures devoted to the theory which underlies microwave semiconducting devices. The series will be divided into four sections: Gunn effect; avalanche diodes; acoustic wave interactions in semiconductors; instability, current oscillations, and carrier wave amplification with drifting holes and electrons.

2 units, Spr (Quate) alternate years, given 1969-70

290. Directed Studies in Applied Physics—Special studies under the direction of a faculty member for which academic credit may properly be allowed. Such studies may include laboratory work or directed reading.

Any quarter (Staff) by arrangement

300. Thesis Research.

Any quarter (Staff) by arrangement

350. Applied Physics Measurements I — Lecture course which, together with 351, is intended to introduce fundamental measurement methods useful in applied physics. Wherever possible, microwave techniques will be utilized to explore the experimental phenomena under investigation. Theory of the properties of waves at microwave and optical frequencies and the related laboratory techniques for measuring these properties. Selected topics from the following: waveguiding systems for electromagnetic waves, resonant cavity modes and field configurations, gaussian mode properties of optical waves, and the attenuation of acoustic waves at microwave frequencies. Prerequisite: concurrent registration in Electrical Engineering 243 or equivalent.

2 units, Aut (Quate) TTh 8


2 units, Aut (Quate) by arrangement

352. Applied Physics Measurements II — Continuation of 350: Electromagnetic theory as related to the laboratory experiments selected from: wave propagation in periodic systems, ferrimagnetic resonance at microwave frequencies, the dielectric properties of materials, properties of lasers as a source of coherent light, the characteristics of superconducting materials, and the properties of bulk semiconductors which exhibit negative differential conductivity at microwave frequencies. Prerequisites: 350 and 351.

2 units, Win (Quate) TTh 8

353. Applied Physics Measurements Laboratory II — Laboratory course to accompany 352. Prerequisites: 350 and 351. Concurrent registration in 352 is required.

2 units, Win (Quate) by arrangement

360. Introduction to Astrophysics I: Solar-Terrestrial Relations—(Enroll in Engineering 207.) Origin and characteristics of the solar wind. Magnetosphere and bow wave; radiation belts; aurorae. Phenomena caused by solar flares: interplanetary shock waves; geomagnetic storms; Forbush effect. Prerequisite: Physics 220, or Electrical Engineering 244, or Aeronautics and Astronautics 285A, or equivalent. Physics 132 desirable.

3 units, Aut (Sturrock) MWF 11


3 units, Win (Sturrock) MWF 11
362. Introduction to Astrophysics III: Stars and Galaxies—(Enroll in Engineering 209.) Radiative and convective energy transport; equation of state; opacity; nuclear processes. Hertzsprung-Russell diagram; stellar evolution. Galactic morphology; structure of our galaxy; spiral arms. Radio galaxies; quasistellar radio sources; cosmic rays. Prerequisite: Physics 220, or Electrical Engineering 244, or Aeronautics and Astronautics 285A, or equivalent. Physics 132 desirable.

3 units, Spr (Sturrock) MWF 11

363. Astrophysics Seminar—(Enroll in Engineering 210.) Discussion of research problems and current literature in astrophysics with contributions by faculty, students and outside specialists.

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

375. Lattice Dynamics—A study of the vibrational properties of harmonic crystals, disordered alloys and anharmonic systems. While formalism, realistic interaction models and methods of observation will be of primary concern, thermodynamic parameters such as specific heat, thermal expansion and thermal conductivity will also be discussed. Prerequisite: introductory courses in solid-state physics and quantum mechanics.

3 units, Win (Bienenstock) MWF 9, alternate years, given 1969–70

376. Theory of Phase Transitions and Critical Phenomena—Modern statistical mechanical treatments of phase transitions and critical phenomena. After an introduction to statistical mechanics, the following topics will be treated: ferromagnetism, alloy order-disorder transitions, condensation and melting. Prerequisites: Physics 171 or Materials Science 222, plus an introduction to quantum mechanics.

3 units, Win (Bienenstock) 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 (Harrison) MWF 10

378. 3 units, Win (Harrison) 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; 378 and 379 may be taken concurrently.

2 units, Spr (Geballe) TTh 3:15

390A. Solid–State Physics Seminar—Discussion of research problems and current literature 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 Molecules—A seminar devoted to the discussion of biological molecules from the standpoint of physics. Research problems and current literature on topics including fluorescence, phosphorescence, spin resonance, Mossbauer techniques, hypochromism, conformational transitions, energy transfer and other transport phenomena.

1 unit, Aut, Win, Spr (Weissbluth)

ART and ARCHITECTURE

Emeriti: Edward McN. Farmer (Professor); Victor M. Arnautoff (Assistant Professor) Chairman: Lorenz Eitner

Professors: Lorenz Eitner, Albert Elsen, Ray N. Faulkner, Matthew S. Kahn, Daniel M. Mendelowitz, Michael Sullivan, Victor K. Thompson

Associate Professors: Keith Boyle, Elliot W. Eisner, Kurt W. Forster, Frank Lobdell, Dwight C. Miller, Nathan Oliveira

Assistant Professors: Gerald M. Ackerman, William Bowman, John-David P. LaPlante, Suzanne Lewis

P. Clark, Gerald Davis, Aaron Green, Heywood Mansergh, Robert C. Peterson, Eldridge T. Spencer, Goodwin B. Steinberg, Walter Stromquist, John Stypula, John C. Worsley, George J. Young; Kathryn I. Stedman (Landscape Architecture); Myron D. Alexander (Law); Dwight A. Coddington (Mechanical Engineering); John T. Law, Bart Lytton, Harry L. Sanders (Planning); David J. Hammond, Isadore Thompson (Structural Engineering)

Principal Adviser to Undergraduate Studio Majors: Keith Boyle
Principal Adviser to Undergraduate Art History Majors: Albert Elsen
Principal Adviser to Undergraduate Architecture Majors: Victor Thompson

Offerings and Facilities

The Department offers courses of study in four areas: (1) in the history of art, (2) in the practice of drawing, painting, sculpture, design and printmaking, (3) in architecture, and (4) in art education. The undergraduate program of the Department is designed to introduce students to the humanistic study of the visual arts. The courses are intended to increase the students' understanding of the meaning and purpose of the arts, of their historical development, their role in society, and their relationship to such other humanistic disciplines as literature, music, and philosophy. The work in classroom and studio is designed to intensify the students' visual perception of the formal and expressive means of art and to encourage insight into a variety of technical processes. The collections of the Stanford Museum and the exhibitions program of the Stanford Gallery supplement the regular academic program of the Department.

Programs of Study

Undergraduates may major in Art History, the Practice of Art (Studio), or in Architecture studies. A freshman or sophomore intending to major in one of these areas should consult with an adviser appointed by the Department in order to plan his course of study.

Graduate programs are offered in Art History, Studio (including Product Design), Architecture, and Art Education.

All graduate students are required to take an active part in the practical work of the Department, as teaching assistants, research assistants, or in other capacities, to be determined in consultation with their advisers.

During the first two years of their resident graduate work at Stanford, students are required to live in the immediate proximity of the University. Exceptions may be granted only on the basis of a petition formally submitted to the 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
39 units in courses in art history numbered over 100
3 units each—Art 40 and Art 50
Total units—48

Each undergraduate major in the history of art shall, in consultation with his adviser, select a coherent and substantial minor program in anthropology, classics, history, literature, philosophy, or some other area approved by the adviser. He shall, furthermore, take at least one year of beginning German, French, or Italian, or present proof of reading ability in one of these languages.

Master of Arts

The University's basic requirements for the Master's degree are set forth in the section "Degrees" in this bulletin. The following are Departmental requirements:

Admission to Candidacy—Completion of the University's requirements for a Bachelor of Arts degree in the history of art, or an approximately equivalent training, is required of students entering a program of study for the Master of Arts. Provisional enrollment may be permitted, however, in cases in which previous training has been deficient, with the understanding that the deficiency will be remedied in advance of Departmental approval of candidacy.

Recommendation for the Degree—To be recommended to the University Committee on the Graduate Division for the degree of Master of Arts in the history of art, the student must have satisfied the following requirements:

1. Completion of a minimum of three full quarters of graduate work in residence or its equivalent at this University.
2. Completion of a total of at least 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 periods in the history of art (the student may choose from the following: Ancient, Medieval, Renaissance, Baroque, Modern, and 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 the Graduate Division. 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 industrial design, undertaken on a collaborative basis with the Department of Mechanical Engineering as described in the section, "Industrial Design"; (2) concentrated study in Graphic or Three-Dimensional Design within the framework of the studio program where students enroll in advanced courses oriented toward their professional objectives. Students in both programs are expected to participate in an advanced design seminar where critiques are based upon creative student work from varied design disciplines.

Admission to candidacy for the degree of Master of Arts is based on:

1. The equivalent of a Bachelor of Arts degree in art at this University.
2. A grade point average of B— in at least 65 units of undergraduate work in art.
3. Formal admission to candidacy granted by the University Committee on the Graduate Division.
4. Candidates for admission must submit six or more slides of paintings, lithographs or sculpture and six or more slides of drawings. Design candidates must submit a portfolio of twelve or more slides or photos of creative work, including original work when possible.
5. Applications and portfolios for the studio program must be submitted by February 1. They will be reviewed the first week of February. Students accepted are admitted for the beginning of the following Autumn Quarter only; no applicants for mid-year entrance will be considered.

The requirements for the degree of Master of Arts are:

1. Painting, sculpture and lithography students must participate in a weekly seminar in which their work is criticized and discussed in detail.
2. Completion of a minimum of three full quarters of graduate work in residence or its equivalent at this University.
3. Completion of the equivalent of 45 units of selected third- and fourth-year undergraduate and graduate courses. At least 30 units of this work must be in art with a grade of B or above and distributed as follows:
   a) 18 units in one of the four areas of concentration: (a) Drawing and Painting, (b) Sculpture, (c) Design, or (d) Printmaking.
   b) A total of 6 units in the remaining areas of concentration.
   c) 6 units of work on thesis or creative project.

The studio faculty reserves the right to make use of graduate painting, sculpture, and lithographs in exhibitions serving the interests of the Graduate Program, and shall retain for its permanent collection one work by each graduate at the time of his graduation.

PRODUCT DESIGN

A Master of Arts in Art with emphasis in Product Design is offered jointly by the Department of Art and Architecture and the School of Engineering (Department of Mechanical Engineering). For information concerning the requirements for this program, please direct inquiries to the Chairman of the Design Committee of this Department.

ART EDUCATION

MASTER OF ARTS IN TEACHING

The degree of Master of Arts in Teaching is offered by this Department and the School
of Education for teachers who wish further to strengthen their academic preparation. The candidate must have a teaching credential. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education. Detailed requirements are outlined in the section "School of Education" in this bulletin.

**DOCTOR OF EDUCATION AND DOCTOR OF PHILOSOPHY IN EDUCATION**

In cooperation with the School of Education the Department offers work leading to the Ed.D. and Ph.D. degrees with a concentration in Art Education. Consult the section on "Graduate Degrees" listed in the "School of Education" section in this bulletin. Complete information concerning these degrees may be secured from the Office of the Dean of the School of Education.

**TEACHING CREDENTIAL (SECONDARY)**

A program leading to a Master of Arts degree with a specialization in art education and/or including a California Teaching Credential in art is offered 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.

**DIVISION OF ARCHITECTURE**

**OFFERINGS AND FACILITIES**

The program in architecture is basically concerned with providing the opportunity for a broad educational background followed by professional training to prepare the student for the practice of architecture. The program in architecture believes that the student should be technically trained in order that he may be immediately useful to the profession upon graduation. It further believes that the architect should be so educated in the broader aspects of humanities and sciences, and engineering that his own specialization will become a meaningful element in the total picture of contemporary culture. In addition to the small full-time staff, lecturers from the professional fields of architecture, city planning and engineering serve the University on a part-time basis and contribute the inspiration and leadership of the program. Facilities include individually assigned drafting space, workshop, and materials laboratory. Approximately 15 local architects' offices cooperate to serve the students as teaching offices. These include the offices of George L. Cody; Walter E. Eagle; Ehrlich, Heft and Rominger; Albert H. Hoover and Associates; Richard P. Hopkins; Paul James Huston; Ernest J. Kump Associates; John T. Law; Hawley and Peterson; Robert C. Peterson; Sabin and O'Neal; Spencer, Lee and Busse; Edward D. Stone; Clark, Stromquist and Potter; Worsley and Rankin.

**PROGRAMS OF STUDY**

Two programs of study are offered. A pre-professional program at the undergraduate level leading to the degree of Bachelor of Arts in architecture. The second program of study is professional in nature and is offered at the graduate level. It leads to the degree of Master of Architecture.

**BACHELOR OF ARTS**

The undergraduate curriculum provides the opportunity for a broad liberal education combined with a pre-professional course of studies. The student is introduced to the following three design disciplines which form a major part of environmental design: urban design, architecture, landscape architecture and interior design. The intent of the program is to provide the student with an awareness of the nature of these disciplines and their relationship. The program requires approximately two years of general educational requirements and two years of a pre-professional program.

**Required Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture 71, 171, 181, 182</td>
<td>13</td>
</tr>
<tr>
<td>Art 5, 10, 60, 160</td>
<td>12</td>
</tr>
<tr>
<td>Civil Engineering 20, 170, 180, 181, 182, 183, 190, Computer Science 126, Engineering 11, 15, Mathematics 41, 42, 43</td>
<td>46</td>
</tr>
<tr>
<td>Urban Design 192, 193</td>
<td>6</td>
</tr>
<tr>
<td>Mechanical Engineering 112A,B,C, Physics 21</td>
<td>13</td>
</tr>
</tbody>
</table>

**MASTER OF ARCHITECTURE**

A two-year graduate program which prepares the student for the practice of architecture. In addition to the required professional courses, each student varies his program to suit individual needs by electing courses from the four areas of minor specialization: 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 approximately equivalent training is required. Provisional enrollment may be granted to students deficient in these requirements provided that these deficiencies will be removed prior to approval of candidacy. Applicants shall have a grade point average of B.

Recommendation for the Degree—To be recommended to the University Committee on the Graduate Division for the degree of Master of Architecture, the student shall have completed the following courses with a grade point average of B.

<table>
<thead>
<tr>
<th>Required Courses</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Design 395, 396, 401, 402</td>
<td>19</td>
</tr>
<tr>
<td>Civil Engineering 223, 224, 233, 243</td>
<td>12</td>
</tr>
<tr>
<td>Engineering-Economic Planning 210, 211</td>
<td>6</td>
</tr>
</tbody>
</table>

Minor Specialization—10 units selected with approval of adviser from areas of civil engineering, engineering-economics systems, mechanical engineering, political science, and sociology.

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 Reformation.

3 units, Aut (Forster) given 1970–71

111B. Northern Renaissance Art II—Art and architecture in France during the sixteenth century with emphasis on the First School of Fontainebleau.

3 units, Win (Forster) given 1970–71

111C. Art in the Lowlands During Fifteenth and Sixteenth Centuries.

3 units (Staff)

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.

115A. Art in Italy During the Seventeenth Century—Important developments in painting and sculpture with emphasis on Bologna and Rome; major trends of style and iconography.

3 units, Win (Miller)

115B. Painting in the Low Countries and France During the Seventeenth Century—Rubens and the Flemish Baroque; Dutch Painting; Poussin and French Classicism; the Art of the Court of Louis XIV.

3 units, Spr (Miller)


3 units (Miller) given 1969–70
120A. Modern Art I — The movements of Classicism, Romanticism, and Naturalism (1770-1850) in France, England, Germany and Spain; with particular emphasis on painting; David and his School; Goya; Friedrich; Runge; the Nazarenes; Constable and Turner; Gericault; Delacroix; and Ingres.
3 units, Aut (Eitner)

120B. Modern Art II — European art in the second half of the nineteenth century; the painters of Barbizon; Courbet and the Realist Movement; Neo-Romantic and Neo-Classical Counter-Currents in France, England and Germany; Manet and Degas; the Impressionists.
3 units, Win (Eitner, Elsen, Ackerman)

3 units (Eitner, Elsen)

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, Cabo, 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 (Mendelowitz)

#130B. American Art II — American art and architecture during the nineteenth century.
3 units, Win (Mendelowitz)

#130C. American Art III — Architecture, sculpture, painting and the household arts from 1914 to today.
3 units, Spr (Mendelowitz)

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

3 units, any quarter (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: Introduction to Italian Renaissance Studies I — Selected problems in research — monuments, conservation, archival work, style, iconography, programs and patronage, monographic and systematic studies.
3 units, Aut (Forster)

211B. Seminar: Introduction to Italian Renaissance Studies II — Continuation of Art 211A: Autumn and Winter quarters must be taken together.
3 units, Win (Forster)

211C. Seminar: The Historiography of the Italian Renaissance — Readings and critical examination of the literature from Vasari to the present.
3 units, Spr (Forster)

3 units, any quarter (Miller)

216. Seminar in Baroque Art.
3 units, any quarter (Miller)

3 units, any quarter (Ackerman, Eitner, Elsen)

221. Seminar in Nineteenth Century Art.
3 units, any quarter (Ackerman, Eitner, Elsen)

221A. Studies in Modern Painting from 1890–1914.
3 units, any quarter (Elsen)

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)

223A. Studies in the Beginnings of Modern Sculpture I.
3 units, any quarter (Elsen)

223B. Studies in Modern Sculpture II.
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.
3 units, Win (Forster-Hahn)

224B. Seminar: Modern Art, Der Blaue Reiter — Continuation of Art 224A: Winter and spring quarters must be taken together.
3 units, Spr (Forster-Hahn)

3 units, Aut, Win, Spr (LaPlante)

3 units, Aut, Win, Spr (Sullivan)

3 units, Aut, Win, Spr (Mendelowitz)

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)

237A. Research Seminar: Introduction to Methods of Cataloguing — Select originals in the Stanford area will be studied and catalogued.
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

Any quarter (Staff) by arrangement

Any quarter (Staff) by arrangement

RELATED COURSES

Philosophy of Art — See Philosophy 8.

Greek Mythology in Greek Art — See Classics #101.

Classical Greek Painting and Sculpture — See Classics #102.
Hellenistic Painting and Sculpture — 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 Black-Figure Vases — See Classics (Greek) 211.

INTERDEPARTMENTAL SEMINAR
Senior Seminar in Humanities — The Relationship Between the Arts—See Humanities 192.

COURSES IN PRACTICE OF ART (STUDIO)

BASIC COURSES

#40. Basic Drawing and Painting—Basic drawing and painting concepts introduced through charcoal, pencil, pen and ink, colored chalk, and opaque watercolor.
2 units, Aut, Win, Spr (Staff)

#50. Basic Sculpture — Introduction to sculpture through the use of clay, wire, wood construction, and plastic materials.
3 units, Aut, Win, Spr (Staff)

#60. Basic Design—Basic laboratory problems in two- and three-dimensional design.
3 units, Aut, Win, Spr (Staff)

INTERMEDIATE COURSES

140. Drawing I—Life drawing and composition. Prerequisite: 40. May be repeated for credit.
3 units, Aut, Win, Spr (Oliveira)

141. Drawing II — Life drawing and composition. Prerequisite: 40. May be repeated for credit.
3 units, Aut, Win, Spr (Lobdell)

145. Painting I — Introduction to painting procedure. Still life, landscape, and figure studies in oil, watercolor, and varied media. Prerequisite: 40.
3 units, Aut, Win, Spr (Lobdell)

146. Painting II — Extended problems in pictorial organization and content, with stress on oil painting. Prerequisite: 145. May be repeated for credit.
3 units, Aut, Win, Spr (Lobdell)

148. Lithography — Introduction to lithography. Prerequisite: 140. May be repeated for credit.
3 units, Aut, Win, Spr (Oliveira)

150. Sculpture I — Introduction to figure modeling and human anatomy. Prerequisite: 50.
3 units, Aut, Win, Spr (Staff)

151. Sculpture II—Introduction to carving, welding, and construction. Prerequisite: 50.
3 units, Aut, Win, Spr (Staff)

160. Design I—Two- and three-dimensional laboratory problems basic to key areas of design practice (work in wood, paper, paint, metal, etc.). Prerequisite: 60.
3 or more units, Aut, Win, Spr (Kahn, 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

245. Watercolor Landscape Painting—Prerequisite: 145.
4 units, Spr (Mendelowitz)

248. Advanced Lithography.
Aut, Win, Spr (Oliveira) by arrangement

250. Individual Work—Sculpture.
Aut, Win, Spr (Staff) by arrangement

251. Advanced Figure Modeling—Prerequisite: 150.
3 units, Aut, Win, Spr (Staff)
252. Advanced Carving, Modeling, and Construction — Prerequisites: 150 and 151.
3 units, Aut, Win, Spr (Staff)

253. Metal Casting—By consent only.
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.
   3 units, Win (B. Clark) W 11 and F 1:15-5:05

287. Environmental Technology I—Design and specification of building water supply and sanitation.
   2 units, Aut (Coddington) Th 7:30-9:30 p.m.

   2 units, Win (Coddington) Th 7:30-9:30 p.m.

   2 units, Spr (Coddington) Th 7:30-9:30 p.m.

291. Internship I.
   2 units, Aut (Staff) M 1:15-5:05 and W 3:15-5:05

292. Internship II.
   2 units, Win (Staff) M 1:15-5:05 and W 1:15-3:05

293. Internship III.
   2 units, Spr (Staff) M 1:15-5:05 and W 3:15-5:05

390. Independent Study.
   Aut, Win, Spr (Staff) by arrangement

395. Urban Design—Lectures, laboratory work, case study design projects and field trips.
   5 units, Aut (V. Thompson, Callister, Alexander) TTh 1:15-4:05

396. Community Development Laboratory—A case study project involving and serving an actual city, county or community. A multidisciplinary course open to a limited number of graduate students in architecture, business administration, engineering, law and political science.
   4 units, Win (Peterson, Law, Lytton) M 11 and W 3:15-5:05

   5 units, Win (V. Thompson, Stypula, Worsley) TTh 3:15-5:05

402. Master's Project II—Continuation of 401.
   5 units, Spr (V. Thompson, Stromquist, I. Thompson) TTh 1:15-3:05 and alternate W 7:30-9:30 p.m.

COURSES IN ART EDUCATION

213. Foundations of Aesthetic Education—(Enroll in Education 213.)

219. Artistic Development of the Child—(Enroll in Education 219.)


380. Curriculum Theory in Art Education—(Enroll in Education 380.)

480. Directed Reading—(Enroll in Education 480.)

490. Directed Research—(Enroll in Education 490.)

COURSES IN URBAN DESIGN

UNDERGRADUATE COURSES

190. Independent Study.
   Aut, Win, Spr (Staff) by arrangement

192. The Art of Building Cities—History and theory of city planning. Legal background. Case study projects in urban design.
   3 units, Spr (V. Thompson, Steinberg, Alexander) TTh 10-12

193. Site and Landscape Design—Grading, drainage, topography, landscape and plant materials.
   3 units, Spr (Staff, Faulkner, Stedman) TTh 3:15-5:05

GRADUATE COURSES

390. Independent Study.
   Aut, Win, Spr (Staff) by arrangement

395. Urban Design—Lectures, laboratory work, case study design projects and field trips.
   5 units, Aut (V. Thompson, Callister, Alexander) TTh 1:15-4:05

396. Community Development Laboratory—A case study project involving and serving an actual city, county or community. A multidisciplinary course open to a limited number of graduate students in architecture, business administration, engineering, law and political science.
   4 units, Win (Peterson, Law, Lytton) M 11 and W 3:15-5:05

   5 units, Win (V. Thompson, Stypula, Worsley) TTh 3:15-5:05

402. Master's Project II—Continuation of 401.
   5 units, Spr (V. Thompson, Stromquist, I. Thompson) TTh 1:15-3:05 and alternate W 7:30-9:30 p.m.

ASIAN LANGUAGES

Emeritus: Frederic Spiegelberg (Professor)
Chairman: William H. McCullough
Professors: S. Wing Chan, Albert E. Dien, James J. Y. Liu, William H. McCullough,
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. Graduate students registered at Stanford may obtain further information about the scope and na-
structure of the A.M. written examination from the Graduate Adviser.

**Master of Arts: Chinese**

The candidate must:

1. Meet the Department’s requirements for the Bachelor of Arts in Chinese or their equivalent.

2. Complete the following course work:
   - 201, 202, 299; 9 Chinese courses in the Department numbered between 210 and 300;
   - 4 courses, on the upper division or graduate level, in fields such as descriptive linguistics, Chinese history, Chinese philosophy and Chinese art, as approved by the Graduate Adviser.

3. Pass a written examination covering translation from Classical and Modern Chinese; either Chinese poetry and criticism, or Chinese fiction and drama; and one of the following fields: early Chinese history (to the end of the Yuan dynasty), later Chinese history, Chinese philosophy, or Chinese linguistics.

**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, 299; 9 Japanese courses in the Department numbered between 210 and 270;
   - 4 courses on the upper division or graduate level, in fields such as descriptive linguistics, Japanese history, Chinese history, and Chinese literature, as approved by the Graduate Adviser.

3. Pass a written examination covering translation from Classical and Modern Japanese; either Japanese prose literature or Japanese poetry and drama; and one of the following fields: Japanese history, Chinese poetry and criticism, Chinese fiction and drama, Chinese philosophy.

**Doctor of Philosophy**

The Doctor of Philosophy degree is granted in Chinese and in Japanese. Candidates for the degree are expected to acquire a thorough familiarity with Chinese or Japanese 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 passing a written examination. Students must pass this examination before proceeding to the course work described below.

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 East Asian language. If the candidate’s field is Chinese, he will be examined on his ability to read Modern Japanese (on the level of 103) and on his knowledge of and ability to use Japanese reference works of importance in Chinese studies. If his field is Japanese, he will be examined on his ability to read Classical Chinese (on the level of 103) and on his knowledge of and ability to use Chinese reference works of importance in Japanese studies.

5. He must pass a written examination in two fields other than the field chosen for the A.M. written examination. The candidate for the degree in Chinese must choose two of the following: Chinese poetry and criticism, Chinese fiction and drama, early Chinese history, later Chinese history, Chinese philosophy, Chinese linguistics, Chinese Buddhism, Japanese literature. The candidate for the degree in Japanese must choose two of the following: Japanese prose literature, Japanese poetry and drama, Japanese history, Japanese religion, early Chinese history, Chinese philosophy, Chinese poetry and criticism, Chinese fiction and drama.

6. He must also demonstrate fluency in the modern spoken language of his field.

**University oral examination**—General regulations governing the oral examination
will be found in the section "Degrees" in this bulletin. The candidate must be prepared in his field of concentration and in three related fields, as established in consultation with the Graduate Adviser. One of the related fields will normally add a comparative dimension in a Western subject.

Dissertation—The candidate will write a dissertation demonstrating his ability to 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

#151. Chinese Poetry and Drama. 4 units, Aut (Liu) MWF 11

#152. Chinese Fiction. 4 units, Win (Wang) MWF 11

#154. Japanese Prose Literature. 4 units, Aut (Young) MWF 11

#155. Japanese Poetry and Drama. 4 units, Win (Yuasa) MWF 11

193. Early Japanese History—Japanese history to a.d. 1600. 3 to 5 units, Spr (W. McCullough) 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) MTWThF 9
2. 5 units, Win (Kao) MTWThF 9
3. 5 units, Spr (Kao) MTWThF 9

5. Intensive First-Year Modern Chinese—Equivalent to 1, 2, 3 combined. Prerequisite: consent of instructor. 15 units, Sum (——) MTWThF 8–12

#21, 22, 23. Second-Year Modern Chinese—Further study in grammar, reading, conversation, composition. Prerequisite: 3 or equivalent.
21. 5 units, Aut (Chuang) MTWThF 9
22. 5 units, Win (Chuang) MTWThF 9
23. 5 units, Spr (Chuang) MTWThF 9

25. Intensive Second-Year Modern Chinese—Equivalent to 21, 22, 23 combined. Prerequisites: 3 or equivalent and consent of instructor. 15 units, Sum (——) MTWThF 8–12

31, 32, 33. Intermediate Conversation—Prerequisite: 3 or equivalent.
31. 2 units, Aut (Chuang) TTh 11
32. 2 units, Win (Chuang) TTh 11
33. 2 units, Spr (Chuang) TTh 11

41, 42, 43. Intensive Modern Chinese—Intensive study in grammar, reading, conver-
sation, and composition, the equivalent of first-year and second-year Modern Chinese combined. The successful completion of this course will qualify the student to take 101.

41. 10 units, Aut (Chuang, Kao)  
MTWThF 9 and 1:15
42. 10 units, Win (Chuang, Kao)  
MTWThF 9 and 1:15
43. 10 units, Spr (Chuang, Wang, Kao)  
MTWThF 9 and 1:15

ADVANCED

101, 102, 103. Introduction to Classical Chinese—Reading, syntax, composition. Prerequisite: 23 or equivalent.

101. 5 units, Aut (Nivison) MTWThF 9  
102. 5 units, Win (Dien) MTWThF 9  
103. 5 units, Spr (Wang) MTWThF 9

105. Intensive Introduction to Classical Chinese—Equivalent to 101, 102, 103 combined. Prerequisite: 23 or equivalent. Consent of instructor necessary.

15 units, Sum (——) MTWThF 9-12

121, 122, 123. Advanced Conversation — Prerequisite: 33 or equivalent.

121. 2 units, Aut (Kao) TTTh 1:15  
122. 2 units, Win (Kao) TTTh 1:15  
123. 2 units, Spr (Kao) TTTh 1:15

199. Individual Reading in Chinese — (Asian Language majors only.) Prerequisite: 101 or equivalent.

4 units, Win, Spr (Staff) by arrangement

GRADUATE

200. Directed Reading in Chinese—Prerequisite: 103 or equivalent.

1 to 3 units, any quarter (Staff) by arrangement


201. 3 units, Aut (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 permission of the instructor, the courses may be repeated for credit in a consecutive year. Prerequisite: 103 or consent of instructor.

211. 4 units, Aut (Chan) MWF 1:15  
212. 4 units, Win (Chan) MWF 1:15  
213. 4 units, Spr (Chan) MWF 1:15  
(given annually except 1969-70)

215. Modern Expository Chinese—Scholarly and journalistic writings in Chinese. Equivalent to 211, 212, 213, combined. Prerequisite: 23 or equivalent.

15 units, Sum (——) MTWThF 9-12

251, 252. Chinese Philosophical Texts.

251. 4 units, Win (Nivison) WF 2:15-4:05  
252. 4 units, Spr (Nivison) by arrangement

254. Chinese Historical Texts.

4 units, Win (Dien) by arrangement

256, 257. T'ang and Sung Prose Literature.

256. 4 units, Win (Liu) by arrangement  
257. 4 units, Spr (Liu) by arrangement

261, 262. Chinese Poetry — Prerequisite: 251, 254, or equivalent.

261. 4 units, Aut (Liu) WF 2:15-4:05  
262. 4 units, Win (Liu) by arrangement


271. 4 units, Aut (Wang) by arrangement  
272. 4 units, Win (Wang) by arrangement

281, 282. Modern Chinese Literature—Prerequisite: 213 or equivalent.

281. 4 units, Aut (Chan) TTTh 2:15-4:05  
282. 4 units, Win (Chan) TTTh 2:15-4:05


4 units, Spr (Kao) TTTh 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, Lewis, Van Slyke) by arrangement
II. COURSES IN JAPANESE

#1, 2, 3. First-Year Modern Japanese — Conversation, grammar, reading, elementary composition.
   1. 5 units, Aut (Sakamoto) MTWThF 9
   2. 5 units, Win (Sakamoto) MTWThF 9
   3. 5 units, Spr (Sakamoto) MTWThF 9

5. Intensive First-Year Modern Japanese — Equivalent to 1, 2, 3 combined. Prerequisite: consent of instructor.
   15 units, Sum (—) MTWThF 8–12

#21, 22, 23. Second-Year Modern Japanese — Further instruction and practice in conversation, grammar, reading, and composition. Prerequisite: 3 or equivalent.
   21. 5 units, Aut (Kubota) MTWThF 9
   22. 5 units, Win (Kubota) MTWThF 9
   23. 5 units, Spr (Kubota) MTWThF 9

25. Intensive Second-Year Modern Japanese — Equivalent to 21, 22, 23 combined. Prerequisite: 3 or equivalent.
   15 units, Sum (—) MTWThF 8–12

31, 32, 33. Intermediate Conversation — Prerequisite: 3 or equivalent.
   31. 2 units, Aut (Sakamoto) TTh 11
   32. 2 units, Win (Sakamoto) TTh 11
   33. 2 units, Spr (Sakamoto) TTh 11

41, 42, 43. Intensive Modern Japanese — Intensive study in grammar, reading, conversation, and composition, the equivalent of first-year and second-year Modern Japanese combined. The successful completion of this course will qualify the student to take 101.
   41. 10 units, Aut (Kubota, Sakamoto) MTWThF 8:00 and 1:15
   42. 10 units, Win (Kubota, Sakamoto) MTWThF 8:00 and 1:15
   43. 10 units, Spr (Kubota, Sakamoto) MTWThF 8:00 and 1:15

ADVANCED

101, 102, 103. Modern Written Japanese — Reading texts representative of various modern written styles. Prerequisite: 23 or equivalent.
   101. 5 units, Aut (Young) MTWThF 9
   102. 5 units, Win (H. McCullough) MTWThF 9
   103. 5 units, Spr (W. McCullough) MTWThF 9

105. Intensive Modern Written Japanese — Equivalent to 101, 102, 103 combined. Prerequisite: 23 or equivalent.
   15 units, Sum (—) MTWThF 9–12

121, 122, 123. Advanced Conversation — Prerequisite: 33 or equivalent.
   121. 2 units, Aut (Kubota) TTh 1:15
   122. 2 units, Win (Kubota) TTh 1:15
   123. 2 units, Spr (Kubota) TTh 1:15

199. Individual Reading in Japanese — (Asian Languages majors only.) Prerequisite: 101 or equivalent.
   4 units, Win, Spr (Staff) by arrangement

GRADUATE

200. Directed Reading in Japanese — Prerequisite: 103 or equivalent.
   1 to 3 units, any quarter (Staff) by arrangement

   201. 3 units, Aut (W. McCullough) M 2:15–4:05
   202. 3 units, Win (W. McCullough) M 2:15–4:05

   15 units, Sum (—) MTWThF 9–12

   241. 4 units, Aut (H. McCullough) TTh 2:15–4:05
   242. 4 units, Win (Young) TTh 2:15–4:05
   243. 4 units, Spr (Young) TTh 2:15–4:05

246, 247. Japanese Historical Texts — Prerequisite: 243 or equivalent.
   246. 4 units, Aut (W. McCullough) by arrangement
247. 4 units, Win (H. McCullough) 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.
251. 4 units, Aut, Spr (Yuasa) WF 2:15-4:05

261, 262. Classical Japanese Poetry — Prerequisite: 243 or equivalent.
261. 4 units, Win (Yuasa) by arrangement
262. 4 units, Spr (Yuasa) 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 (given annually except 1969-70)

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, Senior Colloquia, Social Sciences (Special Program), Sociology.

BIOLOGICAL SCIENCES

Chairman: Donald Kennedy (on leave 1969-70)


Associate Professors: Philip C. Hanawalt, (Director of Graduate Studies), Harold A. Mooney (Director of Undergraduate Studies), Peter H. Raven (on leave 1969-70), Norman K. Wessells, Dow O. Woodward. By Courtesy: Olaf E. Björkman, David C. Fork


Instructors: Marcia K. Allen, Elizabeth M. Center


Research Biologists: Isabella A. Abbott, Dorothy Newmeyer, Virginia M. Page

ORGANIZATION
The Department of Biological Sciences comprises facilities and personnel housed in the new Herrin Laboratories and Herrin Hall, the Museum Building on the campus, and in the Hopkins Marine Station in Pacific Grove on Monterey Bay.

The Department provides: (1) courses 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 degrees of Master of Arts and Doctor of Philosophy.

A brochure of special interest to prospective candidates for advanced degrees, Graduate Study in the Biological Sciences at Stanford University, is available upon request to the Department. The brochure describes the areas of specialization represented in the Department, facilities for study and research, and the opportunities for financial aid available to graduate students. Interest-
ed students may also wish to consult the departments of Genetics, Medical Microbiology, Anatomy, Physiology, Biochemistry, Pharmacology, Psychology, and the Neurological Sciences program, all of which also conduct graduate programs.

**Programs of Study**

**Bachelor of Arts**

Candidates for the degree of Bachelor of Arts must complete: (1) a group of specified core courses in biology or their equivalents, and (2) sufficient units of elective courses in the biological sciences or closely related fields to make, when added to the units taken in the core curriculum, a total of 40 units. Elective courses may be selected from the offerings in the Department of Biological Sciences or from a list of courses in other departments (see Note 1 below). These elective courses may be chosen with a view to obtaining either depth of training through advanced work in a particular field of specialization or breadth of training through exploration of various fields of biology. Courses included under “1” and “2” must be completed with an average grade of not less than C for those units taken at Stanford as well as for the total program of units.

**Required Core Courses in Biology**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>Fundamentals of Biology</td>
<td>5</td>
</tr>
<tr>
<td>11.</td>
<td>Plants as Organisms</td>
<td>5</td>
</tr>
<tr>
<td>12.</td>
<td>Animals as Organisms</td>
<td>5</td>
</tr>
<tr>
<td>13.</td>
<td>Molecular Biology</td>
<td>3 or 6</td>
</tr>
<tr>
<td>14.</td>
<td>Cell Physiology</td>
<td>5</td>
</tr>
<tr>
<td>15.</td>
<td>Population Biology</td>
<td>4 or 5</td>
</tr>
</tbody>
</table>

**Required Courses in Cognate Fields**

A year (three quarters) of General Chemistry

A half year (two quarters) of Organic Chemistry

A year (three quarters) of General Physics Mathematics through Calculus

It is expected that many students will meet a portion of these requirements by advanced placement on the basis of their high school education. The following Stanford courses fulfill these requirements: Chemistry 1, 2, and 3, or 4 and 5; Chemistry 121 and 123, or 119; Physics 21, 23, and 29; and Mathematics 10, 11, 21, 22, and 23, or 41, 42, and 43. It is strongly recommended that students majoring in the Department of Biological Sciences complete one year of a modern European language, preferably German.

**Typical Schedule for a Four-Year Minimum Program**

**First Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 1, 2, 3,</td>
<td>General Chemistry</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>English 1, 2, 3.</td>
<td>Freshman English</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>History 1, 2, 3.</td>
<td>Western Civilization</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Math. 10, 11, 21.</td>
<td>Analytic Geometry and Calculus</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Group Activities</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Totals .......................... 14 14 15

**Second Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology 10.</td>
<td>Fundamentals of Biology</td>
<td>5</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Biology 11.</td>
<td>Plants as Organisms</td>
<td>—</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>Biology 12.</td>
<td>Animals as Organisms</td>
<td>—</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>Chem. 121, 123.</td>
<td>Organic Chemistry</td>
<td>3</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Math. 22, 23.</td>
<td>Analytic Geometry and Calculus</td>
<td>3</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>German 1, 2, 3.</td>
<td>Introductory German</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Social Science</td>
<td></td>
<td>—</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>Electives (See Note 1)</td>
<td></td>
<td>—</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Group Activities</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Totals .......................... 15 15 17

**Third Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology 113.</td>
<td>Molecular Biology</td>
<td>—</td>
<td>6</td>
<td>(3)</td>
</tr>
<tr>
<td>Biology 114.</td>
<td>Cell Physiology</td>
<td>—</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>Biology 115.</td>
<td>Population Biology</td>
<td>5(4)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Physics 21, 23, 29.</td>
<td>Introductory Physics</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Humanities</td>
<td></td>
<td>4</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>Social Science</td>
<td></td>
<td>—</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>Electives (See Note 1)</td>
<td></td>
<td>3</td>
<td>3</td>
<td>—</td>
</tr>
</tbody>
</table>

Totals .......................... 16 16 15

**Fourth Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electives (See Note 1)</td>
<td></td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

**Note 1.**—Elective courses may be chosen from those offered by the Department of Biological Sciences or by other departments of the University. Courses offered by other departments which may be of interest to biology majors include: Geology 112, 115, 119; Anatomy 201, 203, 209, 212; Pathology 210; Biochemistry 200, 201, 202, 211; Genetics 201, 210, 211, 216; Medical Microbiology 101; Psychology 148, 175.

**Senior Honors Program**

(See Biology 198 under “Courses.”) This program is open to seniors or by petition. 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 will lead to graduation "with Departmental Honors."

**PREMEDICAL STUDENTS**

It is recommended that premedical students who are not biology majors take at least the following courses in biology: 10, 11, 12, and 116. For specific requirements of various medical schools, consult departmental Student Affairs Office.

**PRUDENTAL STUDENTS**

The Council on Dental Education has fixed as the minimum basis for admission to an approved dental school the successful completion of two full academic years of work in an accredited college of liberal arts and science. The college course must include at least a year's credit in English, in biology, in physics, and in inorganic chemistry, and a half-year's credit in organic chemistry. All courses in science should include both class and laboratory instruction.

The predental requirement in biology may be fulfilled by taking either Biology 4 and 5, or Biology 10, 11, and 12.

**THE TEACHER'S RECOMMENDATION**

Programs are provided for candidates seeking either (a) the Standard Teaching Credential (Secondary) with a teaching major or a teaching minor in biology, or (b) the Junior College Credential. Candidates holding the A.B. degree may satisfy the requirements for a Standard Secondary Credential by completing approved courses of study in biology and education in a minimum of four quarters of graduate study. Candidates who hold the degree of Master of Arts or Doctor of Philosophy may qualify for a Junior College Credential in Biological Sciences with a teaching major or minor in biological sciences, botany, or zoology. In satisfying the requirements for a teaching credential, the candidate may offer units transferred from other institutions, but at least one course of advanced character should be taken in this Department. For the details of these programs the prospective candidate should consult the statement on credentials in the section "School of Education" in this bulletin, his adviser in the Department of Biological Sciences, and the Credential Secretary in the School of Education.

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and who wish further to strengthen their academic preparation. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education. Detailed requirements for the course are outlined in the School of Education section.

**ADVANCED STUDY AND RESEARCH**

Advanced courses and research are offered to qualified students in the various biological disciplines represented on the campus and at the Hopkins Marine Station by members of the Departmental faculty. Information concerning these research areas, and facilities and financial aid available to graduate students, will be found in the brochure, *Graduate Study in the Biological Sciences at Stanford University* (available upon request to the Department).

It should be noted that graduate programs in specialized areas of biology are offered in other departments on the campus, e.g., Genetics, Physiology, Psychology, Medical Microbiology, Pharmacology, Anatomy, Biochemistry, Neurological Sciences. 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 Departmental secretary.

**DOCTOR OF PHILOSOPHY**

**Preparation for graduate study**—It is expected that students seeking entrance to graduate study in biology ordinarily will have the equivalent of an undergraduate major in biology at Stanford (see above). It is recognized, however, that students trained in zoology or botany departments, or who may wish to concentrate on biological problems after undergraduate training in another science, may require special consideration. Such students will be advised at the time of initial registration as to how they should complete their background training during the first year of graduate study. In addition to the usual basic undergraduate courses in biology, it is recommended that wherever possible preparation for graduate work include courses in chemistry through organic chemistry, general physics, mathematics through calculus, and foreign languages (preferably German and French, at least 2 years).

The Master's degree is not required in order to proceed for a doctorate, although it may be recommended in specific cases.

**Courses required of all Ph.D. candidates**—Each student must take at least three units of work as a graduate under each of four or more Stanford faculty members. Course work to be taken in preparation for the qualifying examination will be determined in consultation with the graduate adviser or the Director of Graduate Studies.

Additional course requirements: As soon as possible after successful completion of the qualifying examination the student should meet with his major professor and dissertation reading committee to determine what (if any) further course requirements are to be met. Additional requirements may be specified by the major professor or the committee at any time during the student's dissertation work. A requirement may be removed only by action of the committee.

**The Ph.D. Qualifying Examination**—Before being recommended for admission to candidacy for the degree of Doctor of Philosophy, the prospective candidate will be required to pass a qualifying examination, normally during the fourth quarter of registration as a graduate student. The qualifying examination is given once a year near the beginning of the autumn quarter. The status of the student remains probationary until this examination is completed, at which time his eligibility to continue work toward the Ph.D. degree is determined on the basis of his total academic performance during the first four quarters of graduate study.

**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.

**Graduate Seminars,** devoted to the discussion of current literature and research in particular fields of biology, are an important means of attaining professional perspective and competence.

**Language Examinations**—Proficiency in reading scientific literature in one foreign language, normally German, is required 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.

**Dissertation**—"A contribution to knowledge and the result of independent work, expressed in satisfactory form." Abstracts of Ph.D. theses are published in **Dissertation Abstracts.**

**The Oral Examination**—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. Students who wish to qualify for this degree will be informed of the requirements on request to the Director of Graduate Studies of the Department.

FINANCIAL SUPPORT FOR GRADUATE STUDY

Successful candidates for graduate admission are assured of support at the national fellowship level for four years, as long as their progress toward the Ph.D. degree is satisfactory.

All prospective Ph.D. candidates, regardless of the source of the financial support, will be expected to gain teaching experience as an integral part of their graduate training. Before completing his degree, each student will be called upon to assist in laboratory instruction for the equivalent of 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. Forms may be obtained by writing to the Director of Graduate Studies of the Department.

Predoctoral Fellowships—Qualified applicants are asked to take the initiative in applying for predoctoral fellowships from the National Science Foundation and the U.S. Public Health Service (Forms and information: National Science Foundation Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. Deadline: Early 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.

BIOLA E SEMINAR

The Biology Seminar meets on most Monday afternoons at 4:15. Topics of current biological interest are presented by speakers from Stanford and from other institutions, and are announced in the weekly Campus Report. Students are urged to attend.

COURSES

The letter "H" following a number indicates that the course is given at the Hopkins Marine Station.

#4, 5. General Biology—Functional mechanisms in microorganisms, plants, and animals; major biological concepts, including historical development, logical or experimental bases.

Primarily for students who do not intend to major in biology, but may serve as a prerequisite to Biology II and subsequent courses leading to fulfillment of degree or premedical requirements. Lectures, laboratory, demonstrations. Enrollment only by signing class lists.


#10. Fundamentals of Biology—A concentrated introduction to biology for those intending to major in the subject and to take
Biology 11–115. Emphasis on fundamental facts, concepts and questions which underlie later, more detailed, consideration in the core curriculum. Readings, lectures, and discussion-demonstrations.


#11. Plants as Organisms—Structure and functions of plants at the organism level. Prerequisite: 10.

5 units, Win (——) MWF 8; lab. (I) TTh 9–12, (II) TTh 2:15–5:05, (III) WF 2:15–4:05

#12. Animals as Organisms — Basic functions of organisms as carried on by animals. Prerequisite: 11.

5 units, Spr (Oliphant, Wessells) MWF 9; lab. (I) TTh 1:15–4:05, (II) WF 1:15–4:05

100H. Marine Algae—Lectures, laboratory, field work on various classes of algae. Prerequisite: one year of biological science at college level.

5 units, Sum (second term) (I. Abbott, Womersley) TThS

101H. Physiology of Algae—Lectures and occasional demonstrations on the physiology of algae. Designed to accompany Course 100H, in which concurrent registration is desirable. Prerequisite: elementary chemistry.

2 units, Sum (second term) (Blinks) TTh 7:30 p.m.

102. Invertebrate Biology—The phylogeny, classification, morphology, physiology, and ecology of invertebrates. Lectures, laboratory, and field trips. Prerequisite: an elementary biology course.

5 units, Spr (Baxter) MWF 8; lab. TTh 1:15–4:05

103. Comparative Histology — Microscopic structure of animal tissues; special reference to vertebrates.

3 units, Aut (Oliphant) TTh 10; lab. Th 1:15–4:05

105. Immunobiology — Principles of immunology as related to certain problems in biology.

2 units, Win (Feigen) TTh 10

111H. Marine Invertebrates — Structure, classification, biology, phylogeny of lower marine invertebrates, echinoderms, protostomates. Prerequisite: an elementary zoology course.

5 units, Sum (first term) (D. Abbott) TThS

112H. Marine Invertebrates—Continuation of 111H, covering molluscs, annelids, arthropods, allied minor phyla. While the two courses form a continuous sequence, either half may be taken separately. Prerequisite: elementary zoology, preferably also 111H.

5 units, Sum (second term) (D. Abbott) TThS

113A. Molecular Biology — The synthesis, function, interactions of the various macromolecular components of cells, with emphasis on molecular genetics. Prerequisites: 114 and organic chemistry.

3 units, Spr (Woodward) MWF 11

113B. Molecular Biology Laboratory—Designed for students planning to attend graduate school or to undertake further research work. Individual research projects are selected by students, and creativity is encouraged in designing and conducting experiments. Prerequisites: 113A or Biochemistry, can be taken concurrently.

3 units, Spr (Woodward) by arrangement

114A. Cell Physiology—Fundamental activities of life as exemplified in plant and animal cells. Prerequisite: 12 and organic chemistry.

5 units, Win (Giese, Hanawalt) MWF 9; lab. (I) T 1:15–4:05, (II) W 1:15–4:05, (III) Th 1:15–4:05, (IV) F 1:15–4:05

114B. Projects in Cell Physiology — Independent experimental studies growing out of the laboratory studies of 114A. May be taken concurrently with 114A or later.

2 units, Win (Giese, Hanawalt, Allen) M 1:15–3:05 and by arrangement

115A. Population Biology—Introduction to the properties of aggregations of organisms. Prerequisites: 10, 11, and 12.

4 units, Aut (Holm, Ehrlich, Mooney, Watt) TThF 11

115B. Population Biology Laboratory—By consent.

1 unit, Aut (Holm, Ehrlich, Mooney) by arrangement

116. Biology of Vertebrates — Structure,
function, development, evolution of vertebrates. Prerequisites: 10, 11, and 12.
3 or 5 units, Aut (Wessells) MWF 9; lab.
(1) TTh 8–11, (II) TTh 1:15–4:05

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, Sum (first term) (Wheeler)

119H. Marine Ecology—Ecological studies of selected marine associations and habitats. Emphasis will be on intertidal ecology. Prerequisites: At least two courses in general biology or zoology. Chemistry and Invertebrate Zoology are recommended. Preference will be given to students registering for both 119H and 120H. The class will meet daily during periods of low tides. Further meetings will be announced, to make a total of 15 meetings.
5 units, Sum (first term) (Wheeler)

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, Sum (second term) (Lee)

124. Comparative Parasitology: Protozoa, Helminths — Principal attention to forms parasitic in man, animals, plants of importance in human economy.
4 units, Spr (Oliphant) TTh 10;
lab. TTh 1:15–4:05

125. Systematics and Ecology of Vascular Plants—Lectures, laboratory, field studies. Prerequisite: 11.
4 or 5 units, Spr (Thomas) WF 1:15;
lab. WF 2:15–5:05; field trips by arrangement

129. The Plant Kingdom: Seed Plants — Structure, development, evolutionary relationships of seed plants. Lectures, laboratory, field trips. Prerequisite: 11.
5 units, Spr (—) MWF 1:15;
lab. WF 2:15–5:05

139. Herpetology I — Lecture, laboratory, field survey of living amphibians, with a synoptic history of herpetology. Prerequisite: consent of instructor.
3 units, Win (Leviton, Myers)
by arrangement

140. Herpetology II — Lecture, laboratory, field survey of living reptiles. Prerequisite: consent of instructor.
3 units, Spr (Leviton) by arrangement

145. Laboratory Techniques in Embryology—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—A lecture and laboratory course surveying developmental patterns, and their experimental modifications, in marine invertebrates, fishes, and algae. Prerequisite: a firm foundation in biology.
5 units, Sum (first term) (Epel) MWF

148H. Comparative and Experimental Embryology—Continuation of 147H: Prerequisite: 147H.
5 units, Sum (second term) (Epel) MWF

150. Evolution and Human Affairs—A synthesis of evolutionary thought with emphasis on the implications for man. Prerequisite: a course in general biology. No credit will be given for 150 following 115A.
3 units, Win (Ehrlich, Holm) MWF 11

151. Evolutionary Genetics—Application of genetics to study of evolution.
2 units, Spr (Regnery) TTh 10, alternate years, given 1969–70

153. The Physiological Basis of Behavior—Properties of neurons and synapses and their relation to integrative processes; sense organs as transducers; information processing in sensory systems; organization of reflexes and the neural analysis of more complex behavior. Prerequisite: 12.
3 units, Win (Wilson) MWF 1:15

156. Introductory Plant Physiology—Principal functions of green plants, including respiratory metabolism, photosynthesis, gas exchange, water and nutrient transport, mineral metabolism, growth, and environmental responses. Prerequisite: 114 and consent of instructor.
5 units, Spr (Ray) MWF 1:15;
lab. MW 2:15–5:05

160. Topics in Population Biology — Interactions of individuals and populations. Prerequisite: 115A.
3 units, Spr (Ehrlich, Holm) MWF 9

174. Zoogeography—Seminar study of geographical distribution, historical migrations
of natural populations of animals. By consent.

2 units, Spr (Leviton, Myers)

175H. Problems in Marine Biology — Field studies, laboratory, lectures, individual problems in marine biology. Designed primarily for undergraduates. Students will be in residence at the Hopkins Marine Station during the entire quarter. Prerequisites: 11 and 12; and Chemistry 1, 2, and 3; and consent of the instructors.

15 units, Spr (D. Abbott, Epel, Gilmartin, Lee, Phillips, Wheeler) MTWThF

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; and Chemistry 1, 2, and 3.

10 units, Sum (second term) (Gilmartin)

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. Prerequisites: 11, 12, 115A, and consent of the instructors.

10 to 15 units, Spr (Mooney, Ehrlich, Holm, Thomas, Watt) by arrangement


4 units (Ehrlich) by arrangement

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 may be counted toward this minimum on the recommendation of the course instructor and with the approval of the Committee on Undergraduate Studies. An essay based on the research must be presented to, and accepted by, both the research director and the Department. The essay will be deposited in the Department Library and in the University Archives. Not more than 6 units of 198 and/or 199 may be applied toward the units of electives required for graduation in Biology.

199. Special Problems. Six units may be counted as elective units.

(Staff) by arrangement

199H. Special Problems.

(Hopkins Marine Station Staff) by arrangement

212. Evolution of the Flowering Plants — Phylogenetic relationships of angiosperms. Prerequisite: 11.

3 units, Win (Raven) MWF 10, alternate years, given 1970–71

213. Viruses — Principles of virus growth, genetics, architecture and assembly. Relation of temperate viruses and other episomes to the host cell. Prerequisite: 113A.

3 units, Aut (Campbell) MWF 9

215. Biosystematics — Current methods of approach to systematic problems in higher plants. Prerequisites: 11 and consent of the 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, 12, 115A, 156, or consent of the instructor.

3 units, Win (Mooney) WF 11; lab F 1:15–4:05

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 autumn quarter in residence at Pacific Grove. Open to matriculated graduate students in biology.

15 units, Aut (Gilmartin) by arrangement
247. Advanced Cell Physiology — Discussion of a selected topic. Prerequisite: 114. By permission. May be repeated for credit.
   3 units, Aut (Giese) M 1:15-3:30

249. Cytogenetics—(Same as Genetics 249.) Principles and modern methods of analysis of major cellular components. The structure and design of chromosomes from bacteriophages to higher organisms. The influence of chromosomal changes in development and evolution. Prerequisites: 4 and 5, or 10, 11 and 12, a knowledge of genetics, and consent of instructor.
   3 units, Aut (Ganesan) MWF 10

250. Molecular Biophysics — A survey of physical approaches to biological problems at the molecular level. Lectures include discussion of intra- and intermolecular forces and their relation to biological structure, physical methods for characterizing macromolecules, the interaction of electromagnetic radiation with biological molecules, isotopic tracer techniques, and classical physics of cellular processes. Open to qualified advanced students upon consent of instructor.
   3 units, Aut (Hanawalt) TTh 10 and T 7:15 p.m.

252. Gene Action—Lectures and discussion of various aspects of gene action and the regulation of enzyme formation. Prerequisite: 113A or Biochemistry 101.
   3 units, Spr (Yanofsky) TTh 9

253. Laboratory in Neurophysiology—Experimental approaches to the electrical properties of neurons, muscle cells, and receptors, and to the organization of central nervous systems. Prerequisites: 114, 115 and consent of the instructor.
   2 units, Aut (Wilson) by arrangement

254. Advanced Topics in Neurobiology — By consent.
   2 units, Spr (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, Chemistry 121 or consent of instructor.
   3 units, Spr (Ponnamperuma) 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, organic chemistry, or consent of the 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. Biochemical Ecology—Readings and discussions on research on the physiological basis of adaptation. By consent of the instructors.
   2 units, Aut (Mooney, Watt) by arrangement

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, discussion and a laboratory project. Prerequisite: 114 and consent of the instructor.
   4 units, Spr (Pittendrigh) by arrangement

260. Seminar in Population Biology—Readings and discussions on research of current or special interest. Prerequisites: 115A and consent of instructors. May be repeated for credit.
   1 unit (Ehrlich, Holm, Mooney, Watt) by arrangement

261H. Comparative Biochemistry of Marine Organisms—Prerequisites: elementary biology and organic chemistry.
   5 units, Sum (first term) (Phillips) MWF

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, Sum (second term) (Giese) TTh

   (Ehrlich, Mooney) by arrangement
BIOLOGICAL SCIENCES

300. Research.
(Staff) by arrangement

300H. Research.
(Hopkins Marine Station Staff) by arrangement

350. Graduate Seminars.
(Staff) by arrangement
See also Senior Colloquia.

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; Mitchel Weissbluth, Associate Professor of Applied Physics; Donald M. Wilson, Professor of Physiology; two student members elected annually by the students from their 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; Mossbauer resonance in iron proteins; phosphorescence of amino acids and peptides; structure of iron-nucleotides by X-ray diffraction; 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; physiology and biomedical engineering; and endocrine control systems.

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.
E.E. 204. Brains, Machines and Mathematics.
Genetics 243. Cytogenetics.
Genetics 309. Selected Topics in Neurobiology.
Radiology 201. Biological and Clinical Effects of Radiation (see Medical School Bulletin.)

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.

Financial support for a limited number of students is provided by a training grant from the National Institute of General Medical Sciences. Students are also encouraged to take the initiative in applying for predoctoral fellowships.

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 two foreign languages selected from French, German, or Russian; or proficiency in one foreign language and one computer language.

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

220B, 221B. 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 the instructor.

220B. 3 units, Win (Jacobs) by arrangement
221B. 3 units, Spr (Jacobs) by arrangement

251B. Biophysical Measurements—Experimental procedures and methods of interpretation with modern biophysical instruments and techniques. Selected laboratory exercises will be arranged to provide experience with several of the following methods (the selection to be determined largely by student interest): Spectrophotometry, light scattering, electron microscopy, nuclear and electron magnetic resonance, electrophoresis, radioactive tracer techniques, ultracentrifugation, etc.

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


2 units, Win (Pattee) by arrangement

299B. Special Problems or Readings—Intensive study of literature on a special topic in biophysics.

Any quarter (Staff) by arrangement

300B. Research.

Any quarter (Staff) by arrangement

DIVISION OF MARINE BIOLOGY AND OCEANOGRAPHY, HOPKINS MARINE STATION

Emeriti: Lawrence R. Blinks, Rolf L. Bolin, Cornelis B. vanNiel (Professors)
Director: John H. Phillips, Jr.
Associate Director: Donald P. Abbott
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.
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.
For detailed descriptions of courses, see listings above under Biological Sciences; also the Hopkins Marine Station Bulletin (issued in March).

First Term

111H. Marine Invertebrates.
5 units (D. Abbott) TThS

117H. Zooplankton.
5 units (Wheeler) MWF

119H. Marine Ecology.
5 units (Lee) meetings scheduled according to tides

147H. Comparative and Experimental Embryology.
5 units (Epel) MWF

176H. Problems in Biological Oceanography.
10 units (Gilmartin)
199H. Special Problems — (See autumn, winter, spring quarters, above.)
   (Staff) by arrangement

261H. Comparative Biochemistry of Marine Organisms.
   5 units (Phillips) MWF

300H. Research — (See autumn, winter, spring quarters, above.)
   (Staff) by arrangement

Second Term

100H. Marine Algae.
   5 units (I. Abbott) TThS

101H. Lectures in Algae Physiology.
   2 units (Blinks) TTh 7:30–9:30 p.m.

112H. Marine Invertebrates—Continuation of 111H.
   5 units (D. Abbott) TThS

120H. Marine Ecology.
   5 units (Lee) meetings scheduled according to tides

148H. Comparative and Experimental Embryology.
   5 units (Epel) MWF

199H. Special Problems—(See under First Term.)
   (Staff) by arrangement

269H. Ecological Physiology.
   5 units (Giese) MWF

300H. Research — (See under First Term.)
   (Staff) by arrangement

DIVISION OF SYSTEMATIC BIOLOGY

Emeriti: Roxana S. Ferris (Curator); Willis H. Rich, Ira L. Wiggins (Professors)
Director: Richard W. Holm
Professors: Paul R. Ehrlich, Richard W. Holm, George S. Myers
Associate Professor: Peter H. Raven
Curators: Paul R. Ehrlich (Entomological Collections), George S. Myers (Zoological Collections), John H. Thomas (Dudley Herbarium)
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 and herpetology, including taxonomy, morphology, ecology, and distribution); and (c) population biology.

DUDLEY HERBARIUM

The Dudley Herbarium, named in honor of Professor William Russel Dudley, is especially rich in material from western North America and offers unusual facilities for critical systematic and distributional studies of the floras of that region. The Harvey Herbarium, comprising about 65,000 sheets, and the herbarium of the late Dr. Herman Knoche, containing over 125,000 sheets, furnish authentic material from Europe and the Mediterranean region. They contain many historical, frequently cited specimens and are of great value to investigators studying plants recently introduced into North America or those closely related to Old World species. The collections of the Dudley Herbarium now number about 700,000 sheets.

ENTOMOLOGICAL COLLECTIONS

The entomological collections are restricted to those being used in particular research projects. No general collections are maintained except for teaching purposes.

ZOOLOGICAL COLLECTIONS

The collection of fishes is one of the largest and most important in the world, its basis
being the material collected by Dr. David Starr Jordan, his associates, and his students. The marine and fresh water fishes of both eastern and western North America, the West Indies, Central America, Japan, eastern China, the Philippines, the Malay Peninsula, Hawaii, and Polynesia are well represented. In addition, there are large bathyal collections from the North Pacific and other parts of the world, as well as extensive series of fishes of Peru, Colombia, the Galapagos Islands, Venezuela, British Guiana, the Amazon, Cameroon, South and East Africa, India, the Malay Archipelago, and Australia.

The herpetological collections contain an extensive representation of the amphibians and reptiles of the West and considerable material from southeastern Asia and tropical America.

CHEMISTRY

Emeriti: Frederick O. Koenig, Philip A. Leighton, J. Murray Luck, J. Pearce Mitchell, Carl R. Noller (Professors)

Chairman: Paul J. Flory
Vice Chairman: Douglas A. Skoog


Associate Professor: John I. Brauman
Assistant Professors: Lawrence J. Altman, Hans C. Andersen, Robert Pecora, Paul G. Simpson, Leonard M. Stephenson

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 to the American Chemical Society or to the B.S. degree with Honors.

Students who have taken the College Board Advanced Placement Examination in Chemistry and receive a composite score of 4 will be excused from Chemistry 1 and 2, or from Chemistry 4. Those receiving composite scores of 5 may be excused from Chemistry 3 or 5 on the recommendation of the Committee on Undergraduate Study.

PROGRAMS OF STUDY

MINIMUM REQUIREMENTS FOR THE BACHELOR OF SCIENCE DEGREE

General studies requirement; the equivalent of 18 units of German, or 12 units of German and 12 units of either French or Russian; Mathematics 10, 11, 21, 22, 23, or 41, 42, 43; Physics 51, 53, 54, 55, 56, 57, 58; Chemistry 1, 2, 3, or 4, 5; 113, 114, 116, 121, 122, 123, 124, 125, 171, 173, 175, 176. In addition Chemistry 153 is strongly recommended. Premedical students majoring in chemistry may substitute Physics 21, 23, 29 for Physics 51-58 provided they also complete Biology 10 (or 4, 5), 11, 12, 116. All candidates for graduation with chemistry as the major subject are required to have a grade point average of at least 2.00 in their chemistry courses. Students interested in attending overseas campuses should consult their advisers as early as possible in order to avoid scheduling problems.

AMERICAN CHEMICAL SOCIETY CERTIFICATION

Students who wish to be certified as having met the minimum requirements of the American Chemical Society for professional training must complete, in addition to the above requirements, Chemistry 153; at least three units from Chemistry 128, 142, or 190; and at least three units from one of the following: Chemistry 141, 183, 185; any chemistry course numbered above 200 for which permission to register has been granted by the instructor; Biochemistry 101; or an advanced course in mathematics or physics.
HONORS PROGRAM

A limited number of undergraduates may be admitted to the Chemistry Honors Program at the beginning of the senior year. Those completing the program satisfactorily will receive the degree of Bachelor of Science in Chemistry with Honors.

To be admitted to the program, the student must have a grade point average of at least 3.0 in all course work in the University and of 3.30 in courses in chemistry, physics, and mathematics. In addition to the minimum requirements for the B.S. degree, the student must complete nine units of Chemistry 190 to be taken three units per quarter for three quarters; 3 or 4 units from Chemistry 126, 153, 183, 185, 221, 223, 225, 241, 251, 253, 255, 271, 273, 275; and nine additional units of courses from the above list or from Biochemistry 101, 102, Mathematics 130, 131, 132, physics lecture courses numbered 100 and higher, or other advanced courses approved by the student's adviser and by the supervisor of his work in Chemistry 190.

Students who wish to be admitted to the Honors Program but who do not meet all of the above formal requirements, may petition the Department for admission.

TYPICAL SCHEDULE FOR FOUR-YEAR MINIMUM PROGRAM

First Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 1, 2, 3. General Chemistry</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>English 1, 2, 3. Freshman English</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>German 1, 2, 3. First-Year German</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Math. 10, 11, 21. Analytic Geometry and Calculus</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>14</strong></td>
<td><strong>14</strong></td>
<td><strong>15</strong></td>
<td></td>
</tr>
</tbody>
</table>

Second Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 121, 123, 125. Organic Chemistry</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Chem. 122, 124. Organic Laboratory</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>German 22, 23. Second-Year Reading</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math. 22, 23. Analytic Geometry and Calculus</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics 51, 53, 54. Mechanics, Sound, Electricity</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Science</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electives (See Note 1)</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>15</strong></td>
<td><strong>16</strong></td>
<td><strong>15</strong></td>
<td></td>
</tr>
</tbody>
</table>

Third Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 113, 114. Quantitative Analysis</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chem. 116. Instrumental Analysis</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fourth Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem. 171, 173, 175. Physical Chemistry</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Chem. 176. Physical Chemistry Laboratory</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History 1, 2, 3. Western Civilization</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Physics 55, 56, 57, 58. Light, Heat, Atomic Physics</td>
<td>5</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Science</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electives (See Note 1)</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>16</strong></td>
<td><strong>17</strong></td>
<td><strong>15</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note 1.—Elective courses may be chosen from any offered by the Chemistry Department or by other departments of the University. Courses offered by other departments that may be of particular interest to chemistry majors include: Ch.E. 10, 130A, 130B, 150, 204; Economics 1; English 102; Mathematics 44, 130, 131, 132; Physics 61, 110, 111, 140; Statistics 110; Geology 1, 25; Engr. 50; Min.E. 105; Mat.Sci. 107; Microbiology 101; Biology 11, 12, 13, 16; Biochem. 101, 102.

TEACHING CREDENTIALS

The requirements for certification to teach chemistry in the secondary schools and junior colleges of California may be ascertained by consulting the section on credentials under “School of Education” in this bulletin and the Credential Secretary of the School of Education.

ADVANCED DEGREES IN CHEMISTRY

GENERAL REQUIREMENTS

Qualifying examinations are given prior to the first week of the autumn quarter. Each new graduate student must take these examinations on entrance. Satisfactory performance is required for permission to continue work for an advanced degree. Thesis research may not be started until the candidate has passed the qualifying examinations. Students who do not complete the remaining requirements for an advanced degree within six years after entrance as a graduate student must repeat and pass the qualifying examinations and must meet any other requirements established by the faculty before the degree will be granted.

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 26, 27, 1969, 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 26, 1969. 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 chemistry ordinarily will be met in German and in French or Russian. Proposals to substitute for French or Russian another language or a program of course work will be considered by the Department on petition by the candidate. Candidates for the Ph.D. degree are required to participate continually in the Department seminar (Chemistry 300), and in the division seminar of the major subject.

All students majoring in inorganic chemistry are required to take (1) Chemistry 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 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 153, 221, 223, 225, 271, and 273.

The chemical physics program is designed solely as a convenience to the unusual chemistry graduate student with an exceptionally strong mathematics and physics background. A student may carry out graduate studies in chemical physics equally well majoring either in physical chemistry or in chemical physics. Students majoring in chemical physics are required to take (1) Chemistry 271, 273, and 275 (or be exempted therefrom by passing special examinations given by the professors in charge of these courses); (2) Chemistry 281, 283, and 285; (3) such other courses as may be recommended by the student's adviser.

Before a candidate may request scheduling of the University oral examination, clearance must be obtained from the chairman of the Department Graduate Study Committee. Conditions that must be fulfilled before clearance is granted vary with the different divisions of the Department and may be ascertained by consulting the chairman of the Committee. The University oral examination may not be taken during the summer quarter except after favorable action on a special petition filed not later than the third week of the spring quarter.

It is the policy of the Department to encourage and support in every possible way the pursuit of research and of other work along advanced lines by qualified students. Information concerning staff members with lists of their recent research publications will be found in the Directory of Graduate Research published by the American Chemical Society.

Minor in Chemistry—Candidates for the degree of Doctor of Philosophy in other departments who wish to minor in chemistry must complete with a grade point average of 3.0 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, Dow Chemical Company Fellowship, Edward Curtis Franklin Fellowship, James W. McBain Memorial Fellowship, Stauffer Chemical Company Fellowship, and Frederick P. Whitaker Fellowship are granted only to graduate students. The William H. Nichols Scholarships, David L. and Lavinia E. Sloan Memorial Scholarship, John Mason 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, electrochemistry and elementary thermodynamics. Prerequisite: 1 or consent of instructor.

5 units, Spr (Loving) TTh 11, Sum (Staff) MWF 11

#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. MWF 8; 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

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 5 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) MWFThFS 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) MWF 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) TThS 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

126. Advanced Organic Preparations—Prerequisites: 124 and 125.

3 units, Aut (Bonner) MWF 1:15-5:05

141. Nuclear Chemistry—(Enroll in Civil Engineering 172.) Properties of nuclei and radioisotopes; nuclear reactions; fission, fusion, reactors, and accelerators; radiation detection and measurement; radiation safety; radiation chemistry, radiotracers, radiotracer analysis, and their applications. Prerequisites: 3 or 5, Mathematics 23, and Physics 57, or equivalent.

3 units, Aut (Kruger) TTh 10

142. Radiochemistry Laboratory—(Enroll in Civil Engineering 176.) Nuclear reactions, radioisotope production, radioactivity genetics and separations, radiotracer methods in laboratory and engineering practices. Prerequisite: Engineering 171, 172, or 175, or consent of instructor.

3 units, Win (Staff) TTh 1:15 and one lab. by arrangement

143. Environmental Radioactivity—(Enroll in Civil Engineering 279.) 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: 3, Civil Engineering 170, or Physics, or equivalent with consent of instructor.

3 units, Aut (Kruger) TTh 11

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

175. Physical Chemistry—Introduction to kinetic theory and statistical mechanics: molecular theory of matter and heat, transport phenomena in gases, Boltzmann distribution law, partition functions for ideal gases. Introduction to chemical kinetics: measurement of rates of reactions, rela-
ship between rate and reaction mechanism, consideration of specific reactions, transition-state theory of reaction rates. Prerequisite: 173.

3 units, Spr (Andersen) 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 (Simpson) lec. T 10; lab. TTh 1:15-4:05 or WF 1:15-4:05

183. Macromolecules — Basic principles from a molecular point of view. Constitution of polymers, molecular weights and molecular weight distributions, resumé of processes of polymerization, configurations of macromolecules, statistical thermodynamics of high elasticity, macromolecular solutions, phase transitions and the solid state. Biological polymers are included among examples throughout. Prerequisites: 171, 173 and 175, or equivalent, or consent of the instructor.

3 units, Win (Flory) TThS 10

185. Macromolecules—Continuation of 183: Prerequisite: 183.

2 units, Spr (Flory) TThS 10

GRADUATE COURSES

Undergraduates may register for chemistry courses numbered 200 and above only if admitted to the Honors Program or if special permission has been granted by the instructor in the course.

221. Advanced Organic Chemistry—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) M 10 and WF 9

223. Advanced Organic Chemistry — Continuation of 221: Organic reactions, new synthetic methods, conformational analysis and exercises in the synthesis of complex molecules. Prerequisite: 221 or consent of instructor.

3 units, Win (Johnson) MWF 9

225. Advanced Organic Chemistry — Continuation of 223: Theory and application of synthetic organic chemistry, with special emphasis of utility in the areas of photochemistry, inorganic-organic chemistry and bio-organic chemistry. Prerequisite: 223 or consent of instructor.

3 units, Spr (van Tamelen) MWF 9

227. Selected Topics in Organic Chemistry — Since this course may be repeated for credit, the subject matter differs usually from year to year. Principal attention is given to (1) applications of physical methods (notably, mass spectrometry and optical rotatory dispersion) to organic chemical problems; (2) synthetic reactions in the steroid field, and (3) degradative organic chemistry with illustrations from the field of natural products.

3 units, Aut (Djerassi) M 8-10 and W 8

229. Organic Chemistry Seminar — Attendance is required of all graduate students majoring in organic chemistry.

1 unit, Aut, Win, Spr (Staff) Th 4


2 units, Spr (Altman, Brauman) by arrangement


2 units, Aut (Loring) TTh 9

251. Advanced Inorganic Chemistry—The chemistry of complex ions. Prerequisite: one year of physical chemistry.

2 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

255. Advanced Inorganic Chemistry — Chemical reactions of organotransition metal complexes and their role in homogeneous catalysis, analogous patterns among reactions of transition metal complexes in lower oxidation states. Physical methods of struc-
ture determination. Prerequisite: one year of physical chemistry.

3 units, Spr (Collman) TTh 11 and one hour by arrangement

261. Thermodynamics of Irreversible Processes — (Enroll in Chemical Engineering 230A.) A course dealing with the main developments in the thermodynamic treatment of irreversible chemical and electrochemical processes, transport processes, coupling phenomena, etc., with special emphasis on topics and methods of interest to students of chemical engineering, physical chemistry, and related fields. Prerequisite: 175.

3 units, Aut (Van Rysselberghe) by arrangement, alternate years, given 1969–70

263. Thermodynamics of Irreversible Processes—Complements 261; separately open to qualified students.

2 units, Win (Van Rysselberghe) by arrangement, alternate years, given 1969–70

265. Electrochemical Concepts and Conventions—A survey of the fundamentals of electrochemistry. Prerequisite: 175.

1 unit, Win (Van Rysselberghe) by arrangement, alternate years, given 1969–70

267. Electrochemical Thermodynamics and Kinetics—Thermodynamic treatment of reversible cells, electrodes; irreversible phenomena in electrochemical systems, kinetics of electrode processes, polarization and overvoltage, Tafel law, electrochemical procedures in physical, analytical chemistry. Prerequisite: 175.

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

269. Electrochemical Thermodynamics and Kinetics—Continuation of 267: Prerequisite: 265 or 267.

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

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-Op-
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: Brooks Otis

Professors: Mark Edwards, Brooks Otis, Lionel Pearson, Antony E. Raubitschek, T. B. L. Webster

Associate Professor: Edwin M. Good (Religion and Hebrew)

Assistant Professors: William Berg, Andrew Devine, Ronald Mellor, John Moore, Michael Wigodsky. Acting: N. Gregson Davis

The Department of Classics offers work in the Greek, Latin, and Hebrew languages and literatures, in Greek and Roman History and in Classical Archaeology. It aims to develop in the student three things: a competence in the classical languages, an appreciation, comprehension, and enjoyment of classical literature, and an understanding of the history and culture of the ancient world. The Department is interested both in students who wish to do their major work in Classics and in students who wish to relate Classics to work in such other departments as English, Philosophy, History, and the Modern Languages. Study of the classics as a major subject equips students for teaching Latin and Greek in high school and college and is also an essential part of a liberal education.

The General Studies Foreign Language requirements can be fulfilled by courses in Greek, Latin, or Hebrew, the Basic requirement (for all students) by completing the work of the second year, as described below in Sections I, II and III, the Additional requirement (for the A.B. degree) by courses at the 100 level. Humanities 61 and courses marked # satisfy Area requirements in Humanities (Fine Arts or Literature).

ADMISSION TO THE DEPARTMENT

Students should enroll as majors in the Department as early as possible, since they must complete the second-year courses in Latin and Greek (Latin 23 or 28, Greek 23) or have reached an equivalent standard through work done elsewhere before they can be admitted to courses on the 100 level. Students interested in Greek should start at latest in the winter quarter of their sophomore year and if possible in their freshman year.

PROGRAMS OF STUDY

BACHELOR OF ARTS

The Degree of Bachelor of Arts in Classics may be taken either in 1: Classics (Latin and Greek), 2: Latin or Greek, or 3: Latin or Greek with a related minor.

A student's program of study should be prepared in advance after consultation with his Departmental adviser. Major students must register each quarter for at least one course in the major subject. A student interested in obtaining certification for teaching Latin in the State of California should consult the Chairman of the Department or his adviser.

1. Latin and Greek. 28 units in Latin courses and 28 units in Greek, all in courses at the 100 level or higher. At least 4 units at the 100 level in Latin composition and 4 units in Greek composition must be included, and, if recommended by the student's adviser, one or both of the 170 series (Latin 171-173; Greek 171-173). (This major is recommended for students who are interested in graduate work in Classics or in related fields such as Ancient History, Medieval History, Ancient and Medieval Philosophy, etc.)
2. Latin or Greek
   a) Latin: 28 units in Latin courses, all at the 100 level or higher, including at least 4 units at the 100 level in Latin composition and, if recommended by the student’s advisor, the 170 series (171–173); two courses in Roman history; Humanities 61 or some work in Greek history or ancient art or some study of Greek.
   b) Greek: 28 units in Greek courses, all at the 100 level or higher, including at least 4 units at the 100 level in Greek composition and, if recommended by the student’s advisor, the 170 series (171–173) two courses in Greek history; Humanities 61 or some work in Roman history or ancient art or some study of Latin.
3. Latin or Greek with related minor. As in “(2)” above for (a) Latin or (b) Greek, with an additional minor program of 20 units in (a) Greek or (b) Latin or French, German, Italian, English, Philosophy or History.

Combined Majors
   Students may with the consent of the 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 12 shall be on the 100 level or above, and 4 units in related courses (Greek or Roman history, ancient art).

Honors Program in Humanities
   For acceptable majors in Classics an Honors Program in Humanities is offered, a description of which will be found under “Humanities Special Programs.”

Teaching Credentials
   For information concerning the requirements for teaching credentials, consult the “School of Education” section of this bulletin and the Credential Secretary, School of Education.

Rome Classical Center
   There will be an opportunity for some Classics majors to attend the Intercollegiate Classical Center at Rome. The program in Rome is specially designed for classical undergraduates. The Center is managed by Stanford University for 30 constituent colleges and universities including Stanford. It is open to Stanford majors in Classics (see the Center brochure) and all courses given in the Center receive full credit at Stanford and count toward a Stanford major in Classics. The courses presently given at the Center with the numbers used on Stanford Class cards are:
   - 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 18 units of graduate courses and 18 units of work at the 150 or 170 levels.
   3. The satisfactory completion of one Greek course at the 100 level (if his undergraduate major has been Latin) or one Latin course at the 100 level (if his undergraduate major has been Greek).
   4. The passing of an examination testing the candidate’s ability to translate into En-
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) A final written examination in two classical authors (one Greek and one Latin) and in two fields, one of which must be historical. Each student must submit a syllabus for each author and each field. The examination will be drawn up on the basis of this syllabus after it has been approved by the Department.

   d) A colloquium on the candidate's dissertation and an oral examination on two or more special topics, such as selected authors or selected aspects of Greek or Roman literature, history, archaeology, philosophy, epigraphy or palaeography.

   e) Candidates must pass examinations in Latin and Greek Composition unless they receive a grade of A in one quarter of Advanced Greek and Latin Composition (Greek 205, Latin 205) or a grade of B in two consecutive quarters of the same.

3. The examinations in translation from Greek and Latin authors will normally be taken in the autumn term of the second or third year of graduate work, the final written examination in the spring term of the same year, the dissertation colloquium and special topics examination in the spring following. The period between the translation and final written examinations will be devoted largely to an intensive preparation for the latter examination, during the course of which candidates will be expected to make full use of relevant secondary material in modern languages. They should therefore plan to satisfy the requirements in composition and French and German as soon as possible, preferably before the time of the translation examination. Except in very special circumstances they will not be allowed to take the final written examination until the other three sets of examinations have been successfully completed.

4. Each candidate (not later than the end of the quarter in which he takes his final written examination) must submit to the 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.

Note—So far as possible, names of instructors are given for each course, but some changes, especially in more elementary courses, are inevitable.

I. COURSES IN GREEK
FIRST- AND SECOND-YEAR COURSES

Students may begin the study of Greek in autumn quarter with the series of courses 1–3, or in winter quarter with the series 1A, 1B, which is intended to cover approximately the same ground at a faster pace. Those with some knowledge of Greek should consult a member of the Department to determine at what stage they should start their work. In the second-year courses some meetings will be devoted to grammar and composition exercises.

The General Studies Basic Languages requirement can be fulfilled by successful completion of 23, with 8 units of second-year work. The following table shows the sequence of courses offered each year:

<table>
<thead>
<tr>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>22</td>
<td>23</td>
<td>100</td>
</tr>
</tbody>
</table>

#1. First-Year Greek—For beginners.
4 units, Aut (Moore) MTWF 10

#2. First-Year Greek—Continuation of 1.
4 units, Win (Moore) MTWF 1:15

#3. First-Year Greek—Continuation of 2.
4 units, Spr (Moore) MTWF 10

#1A. First-Year Greek — Accelerated course.
5 units, Win (Berg) MTWThF 1:15

#1B. First-Year Greek — Continuation of 1A.
5 units, Spr (Berg) MTWThF 1:15

#22. Second-Year Greek — Xenophon, Plato.
3 to 4 units, Aut (Raubitschek) TTh 10 and one hour by arrangement

#23. Second-Year Greek — Homer, Odyssey.
3 to 4 units, Win (Berg) TTh 10 and one hour by arrangement

1 to 2 units, by arrangement

#100. Second-Year Greek — Euripides, Alcestis.
3 to 4 units, Spr (Moore) TTh 10 and one hour by arrangement

THIRD- AND FOURTH-YEAR COURSES

The series 101–103 is offered every year. 151–153 and 161–163 are offered in alternate years and may be taken in succession.

#101. Tragedy—Sophocles, Philoctetes.
3 to 4 units, Aut (Webster) MWF 10

#102. Homer, Iliad.
3 to 4 units, Win (Wigodsky) MWF 10

#103. Attic Prose—See 173.

105. Greek Composition—See 175.

115. Greek Composition—See 175.

151. Aristophanes.
3 to 4 units, Aut (Berg) TTh 11 and one hour by arrangement

152. Herodotus.
3 to 4 units, Win (Raubitschek) TTh 11 and one hour by arrangement

160. Individual Work.
By arrangement

161. Hesiod and Aeschylus.
3 to 4 units, Aut (——) MWF 10, given 1970–71

#162. Plato and Aristotle.
3 to 4 units, Win (——) MWF 10, given 1970–71

163. Plato and Aristotle — Continuation of 162.
3 to 4 units, Spr (——) MWF 10, given 1970–71

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

171. History of Greek Literature: Epic and Lyric.
4 units, Aut (Edwards) MWF 10
172. History of Greek Literature: Comedy, Tragedy.
   4 units, Win (Moore) MWF 10
   4 units, Spr (Webster) MWF 10
175. Greek Composition.
   2 units, Aut, Win (Raubitschek) TTh 1:15
See also Courses (Latin and Greek) listed under VII.

GRADUATE COURSES
205. Prose Composition for Graduates.
   2 units, Aut, Win, Spr (Pearson) by arrangement
206. Solon.
   4 units, Aut (Raubitschek) by arrangement
207. Metrics.
   4 units, Aut (Webster) W 2:15
208. Pre-Socratics.
   4 units, Aut (Moore) T 2:15
209. Odyssey.
   4 units, Win (Edwards) Th 2:15
210. Plato.
   4 units, Win (Moore) T 2:15
211. Attic Black-Figure Vases.
   4 units, Win (Webster) by arrangement
212. Fourth Century.
   4 units, Spr (Otis) by arrangement
213. Aeschylus.
   4 units, Spr (Webster) T 2:15
214. Orpheus.
   4 units, Spr (Berg) by arrangement
215. Demosthenes—Public Speeches.
   4 units, Spr (Pearson) by arrangement
216. Thucydides VIII.
   4 units, Spr (Raubitschek) by arrangement
217. Directed Reading.
   By arrangement
See also Classics 201, 207, and 208.

FIRST- AND SECOND-YEAR COURSES
A placement test will be set for freshmen in the autumn (and for other students by arrangement) to determine at what stage they should begin; they will be ranked as follows on the basis of the test:

1. General Studies Basic requirement completed—eligible for third-year course.
2. 3 units needed to complete requirement.
3. More elementary work needed.

#5. Accelerated Course in Elementary Latin.
   5 units, Aut (——) MTWTThF 9
#6. Accelerated Course in Elementary Latin—Continuation of 5.
   5 units, Win (——) MTWTThF 9
   5 units, Spr (——) MTWTThF 9
#23. Introduction to Latin Poetry.
   3 units, Aut (Wigodsky) MWF 10
109. Christian or Medieval Latin Authors—Prerequisite: 7, 23, or equivalent.
   3 units, Spr (——) by arrangement

THIRD- AND FOURTH-YEAR COURSES
The series 151–153 and 161–163 will be offered in alternate years and may be taken in successive years.

#101, 102, 103. The Augustan Age — Horace, Virgil, Livy.
   101. 3 to 4 units, Aut (Davis) MWF 9
   102. 3 to 4 units, Win (Edwards) MWF 9
   103. 3 to 4 units, Spr (Otis) MWF 9
105. Latin Composition, Elementary—See 175.
115. Latin Composition, Intermediate — See 175.

#151. The Letters of Cicero and Pliny.
   3 to 4 units, Aut (Pearson)
#152. Cicero, Oratory.
   3 to 4 units, Win (Pearson)
#153. Roman Comedy or Satire.
   3 to 4 units, Spr (Wigodsky)
155. Latin Composition, Advanced — See 175.

II. COURSES IN LATIN
(Under the direction of Professor Lionel Pearson and the Undergraduate Studies Committee.)
III. COURSES IN HEBREW

#1. First-Year Hebrew — Introduction to classical Hebrew language, emphasizing reading ability in various styles as found in the Hebrew Bible.
5 units, Win (Good) MTWThF 9, given 1970–71

#2. First-Year Hebrew—Continuation of 1.
5 units, Spr (Good) MTWThF 9, given 1970–71

#22. Second-Year Hebrew — Advanced reading in the Hebrew Bible, with particular attention to poetry and poetic structure, critical analysis, and methods of interpretation.
4 units, Aut (Staff) by arrangement

4 units, Win (Staff) by arrangement

4 units, Spr (Staff) by arrangement

160. Directed Reading in Hebrew.
By arrangement

IV. COURSES IN CLASSICAL LITERATURE AND CIVILIZATION

No knowledge of Greek or Latin is required for these courses.

#161. The Classical Epic: Homer, Apollonius, Virgil—A study of the epic in respect to structure, character, theme, and imagery.
3 units, Aut (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

#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, given 1970–71

#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 1970–71

#173. Classical Political Theory—Ancient political ideas (Plato, Aristotle, Polybius, Cicero) and their impact on modern theory.
3 units, Spr (Raubitschek) MWF 11, given 1970–71

V. COURSES IN GREEK AND ROMAN HISTORY
The series 101, 102, 103 and 111, 112, 113 will be offered in alternate years and may be taken in succession.

101. The Ancient World I, the Near East.
4 to 5 units, Aut (Good), given 1970–71

102. The Ancient World II — History of Greece.
4 to 5 units, Aut (Raubitschek)
MTWTh 2:15

103. The Ancient World III — History of Rome.
4 to 5 units, Win (Raubitschek)
MTWTh 2:15

104. 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

For more advanced students—especially for majors and graduate students in Classics or History—work will be offered on an individual basis:

201. Individual Work in Greek History.
By arrangement

202. Individual Work in Roman History.
By arrangement

VI. COURSES IN ARCHAEOLOGY

#101. Greek mythology in Greek Art.
2 units, Aut (Webster) M 11, given 1970–71

#102. Classical Greek Painting and Sculpture.
2 units, Win (Webster) M 11, given 1970–71

#103. Hellenistic Painting and Sculpture.
2 units, Spr (Webster) M 11, given 1970–71

Additional work in the Museum can be arranged.

#104. Early Greek Art.
2 units, Aut (Webster) T 4:15

#105. Athenian Everyday Life.
2 units, Win (Webster) T 4:15

#106. Art and Monuments of the Romans—See Greek 211.
3 units, Spr (Wigodsky)
See Greek 211.
See also Art 100A,B,C, 103B, 201.

VII. GENERAL COURSES

201. Introduction to Classical Scholarship.
1 unit, Aut (Wigodsky, Staff) by arrangement

207, 208. Comparative Grammar of Greek and Latin.
207. 4 units, Win (Devine) by arrangement
208. 4 units, Spr (Devine) 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 1969–70

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: Lyle M. Nelson
Director, Institute for Communication Research: Wilbur Schramm (on leave 1969–70)
Director, Professional Journalism Fellow-
ship Program: Lyle M. Nelson. Assistant to the Director: Harry N. Press


Associate Professor: Edwin B. Parker (on leave 1969-70)


Instructor: Janet K. Voelker

Lecturers: Jules Dundes, Templeton Peck

The Department of Communication engages in research in communication and offers a curriculum which prepares its students for careers in print and broadcast journalism, documentary film, and communication research.

The main objectives of the professional curriculum are to provide a broad program in the social and humanistic studies; to present courses in the processes and effects of communication, and to equip the student with professional values.

A secondary objective is to provide that amount of training in skills and techniques that will sustain the student’s interest in his chosen profession and will assist him in beginning his career.

The technical courses provide not only practice but a content that is an application of some of the principles of the behavioral sciences and humanities. The technical curriculum in this sense is like the curricula of the Schools of Medicine and Engineering which apply the principles of the biological and physical sciences.

ADMISSION

Undergraduate students who have been admitted by the University are accepted as majors provisionally for one quarter. Thereafter, the student’s record is reviewed quarterly by the Department.

Undergraduate majors must enroll in the Department not later than the start of the second quarter of their junior year; this requirement may be waived for applicants entering the Department not later than the start of the first quarter of their senior year, provided that they have a University grade-point average of 3.0 or higher.

Students who wish an undergraduate minor in the Department may arrange for a suitable sequence of preprofessional courses.

Prospective undergraduate students should write the Office of Admissions.

Prospective graduate students should write to: 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 if exceptional circumstances prevent the applicant from taking the tests.

PROGRAMS OF STUDY

BACHELOR OF ARTS

Two Bachelor of Arts degree programs are offered, one in Journalism and one in Broadcasting and Film. Requirements are as follows:

1. Two courses in general or English literature; Psychology 1; Sociology 1 or Anthropology 1. In addition, Journalism students are required to take Economics 1 and Political Science 1 and 10 or 20. (The student who wishes to take both Political Science 10 and 20 may substitute ISA and 15B.)

2. A unified program totaling not less than 20 units of courses numbered 100 or higher shall be arranged, with the approval of the adviser, from one or two other departments such as Anthropology, Art, Economics, English, History, Music, Philosophy, Political Science, Psychology, Sociology, or Speech and Drama.

3. Undergraduate majors must have a grade point average of 2.50 or higher in Communication Department courses in order to receive the departmental recommendation for graduation.

4A. Broadcasting and Film: Communication 1, 141, 142, 180, 200, and 223A.

4B. Journalism: Twenty-five to thirty units in communication of which the following courses are required: 100, 102, 107, 108, 140, 169 and 220. In addition, the student prepar-
ing for newspaper or press association editorial work will take Communication 175; the student interested primarily in writing for consumer magazines and industrial publications will take Communication 150.

While the Department offers no courses in such subjects as science reporting, technical writing, or public relations, appropriate programs of study can be arranged for interested students. For example, a prospective science writer could be permitted to substitute a unified program of courses in the physical sciences in lieu of requirement "2" above.

Majors in Communication may elect one of the following interdisciplinary honors programs:

- Humanities Undergraduate Honors Program
- Social Sciences (Honors Program in Social Thought and Institutions)

**COMMUNICATION HONORS PROGRAM**

In addition to the regular undergraduate programs in communication, a Communication Honors Program is designed for those exceptionally able students who wish, in their major, to pursue an intensive and somewhat independent study of communication. This program is directed toward the integration of a substantial body of theoretical and factual information and the development of both communication skills and creative scholarly skills by independent study, tutorial guidance, small seminars, and research experience. Particular emphasis is placed on the planning of an individual program for the student that will combine his specialized interests with a body of basic knowledge about communication processes. The plan will be aimed at helping the student prepare for a comprehensive examination to be taken in the final quarter of his senior year, over his entire area of communication study. The plan will include arrangements for continuous supervised work in communication skills or in communication research. A report of the work done under this plan will be submitted as an undergraduate thesis at the end of the next to final quarter of the student's senior year. It is possible for a student to elect both the Communication Honors Program and one of the three interdisciplinary honors programs listed above.

**MASTER OF ARTS**

The Master of Arts degree is awarded by the Department in the fields of Journalism, Broadcasting and Film, or Communication Research. Requirements are as follows:

1. The candidate must earn 45 units in graduate residence at Stanford; he must be enrolled as a major in the Department for at least two quarters; he must earn an average grade of B on his entire program of study. 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 under the direction of a major professor must be undertaken. Three to six hours of credit in independent study may be applied to this requirement. A report of the project must be made to the professor directing the independent study. A candidate may petition the Department by the end of the second week of the second quarter for permission to submit the report as a thesis.

2. A unified program of advanced course work is to be arranged with the approval of the adviser. This includes appropriate grounding in research methodology and communication theory and training in one or more communication media.

3. Students in Broadcasting and Film, upon completion of academic work, including the independent project, may be required to pass a comprehensive written examination, after which they spend a three-month internship with a professional film or broadcasting organization. (No tuition is charged for the internship period.) Academic work will include appropriate courses from the following: 200, 205A,B, 206A,B, 208A, B,C, 215, 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, 108, 140, 150, 169 or 175, 207, 215, 220, two quarters of 225, and 309. Remainder of the program is to be a cohesive group of courses from one or two related fields. Students with undergraduate journalism training or media experience should check with their advisers to determine which of the above departmental courses will be required.

No particular specialization in undergraduate work is expected of a candidate. Spe-
cial programs of study may be arranged for individual candidates, which will take account of the nature of their previous preparation.

**Doctor of Philosophy**

The Department offers the Doctor of Philosophy degree in Communication, with programs in Communication Theory and Research, in Developmental Communication and in Public Affairs Communication. All of these degrees are designed primarily for persons interested in teaching and research careers.

In addition to fulfilling the course and residence requirements for the degree, all Ph.D. candidates are required to:

1. Complete requirements for a Master's degree in Communication, and complete a research project. Holders of the Master's degree may be excused from this first year research requirement if the faculty feels that the previous research has been sufficient.

2. Pass a comprehensive written examination in the subjects required of all candidates and in the area of advanced specialty of the particular candidate.

3. Demonstrate reading knowledge of a foreign language. Except by special permission, this language will be Russian, French, Spanish, or German.

4. Pass the University oral examination, which may be either a comprehensive examination covering the same areas as the written examination or a defense of the dissertation.

5. Complete pre-dissertation research project (in addition to the Master's or first-year research requirement) or obtain equivalent research experience sufficient to demonstrate research competence.

6. Have at least one year of work experience in the mass media if they are doctoral candidates in Public Affairs Communication, or, if they are doctoral candidates in Communication Research, have at least one year of work experience in the mass media or another communication activity, prior to writing the dissertation.

7. Complete a dissertation satisfactory to an advisory committee of three or more members and to the University Committee on the Graduate Division.

The following are examples of standard Ph.D. programs in Communication Theory and Research and in Developmental Communication:

1. **Communication Theory**
   Comm. 211. Theory of Communication I
   Comm. 212. Theory of Communication II
   Comm. 213. Theory of Communication III

2. **Methodology**
   Comm. 217. Communication Research Methods I
   Comm. 218. Communication Research Methods II
   Comm. 219. Communication Research Methods III
   Comm. 275. Communication Research: Content Analysis and Scaling
   C.S. 126. Computing in the Social Sciences and Humanities
   Comm. 309. First-Year Research Project
   Comm. 319. Pre-Dissertation Research Project

3. **Statistics**
   Psych. 60. Statistical Methods
   Psych. 151. Statistical Methodology
   Psych. 152. Analysis of Data

4. **Experimental Psychology** (at least two of the following: Psych. 103A and Psych. 103E are strongly recommended)
   Psych. 103A. Experimental Psychology: Higher Mental Processes
   Psych. 103B. Experimental Psychology: Perception
   Psych. 103C. Experimental Psychology: Learning
   Psych. 103D. Experimental Psychology: Social Processes
   Psych. 103E. Experimental Psychology: Social Psychology

5. **Psychology** (at least two courses in social psychology, at least one in learning theory, and at least one in personality or motivation). Example courses are:
   Psych. 212. Advanced Social Psychology
   Psych. 213. Advanced Personality
   Psych. 220. Human Motivation
   Psych. 251. Seminar in Personality Theory and Assessment
   Psych. 254. Principles of Personality Change I
   Psych. 261. Seminar in Social Psychology
   Psych. 262. Seminar in Verbal Behavior
   Psych. 264. Seminar in Learning Theory
   Psych. 267. Seminar in Person Perception
6. Sociology (at least two graduate level courses in Sociology)
Example courses are:
Sociol. 104. Interpersonal Behavior
Sociol. 131. Advanced Social Psychology
Sociol. 217. Problems in Theoretical Analysis
Sociol. 250. Basic Problems in Sociological Theory
Sociol. 253. Theory Construction
Sociol. 264. Seminar in Socialization and Social Control
Sociol. 268. Concepts and Operations in Sociological Analysis
Sociol. 279. Problems in Study of Social Influence
Sociol. 285. Problems in the Analysis of Social Stratification
Candidates in Developmental Communication will complete a dissertation in the area of how people, as they mature, learn to use and, in turn, are influenced by the mass media. They need not take courses in social psychology, but, in addition to the courses suggested in the above program they are required to take:

7. Developmental Communication
Comm. 231. Developmental Communication I
Comm. 232. Developmental Communication II
Comm. 233. Developmental Communication III

8. Developmental Psychology
Psych. 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. Computer Simulation of Cognitive Processes
C.S. 225. Artificial Intelligence
C.S. 243. Computational Linguistics
Phil. 157A,B. Logic
Phil. 164. Philosophy of Science
Anthro. 167. Language and Culture
Anthro. 158. Culture and Personality
Pol. Sci. 312. Research Seminar on Comparative Politics

Other courses and special advanced reading courses may be selected in conference with the adviser.

The following is an example of the Ph.D. program required in Public Affairs Communication:

1. Communication Theory
Comm. 211, 212. Sequence in Communication Theory

2. Structure and Function of the Mass Media
Comm. 220. Mass Communications in Society
Comm. 225. Problems of the Mass Media (at least two quarters)
Comm. 230. Mass Media and Government
And at least two among the following:
Comm. 240. Seminar in Mass Media History
Comm. 245. Economics of the Mass Media
Comm. 255. International Communication
Comm. 256. Communication in Economic and Social Development

3. Methodology
Comm. 217, 218. Sequence in Research Methods
Comm. 227. Analysis of Documentary Evidence
Comm. 309. First-Year Research Project
Comm. 319. Pre-dissertation Research Project

4. Statistics
Psych. 60. Statistical Methods, or Stat. 50. Elementary Statistics
One other statistics course
5. Law
Law 104. Law in Society

6. Political Science, History, Economics — a unified program of five courses in one of these fields and two courses in one or both of the others. Examples of subject areas and courses:

- Political Behavior and Politics:
  - Pol.Sci. 181. Attitude Formation and Voting Behavior
  - Pol.Sci. 184. Legislative Behavior
  - Pol.Sci. 185. Political Parties
  - Pol.Sci. 382A,B. Research Seminar in American Politics

- Political Theory:
  - Pol.Sci. 152. Modern Political Thought
  - Pol.Sci. 158. Theoretical Foundations of Political Sociology

- Public Law:
  - Pol.Sci. 170 (270). The Supreme Court and the Constitution
  - Pol.Sci. 173 (273). Civil Liberties in the U.S.

- Modern European History:
  - Hist. 32. Twentieth Century Europe
  - Hist. 122A,B. Russian Foreign Relations

- United States History:
  - Hist. 166, 167. American Intellectual History
  - Hist. 168, 169. American Social History
  - Hist. 250 to 260. Graduate Seminars in U.S. History

- Economics — History, International and Comparative, Industrial:
  - Econ. 116. Economic History of the United States
  - Econ. 118. Underdeveloped Economics
  - Econ. 120. Comparative Economic Systems
  - Econ. 158. Organization and Social Control of Industry
  - Econ. 165. International Economics
  - Econ. 200. Topics in the History of Economic Thought

- Among other relevant possible areas of concentration are: Comparative Politics, International Relations, Public Administration; East Asian, Middle Eastern and Latin American History; Core Theory of Economics. (Students specializing in any area of economics will need to have the equivalent of at least Econ. 1, 105A and 110A for most advanced courses in that department.)

7. At least two courses from the above or other departments chosen in consultation with an adviser, in preparation for the degree examinations and the dissertation. This requirement is designed especially for students who have not concentrated in the social sciences as undergraduates or as graduate students in other programs.

Ph.D. candidacy expires five years after admission to candidacy by the University Committee on the Graduate Division. Reaplication will require reexamination.

Other programs leading toward the Ph.D. and involving communication may be pursued in the Graduate Division Special Programs. Such programs are individually planned for unusually well-qualified students.

One example would be an Information Science program involving communication and computer science. Applicants for such special programs must first be admitted to a Stanford department. Inquiries about programs involving communication should be directed to the Communication Department.

Minor for the Degree of Doctor of Philosophy — Candidates for the degree of Doctor of Philosophy in other departments who elect a minor in Communication will be required to complete a minimum of 15 units of graduate courses in the Communication Department, including one research methods course and either Communication 211 or Communication 212. The Communication 217 requirement may be waived when comparable research methodology courses have been taken in some other department. The remainder of the course program will be adapted to the particular needs of each candidate.

THE INSTITUTE FOR COMMUNICATION RESEARCH

The Institute for Communication Research operates as an office of project research for the faculties of the Department of Communication and other departments on grants from foundations, communication media, and other agencies, on government...
contracts, and on its own funds. A few research assistantships are available to qualified graduate students. Among the qualifications which will be highly valued in applicants are high scholarship, training in the behavioral sciences (preferably psychology and sociology, including training in statistics and research methodology), and training for or experience with the mass media. For further information about the Institute write to the Director.

**Courses Open to Undergraduates and Graduates**

**I. General**


   5 units, Win (Maccoby) MTW 10 and section

2. 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)

3. 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 1970–71

4. 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**

1. 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

2. 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.

   1 unit, Aut (Rivers) by arrangement
   Spr (Grey) by arrangement

3. Editorial Techniques II — Copy editing, headline writing, news display, illustration, typography, printing processes. To be taken concurrently with 108. Prerequisites: 100 and 102.

   3 units, Win (Weigle) MWF 9


   2 units, Win (Weigle) by arrangement

5. History of Anglo-American Journalism — Open to non-majors.

   3 units, Aut (Weigle) TTh 9

6. Forms of Journalistic Writing — Practice in writing magazine articles, with emphasis on marketing manuscripts. Conferences. Prerequisites: 100 and 102.

   3 units, Win (Rivers) TTh 11

7. 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

8. Legal Aspects of Journalism — Libel, contempt, constitutional guaranties, privacy, copyright, inspection of public records. Communication seniors and graduate students only.

   3 units, Aut (Grey) MW 11

9. Reporting of Public Affairs — Local, state, federal courts; municipal, state, federal administration in the local community. Open only to major students with senior or graduate standing.

   4 units, Win (Grey) MWF 10

10. San Francisco Newspaper Practice — Majors who have made a high record in their
entire program, and especially in 175, are permitted to work in San Francisco in the senior or graduate year, by arrangement with San Francisco newspapers. Work is under supervision of San Francisco newspapermen and faculty of the Department.

5 units, Spr (Weigle) by arrangement

III. BROADCASTING AND FILM

101. Film Aesthetics—A systematic examination of the nature of the film medium, and of attempts to construct theories of film. Attention is given to the problems of aesthetics and communication from the viewpoints of practitioner, critic, and audience.

4 units, Aut (Breitrose) MWF 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, Spr (Breitrose) MWF 9; lab. by arrangement


3 units, Win (Dundes) TTh 9

180. Broadcasting and Film Criticism—The techniques and role of criticism based upon the objectives and potential of these media. For advanced students. Prerequisites: 141 or 142 and consent of instructor.

3 units, Spr (Breitrose) MWF 11

200. Visual and Aural Communication Techniques—An investigation of the techniques of film, television, and sound from the standpoint of the communication of ideas. Students will produce short still picture, film, television and sound assignments. No previous knowledge of the media is required. This course is a prerequisite for all further production work in film and television. (Open only to graduate students in Autumn Quarter.)

5 units, Aut, Win (Breitrose, —)—MW 1:15–3:05

205A. Television Production I—Production and direction of documentary television programs. Prerequisites: 100, 123.

4 units, Win (graduate students only) ( —)—MW 1:15–3:05
Spr (open to undergraduates) ( —)—MW 1:15–3:05

205B. Film Production I—An intermediate course in which students produce their own short films. Prerequisites: 200 and consent of instructor.

4 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.

4 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.

3 units, Aut (Voelker) 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 (Voelker) 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 (Voelker) TTh 10–12

Summer Broadcasting and Film Institute
(See Summer Session Bulletin for 1970.)

Courses for Graduates


3 units, Aut ( —)—W 2:15–4:05

204. Communication Theory—Readings and conferences. By consent of the instructor.

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

207. Survey of Communication Research Methods—Research designs, sampling, data collection, and data analysis. For Journalism A.M. students.

4 units, Win ( —)—MW 4:15–6:05
208A. Seminar in Broadcasting and Film I.
2 units, Aut (Staff) by arrangement

208B. Seminar in Broadcasting and Film II.
2 units, Win (Staff) by arrangement

208C. Seminar in Broadcasting and Film III.
2 units, Spr (Staff) by arrangement

211. Theory of Communication I—Seminar and tutorial meetings, extensive readings and papers. For doctoral candidates planning to continue with the sequence on theory.
4 units, Aut (—) W 2:15-4:05

212. Theory of Communication II—Theory of the communication process. Analysis of the experimental literature in attitude change. Prerequisite: consent of instructor.
4 units, Win (Maccoby) W 2:15-4:05 and additional meetings by arrangement

4 units, Spr (——) M 2:15-4:05 and additional meetings by arrangement

4 units, Aut (Maccoby, Breitrose)
Th 7-10 p.m.

216. The Broadcast Editorial—Analyses of radio and television editorials. Students will research, write, deliver and direct their own editorials.
3 units, Spr (Dundes) T 7:30-10:00 p.m.

217. Communication Research Methods I—Methods of research in mass, group, and interpersonal communication. Application of scientific method to communication research. Design of communication studies for laboratory and field experiments and sample surveys. Conceptualization of variables, sampling, data collection, interview techniques, data processing and data analysis. Report preparation. Prerequisite: previous or concurrent registration in elementary statistics.
4 units, Aut (——) TTh 2:15-4:05

218. Communication Research Methods II—Continuation of 217.
4 units, Win (——) TTh 2:15-4:05

4 units, Spr (——) TTh 2:15-4:05

220. Mass Communications in Society—The nature and social responsibilities of the media, the structure of the industry, problems of regulation, management, educational and commercial interests.
4 units, Spr (Rivers) W 2:15-4:05

222. Documentary Film—Analysis of the techniques and strategies of films designed to effect attitudinal and behavioral change. Prerequisite: consent of instructor.
4 units, Spr (Breitrose) by arrangement given 1970-71

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

4 units, Aut (Grey) by arrangement

5 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 influenced by the media.
4 units, Aut (Leifer) by arrangement

232. Developmental Communication II—Continuation of 231.
4 units, Win (Leifer) by arrangement

4 units, Spr (Leifer) by arrangement

240. Seminar in Mass Media History—Review of the literature and research papers
in the historical development of newspapers, magazines, broadcasting and film.

4 units, Spr (Weigle) by arrangement

245. Economics of the Mass Media—Analysis of the literature in mass media economics and intensive research projects. Primarily for doctoral students in Public Affairs Communication.

4 units, Aut (Grey) by arrangement

255. International Communication — Chief patterns of mass communications throughout the world; philosophies behind them; economic, social, political reasons why a given kind of pattern develops where it does; channels by which nations, cultures communicate with each other; kinds of barrier which intervene in those channels; manipulative communication between nations which is characteristic of the “cold war.”

4 units, Spr (——) M 2:15-4:05

256. Communication in Economic and Social Development — Seminar on the communication problems of economic and social development, and on the uses of the mass media for national integration, social change, and education in the developing countries. Special uses and difficulties of communication research in these countries. Case studies and planning exercises.

3 to 5 units, Spr (——) T 4:15-6:05

270. Advanced Communication Theory and Method Seminar I — May be repeated for credit. Topic and instructor change each year. Prerequisites: 213 and 219.

3 units, Aut (Staff) by arrangement

271. Advanced Communication Theory and Method Seminar II—May be repeated for credit. Topic and instructor change each year. Prerequisites: 213 and 219.

3 units, Win (Staff) by arrangement

272. Advanced Communication Theory and Method Seminar III—May be repeated for credit. Topic and instructor change each year. Prerequisites: 213 and 219.

3 units, Spr (Staff) by arrangement

275. Advanced Data Analysis—Continuation of analysis topics covered in 219: Students 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

 COMPUTER SCIENCE

Chairman: George E. Forsythe


Associate Professors: Jerome A. Feldman, Robert W. Floyd, Gene H. Golub

Assistant Professors: Zohar Manna, D. Jagadopal Reddy

Senior Research Associates and Lecturers: Kenneth M. Colby, Arthur L. Samuel

Lecturers: Lester D. Earnest, John R. Ehrman, Bertram Raphael, Giovanni Wiederhold

Research Associates: James W. Beauchamp, Bruce G. Buchanan, Thomas R. Callahan, David C. Luckham, Roger C. Schank, Georgia L. Sutherland

Affiliated Faculty:

Professors: Rudolf E. Kalman (Electrical Engineering and Operations Research), Robert V. Oakford (Industrial Engineering), Dana S. Scott (Logic and Mathematics)

Assistant Professor: Edward S. Davidson (Electrical Engineering)

OFFERINGS AND FACILITIES

The Department aims to acquaint a variety of students with the technological and intellectual roles of automatic digital computers, and to educate research workers in
computer science. In spite of the diversity of the applications, the methods of attacking problems with computers show a considerable unity, and computer science is concerned with the underlying principles. The field is still young, and the student will find many more questions than answers.

Of the numerous areas of computer science, the Department has competence in numerical analysis, combinatorial mathematics, operations research, artificial intelligence, programming systems and languages, logical design of computer systems, mathematical theory of computation, computer control of external devices, and graphic data processing.

Courses in data processing are offered by the Industrial Engineering Department and in the Graduate School of Business. Courses in optimization and mathematical programming will mainly be found in the Operations Research Department.

Since computer science is inherently interdisciplinary, graduate students of computer science are 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 50A, B, 137, 138, and 139 in their course of study.

In connection with its courses and research, the Department makes considerable use of the Computation Center. See the section "Computation Center" in this bulletin.

The Department conducts a weekly colloquium, presented by the staff and visiting scientists, which covers a spectrum of current research topics.

PROGRAMS OF STUDY

MASTER OF SCIENCE

The University's basic requirements for the Master's degree are discussed in the section "Degrees" in this bulletin. The following are Departmental requirements:

A candidate is expected to complete an approved course program of 45 units; at least 36 units will be in this Department, or selected from the list of suggested courses in other departments which appears at the end of the course offerings in Computer Science. These 36 units must include 6 units of Computer Science 239 and 15 additional units of courses numbered 200 or above.

A student whose primary interest is in the numerical aspects of computing should include in his program Mathematics 106, 113, 114, 115, 130, 131, and Computer Science 137, 138, 204, 237A, B, 238, unless he has taken these courses or equivalent ones elsewhere.

A student whose primary interest is in the non-numeric aspects of computing should include in his program Mathematics 113, 130, Philosophy 160A, B, and Computer Science 137, 139, 204, 231, 236A, B, 238, unless he has taken these courses or equivalent ones elsewhere. Computer Science 208 may be substituted for Philosophy 160A, B.

The candidate must have a 2.50 average in his course work and a 3.00 average in his courses taken in the Computer Science Department.

DOCTOR OF PHILOSOPHY

The University's basic requirements for the doctorate (residence, dissertation, examination, etc.) are discussed in the section "Degrees" in this bulletin. The following are Departmental requirements:

Candidates for the degree of Doctor of Philosophy will follow such courses as are approved by the Department faculty, subject to general University regulations. Each student's program should be arranged to include work in computer science, mathematics, mathematical logic, and possibly such other subjects as statistics, operations research, electrical engineering or psychology, the proportions depending on the student's previous education and his planned research. Since computer science is becoming increasing formal and abstract, we place considerable emphasis on the student's mathematical education and ability.

In any case there are the following requirements for the standard program:

1) The student's course of study must be an approved coherent program of at least 60 units covering the basic areas of computer science and appropriate related work. It should ordinarily include the following courses: Computer Science 204, 208, 224, 225, 231, 236A,B, 237A,B, 238, 239 (6 units), 243, 245, 382 (2 units of presenting papers). Credit is not normally given for units of Course 360 towards satisfying this 60-unit requirement. Credit may be al-
allowed towards these 60 units for up to 24 units of courses taken while a graduate student at another university. Unusual programs involving a large fraction of independent reading and research will be considered for well qualified students upon petition to the Graduate Study Committee of the Department.

2) The student must satisfy the Departmental requirement. Further information may be obtained from the Departmental secretary.

3) The student must pass a qualifying examination before admission to candidacy.

The qualifying examination, normally a written examination, covers the basic areas of computer science. Further information may be obtained from the Department secretary.

The most important requirement for the Ph.D. degree is the dissertation. The Department is now prepared to supervise dissertations in the mathematical theory of computation, numerical analysis, programming languages, artificial intelligence, computer control of external devices, and in certain applications of computers, such as in operations research, and logic.

As part of his training for the Ph.D., each student is required during one or more quarters to perform some teaching, research, or consulting work equivalent to that normally performed by teaching and research assistants.

Ph.D. Minor

For a minor in Computer Science the candidate must complete 15 quarter units of Computer Science courses following a program approved by the Computer Science Department Committee on Graduate Study. Automatic approval will be given for any program which includes C.S. 137, 139, 224, or 238 and two additional courses chosen from C.S. 138 and the 200-level 3-unit courses. In addition the candidate must take and pass a special minor examination.

**Teaching and Research Assistantships**

There are graduate assistantships available in both the Computer Science Department and the Computation Center. Assistants will receive a tuition scholarship for up to nine units of study per quarter during the academic year, and in addition will receive stipends for the nine-month academic year ranging approximately from $2500 to $2800. Some may work full time in the summer for between $590 and $700 per month.

Duties in the academic year involve less than twenty hours of work per week. Part of this is in assisting Stanford people with their programs and methods for solving problems with computers, often in connection with formal or informal programming courses. Part of the time is spent in developing programs and systems for solving problems of general interest on computers, or in assisting senior staff members with research in computer science. Approximately two hours of the work week are spent in attendance at Computer Science Department colloquia and seminars.

Applicants for assistantships are expected to have a background in computing at least as deep as that achieved in courses 50A, B or 136, together with some knowledge of a machine language. A deeper background is preferable. An applicant's major field may be computer science, mathematics, statistics, physics, psychology, electrical engineering, or other discipline in which there is significant research involving the use of automatic digital computers. Because of the great need for improved computing and programming systems as tools for research, preference will generally be given to students of computer science.

Further information may be obtained from the 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 for Undergraduate Students**

5. Introduction to Programming — This course is an introduction to a specific procedure-oriented language for describing computational processes. There will be practice in solving elementary problems on Stanford's automatic digital computers. The course is limited to freshman and sopho-
more students. Prerequisite: Mathematics 0 or equivalent.

3 units, Aut (——) MWF 11
Win (Oakford) TTh 2:15-3:30
Spr (——) MWF 11

50A,B. Introduction to Computer Science—
The significance of computers and the fundamental techniques of computer science. Concept of, and properties of algorithms; language, notation and style for describing algorithms; analysis of computational problems and development of algorithms for their solution; use of a programming language to solve problems over a wide range of applications on a digital computer. Prerequisite for 50A: Mathematics 21 or 42 or equivalent. Prerequisite for 50B: 5 or 50A or equivalent.

#50A. 3 units, Aut (——) lec. MW 1:15;
—(——) discussions F 1:15
Win (——) lec. TTh 10;
—(——) discussions, by arrangement
Spr (——) lec. MW 11;
—(——) discussions F 11

50B. 3 units, Spr (——) MWF 1:15

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

#126. Computing in the Social Sciences and Humanities — It is recommended that students with the prerequisites for courses 50A or 136 take one of those courses. The syllabus is roughly that of course 136, but the problems are selected more from non-numerical applications. Prerequisite: Mathematics 0 or equivalent.

3 units, Aut (——) MWF 2:15
Win (——) MWF 2:15
Sum (——) MTWTh 10

127. Numerical Methods for Scientists and Engineers—This survey course is designed to acquaint seniors and graduate students in science and engineering with methods and techniques for solving scientific problems of a mathematical type on automatic digital computers. Stress is given to practical problems and pragmatics. Program libraries are studied and used. Problems to be discussed include 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: 5, 50A, 126, or 136 and Mathematics 113 and 130.

3 units, Win (Forsythe) MWF 11

136. Introduction to Algorithmic Processes —Concept and properties of an algorithm; language and notation for describing algorithms; analysis of computational problems and development of algorithms for their solution; use of a specific procedure-oriented language to solve simple numerical and non-numerical problems using an automatic digital computer. Prerequisite: Mathematics 23 or 43.

3 units, Aut (——) lec. MW 11
—(——) discussions F 11
Win (——) lec. MW 10
—(——) discussions F 10
Spr (——) lec. TTh 10
—(——) discussions, by arrangement
Sum (——) MTWTh 9 or MTWTh 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 automatic 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. The art of computation. Assigned problems will include analytical problems and also problems to be solved with the aid of an automatic digital computer. Prerequisites: 50A or 136 and Mathematics 130 or equivalents.

3 units, Win (——) MWF 2:15

138. Numerical Analysis — Continuation of 137: Also the numerical analysis of functions of several variables, including problems of linear algebra. Least-squares approximation. Prerequisites: 137 and Mathematics 113, or equivalents.

3 units, Spr (——) MWF 2:15

139. Computer Organization and Information Structures—Logical structure of computer systems: flow of control, instruction
codes, input-output, subroutines, interpretive and assembly systems, pushdown stacks, recent advances in computer organization, etc. Study of information representations and their relation to processing techniques. Several computer projects will be included. Prerequisite: 50A or 136 or equivalent.

3 units, Aut (——) TTh 2:15-3:30; MWF 1:15
Win (——) MWF 1:15

150. Combinatorial Analysis—Introduction to general combinatorial theory; theory of graphs, network flow and matroids; convex polytope structures.

Permutations and combinations, partitions, generating functions and recursions. Properties of trees, directed and undirected graphs, etc. Extremal problems like the shortest path, minimum covering, maximum packing, assignment problem, etc. Groups and their graphs, incidence matrices, Euler relations on faces, etc. Applications to finite geometries, orthogonal Latin squares, block designs, etc. Students are encouraged to program algorithms on a computer. Prerequisite: Mathematics 44 or equivalent.

3 units, Win (Knuth) by arrangement

199. Undergraduate Honors.

Any quarter (Staff) by arrangement

COURSES INTENDED PRIMARILY FOR GRADUATE STUDENTS

204. Problem Seminar — The solution by digital computing of various problems, numerical and symbolic, using several 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) by arrangement

208. Foundations for Computer Science—An introduction to logic, algorithms and computability. Topics from mathematical logic, set theory, recursive function theory and the theory of algorithms. Abstract models of computability: Turing machines, minimal machines, dominoes and rewriting systems. Prerequisite: 139 (may be taken concurrently).

3 units, Aut (Manna) MWF 10

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: 50A, 128, or 136.

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. Research project involving computer program will be required. Prerequisites: 224 and 238, or equivalents.

3 units, Win (Feigenbaum) TTh 1:15-2:30


3 units, Aut (——) MWF 9
Win (McCluskey) MWF 9

233. Topics in Numerical Analysis—Selected topics in numerical analysis. Prerequisite: consent of instructor.

3 units, Aut (——) by arrangement

236A,B. Systems Programming and the Theory of Formal Languages—The technique of constructing systems programs: supervisory programs (monitors), input-output systems, interpreters and compilers for procedure-oriented languages like ALGOL. Selected topics from the theory of formal languages: syntactic analysis and semantic interpretation. Prerequisite: 139 or equivalent.

236A. 3 units, Win (Floyd) TTh 2:35-3:50
236B. 3 units, Spr (Knuth) TTh 2:15-3:30


3 units, Aut (——) MWF 9

237B,C. Advanced Numerical Analysis — Selected topics are covered in depth from

237B. 3 units, Win (Golub) MWF 10

237C. 3 units, Spr (——) by arrangement

238. List Processing and Symbol Manipulation—The LISP programming language with applications to symbolic differentiation, integration, simplification of algebraic expressions, and compiling. Design of list-processing systems. Prerequisite: 136 or substantial programming experience.

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

239. Computer Laboratory — A substantial computational program is undertaken and well documented. Prerequisite: 138 or 139, or equivalent.

Any quarter (Staff) by arrangement

243. Mathematical Theory of Computation —Semantics and syntax of programming languages; formal systems for proving equivalence of programs; computability and unsolvability; computer proof procedures; related topics in mathematical logic. Prerequisite: 238 and Philosophy 160A,B, or equivalents.

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

245. Advanced Topics in Artificial Intelligence Research—Analysis and discussion of selected frontier research problems in the field. Research paper will be required. Prerequisite: 225.

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

246. Control of Computing 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. Prerequisites: 137, 231, 236A, 238.

3 units, MWF 9

250. Graphic Data Processing—Picture description languages, control languages, and data structures; picture recognition: preprocessing and encoding, 2-D transformations, 3-D transformations, projective transformations, primitive recognizers, and classification; graphic displays and graphic input devices, control programs; applications of graphic techniques. Prerequisites: 137, 231, 236A, 238.

Alternate years, given 1970–71

341. Large Scale Systems in Mathematical Programming—Development of efficient solution methods for optimizing special large-scale linear inequality systems such as those encountered in control theory, programming in a Markov chain, investment and economic planning, multi-commodity network flows, multi-production and distribution models, and those that arise as a solution procedure for nonlinear, integer, and stochastic programming problems. The decomposition principle, partitioning proposals, and compact inverse schemes will be developed and applied to various special structures. The role of flexible computer languages to assist in the experimental development will be discussed. Prerequisite: Operations Research 340C or equivalent.

3 units, Aut (Dantzig) by arrangement

360. Advanced Reading and Research.

Any quarter (Staff) by arrangement

382. Computer Science Seminar—A variety of special-interest seminars are offered each quarter on such topics as (a) numerical analysis, (b) programming, (c) artificial intelligence, (d) pattern recognition. These seminars cover topics of current research in their respective areas.

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

The following courses offered in other departments may be of especial interest to students of computer science:

Analog Computation—See Electrical Engineering 283.

Data Processing—See Industrial Engineering 141, 141A, 161, 162, 257.

Data Processing in Business Problems—See Business 366, 367.

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.
Mathematics—See Mathematics courses.
Recursion Theory — See Philosophy 293A, B,C.
Statistical Methods of Econometrics — See Economics 272.
Theory of Automata—See Philosophy 162 and Electrical Engineering 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)

The Committee on East Asian Studies administers the master’s program in East Asian Studies, an interdisciplinary program in the humanities and the social sciences encompassing Anthropology, Art, Asian Languages, Economics, Political Science, History, Education, and Philosophy.

Background on East Asia or its languages is not required of applicants to the program, although some background is desirable. Graduate Record Examination is required of all native English-speaking applicants.

The student normally completes this program in two years. About one-half of his work is devoted to studying either Chinese or Japanese. An equivalent of three years of either language is minimally required for the degree; at the same time, students are encouraged to continue with some language work beyond the third year as long as they are in the program. The other half of the student’s work consists of nine non-language courses distributed as follows:

1. A three-course sequence on East Asian civilization (History 91, 92, 93).
2. Three related courses in a department, including at least one seminar in which a research paper on East Asia is written.
3. Three courses related to East Asia selected from departments of the student’s choice.

There is no thesis requirement for the Master’s degree in this program. Inquiries concerning this program should be addressed to the director of the Master’s Program in East Asian Studies, 551 Salvatierra, Stanford University, Stanford, California 94305.

ECONOMICS


Chairman: Lorie Tarshis


Associate Professors: Takeshi Amemiya, Paul A. David, Donald B. Keesing, Serge-Christophe Kolm, Mordecai Kurz, Ronald I. McKinnon, Koji Taira


Affiliated Faculty:

Professors: Roger W. Gray, Bruce F. Johnston, William O. Jones (Food Research Institute)

Associate Professors: William E. Coman (Graduate School of Business), John A. Jamison (Food Research Institute), Henry
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 for 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 Serra House or 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.

Qualified graduate students in economics are given the opportunity for training and research in the special fields of the Food Research Institute. A few courses for undergraduates are conducted by the Institute, as well. Courses offered by the Institute count toward completion of requirements for degrees in economics.

PROGRAMS OF STUDY

BACHELOR OF ARTS

The following Departmental requirements are in addition to the University’s basic requirements for the Bachelor’s degree:

Enrollment in the Department—Students who have not yet taken any economics courses at Stanford may be enrolled in the Department upon request. All other students will be enrolled only if they have had a C average or better in their previous work in economics at Stanford; however, deficiencies in this average may be made up by repeating courses.

Graduation—The student is urged to select his program of study carefully, with a view to his own special needs and interests. His Departmental adviser will be prepared to advise him on his program at any time.

To be recommended by the Department for the degree of Bachelor of Arts in economics, the student must have satisfied the following requirements:

1. Completion of 45 units in courses in economics, and with the permission of the student’s adviser, in the curricula of the Food Research Institute and of Engineering-Economic Systems.
   a) Economics 1, 5, 105, 10, 110, and 111 or their equivalent shall be included in the 45 units. Economics 5 and 10 shall be completed by the end of the junior year.
   b) Economics courses taken at other universities may be included in the 45 units. The Director of Undergraduate Study for the Department will establish the amount of credit to be granted toward completion of the Departmental requirements. However, if the elementary course is repeated at Stanford, credit will not also be given for the elementary course taken at another institution toward the required 45 units, and in any case no more than 5 units credit will be given for such a course.
   c) A minimum of 30 units of courses numbered 100 or above, of which 20 must be taken at Stanford, shall be included in the 45 units, except that for this requirement Economics 190 and 191 will be counted as first- or second-year courses.

2. An average grade of C or better shall have been received for all course units completed at Stanford in economics and the curricula of the Food Research Institute and Engineering-Economic Systems.

3. Completion of a program, approved by the student’s adviser, of at least 25 units
of courses numbered 100 and above (in history, courses numbered 20 or above) in not more than two of the following subjects: cultural anthropology, history, industrial engineering, mathematics including computer science and statistics (including courses in differential and integral calculus numbered below 100 for which full credit is given), philosophy, political science, psychology, and sociology. This requirement may be satisfied on a pass-fail basis so long as this is compatible with the rules of the University.

The Undergraduate Honors Program —
Two programs are offered which lead to a degree of Bachelor of Arts with honors. The purpose of Honors Program I is to encourage more intensive study of economics than is required for the basic major program. The purpose of Honors Program II is to encourage study of economics in close conjunction with other disciplines. The two programs have these requirements in common:

1. Completion of courses in economics numbered 1, 5, 10, 105, 110, and 111.
2. Achievement of a grade point average of at least 3.0 in all economics courses.

The specific requirement of Honors Program I is:

1. Completion of no less than 55 units in economics and the curricula of the Food Research Institute and Engineering-Economic Systems. These units are to include the core courses listed above and 10 units of Honors Seminar 199. The general requirement of 25 units in complementary fields is not waived.

The specific requirements of Honors Program II are:

1. Completion of 70 units in economics and related fields according to a schedule approved in detail by the departmental Director of Undergraduate Studies and undertaken no later than the second quarter of the student’s junior year. These units are to include the core courses listed above. The general requirement of 25 units in complementary fields is waived.
2. Completion of one quarter in the Honors Seminar 199, involving presentation of one or more essays based on the Honors Program.

A candidate for admission to the Honors Program should apply to the Director of Undergraduate Study in the third quarter of his junior year if possible.

ADVANCED DEGREES

MASTER OF ARTS

The University’s basic requirements for the Master’s degree (residence, thesis, etc.) are set forth in the section “Degrees” in this bulletin. The following are Departmental requirements:

Admission to Candidacy—Completion of the Stanford requirements for a Bachelor of Arts degree in economics, or an approximately equivalent training, is required of students who undertake a program of study for the degree of Master of Arts in economics. Provisional enrollment may be permitted, however, in cases in which previous training has been deficient, with the understanding that the deficiency will be remedied in advance of departmental approval of candidacy. Admission to candidacy for the degree will be restricted to students whose record bears promise of successful graduate work.

Recommendation for the Degree—To be recommended to the University Committee on the Graduate Division for the degree of Master of Arts in economics, the student must have satisfied the following requirements:

1. Completion of a program of study at Stanford amounting to not less than 45 units of credit. No courses numbered below 100 and no courses completed with a grade less than C may be counted toward the 45 units required. Ordinarily the program will include at least 30 units of economics, of which at least 15 units (or 10 units in addition to the thesis) must be in courses at the 200 level. Courses in subjects closely related to economics may be included with the approval of the Director of Graduate Study in Economics.

2. Completion of a thesis acceptable to the Department, or of two term papers of acceptable quality in courses numbered 200 or over. Credit will be allowed for the thesis to a maximum of 9 units toward the 45 units required for the degree.

3. An average grade of B or better shall have been received for the first 45 units of course work completed and for all additional units approved by the Department.
DOCTOR OF PHILOSOPHY

The University's basic requirements for the doctorate (residence, dissertation, examination, etc.) are set forth in the section "Degrees" in this bulletin. The following are Departmental requirements:

Admission to Candidacy — The Director of Graduate Study in Economics will recommend the student to the University Committee on the Graduate Division for admission to candidacy for the degree of Doctor of Philosophy in economics when the following conditions have been satisfied:

1. The student must have passed satisfactorily the two comprehensive field examinations in "Price and Allocation Theory" and in "Theory of Income and Economic Fluctuations." These examinations will normally be given at the end of the spring quarter and will cover the subject matter of Economics 202, 203, 204, and 210, 211, 212.

2. Candidates for the Ph.D. degree will be required to demonstrate a reading knowledge of economics in one foreign language, except that additional training may be required of students whose dissertations are concerned with foreign economic systems or require more than ordinary acquaintance with literature in a foreign language. The language selection must be approved by the Director of Graduate Study.

The requirement may be satisfied in either of two ways: (a) by completion with passing grade of a second-year reading course equivalent, for the language concerned, to French 23; (b) by passing a special reading examination, to be given preferably by a qualified member of the Department of Economics or, in place of this, the relevant language department. This examination will be scheduled once annually.

3. The minimum mathematics requirement of the Department is satisfied by successful completion of Mathematics 43 with a grade of C or better, or its equivalent (as judged by an examination administered by the Department). This requirement should be satisfied as soon as possible after first graduate registration in the Department. Those with little or no previous mathematical background are strongly advised to register their first autumn quarter for Mathematics 41.

While the minimum requirements of the Department will be satisfied by Mathematics 43, continuation in mathematics is recommended. The Director of Graduate Study will advise on suitable additional mathematics and statistics courses of use to economists.

Students admitted to the Department to pursue work toward the Ph.D. are normally expected to satisfy the requirements for admission to candidacy by the end of their first year in residence. Hence, previous preparation in mathematics, a foreign language, or both is desirable.

Recommendation for the Degree—Before being recommended for the degree of Doctor of Philosophy in Economics, the student must have completed the following requirements:

1. Qualification in background subjects.
   a) For those who do not elect Econometrics as a field (see below), an acquaintance with the statistical tools used in economics equivalent to Economics 171.
   b) Economics 200. History of Economic Thought. Students will be expected to satisfy this requirement by the end of their second year in residence.

2. Qualification in six fields of study (if no minor subject is offered) or in three fields of study and a minor subject. All candidates without exception will be expected to qualify in "Price and Allocation Theory" and "Theory of Income and Economic Fluctuations." The remaining fields may be chosen according to the following options:
   a) Option A—Without a Minor Subject.
      The preparation required will be determined by the professor or professors in charge of each field and will normally consist of a two-quarter sequence at the 200 level or approximately equivalent preparation. An approved program of study, such as Economic Development in East Asian countries may, at the discretion of the Director of Graduate Study, be substituted for one field. Such programs may include work in other departments. Students electing Option A are expected to complete the requirements in at least five fields by the end of their second year in residence.
1) Economic Development or Economic History

2) Three other fields, one of which may be the field not chosen under 1), chosen from the following list:
   Monetary Theory
   Public Finance
   Labor Economics
   Structure of Industry
   International Economics
   Econometrics
   Mathematical Economics
   Economic Development
   Economic History

b) Option B—With a Minor Subject. Students who elect Option B will be expected, if possible, to complete their minor requirement and the third comprehensive by the end of their second year in residence.

1) Economic History or Economic Development.

2) A minor subject, the choice of which must be approved by the Director of Graduate Study and the requirements for which are determined by the department concerned. Students interested in specializing in Mathematical Economics or Econometrics are encouraged to minor in statistics.

Comprehensive field examinations will be scheduled once annually, usually at the close of the sequence designed to prepare for them. The minimal standard of qualification in each field will be a grade of B on the appropriate examination. However, students will not typically be recommended for the Ph.D degree with a record of only B's in the six comprehensive examinations (Option A). Successful candidates are expected to pass with distinction in some fields of economics.

3. Training in independent research. Participation in two year-long seminars in two fields and preparation of satisfactory reports or papers in each. Under normal circumstances one of the two seminars will be in the field in which the candidate's dissertation lies and his continued participation in that seminar is encouraged. Seminars will in part be designed to assist the student in locating a suitable dissertation topic. Satisfaction of this requirement is expected no later than the end of the third year of graduate residence.

4. Teaching experience. Candidates for the Ph.D. in economics are expected to acquire minimal teaching experience equivalent to that of a teaching assistant in the Department for one quarter. Under exceptional circumstances and upon recommendation of the Departmental Graduate Study Committee, the Director of Graduate Study may excuse a student from this requirement. It is not permitted to satisfy this requirement during the first year of graduate study; it will normally be satisfied by the end of the third year of residence.

5. Satisfactory performance in the University oral examination. Except in special cases, the first four stages of preparation must be completed before the student is admitted to the University oral examination. This examination is held for each student after his Departmental dissertation committee has certified to the Director of Graduate Study in Economics that the dissertation is complete in at least rough-draft form. The examination is based on the dissertation and on the field or fields of economics within which it lies.


Minor for the Degree of Doctor of Philosophy—To be recommended for the degree of Doctor of Philosophy with economics as a minor subject, the student is required to qualify in three fields of economics, one of which must be either “Price and Allocation Theory” or “Theory of Income and Economic Fluctuations.” Qualification in these fields is tested in the Departmental comprehensive written examinations that are given once annually. The standard of achievement in these examinations is the same for minor as for major candidates.

FELLOWSHIPS AND ASSISTANTSHIPS

The attention of prospective graduate students is directed to the fact that the Department awards a number of fellowships for graduate study in economics. These grants range up to $4,000 (inclusive of tuition) with special allowances under certain circum-
stances. Furthermore, students who make a good record during their first year may be assured of favorable consideration for further support for a period of up to three more years. This is true regardless of whether the student has come on a Departmental or an outside (NSF, Woodrow Wilson, etc.) fellowship initially.

Completed application forms for graduate fellowships should be filed before January 15 at the Office of Financial Aids and at the same time as completed application forms for admission are filed with the Admissions Office.

Opportunities for employment as research assistants are also available. The salary scale for half-time employment depends upon the student’s experience and ability.

Qualified graduate students who wish to combine their studies with part-time teaching may apply for teaching assistantships which carry a stipend for three quarters of half-time teaching and a tuition scholarship covering up to half-time tuition and fees. Graduate students may apply for a teaching assistantship without a tuition scholarship if they are not subject to tuition charges or if they do not require scholarship aid.

Entering students are not normally considered for research or teaching assistantships.

**Courses**

*Note* — It is not possible at the date this announcement goes to press to schedule courses accurately for the year. Application should be made to the secretary of the Department after March for information about the exact times at which courses will be given in 1969–70.

1. **Elementary Economics** — The functioning of a modern market economy; the determination of national income and its distribution; the composition of output; the growth of economy.
   5 units, Aut, Win, Spr (Staff) MTWThF 9

2. **Economic Problems and Issues** — Intended for non-majors. A survey of some significant public problems to which the economist can make a policy contribution. The selection will be made from the following list: The Poverty Problem; Economics of Discrimination; Economics of Medical Care; Cultural Institutions in Today’s Economy; Traffic Congestion, Cities and Housing; Economics of Education; International Monetary Reform, and so on. This course may be repeated for credit with the consent of instructor. Prerequisite: 1.
   3 units (Staff)

5. **Economics of Prices and Markets I** — The role of prices in the allocation of economic resources; behavior of consumers and firms; market structure. (May be taken as 105A by graduate students.) Prerequisite: 1 or equivalent.
   5 units, Aut, Win, Spr (Staff) MTWThF 9

6. **Price Theory and Policy** — Content same as Economics 5 but use will be made of mathematical tools in presentation. (May be taken as 106A by graduate students.) Prerequisites: 1 or equivalent and Mathematics 23, 43 or 63.
   5 units, Aut, Win (Staff) MTWThF

7. **Introduction to Statistics** — (Enroll in Statistics 7.) Especially designed for students of economics, sociology and other social sciences.
   5 units, Aut, Win (Anderson) MTWThF 3:15

10. **Money, Income, and Employment I** — An analysis of major sectors and markets in the economic system and of national economic accounts. (May be taken as 110A by graduate students.) Prerequisite: 1 or equivalent.
    5 units, Aut, Win, Spr (Staff) MTWTh

105. **Economics of Prices and Markets II** — Distribution of income; problems in marginal cost pricing; monopoly power, its sources and impact. Topics from general equilibrium, social welfare, uncertainty and in intertemporal allocation fields. Prerequisite: 5.
    5 units (Staff) MTWTh

106. **Price Theory and Policy** — Content same as Economics 105 but use will be made of mathematical tools in presentation. Prerequisite: 6 or consent of instructor.
    5 units (Staff) MTWTh

110. **Money, Income, and Employment II** — An analysis of equilibrium, instability, and growth in the economic system as a whole. Prerequisite: 10.
    5 units (Staff) MTWTh

111. **Money, Income, and Employment III** — An analysis of policies and techniques of
regulation for stability, growth, and other objectives in the economic system as a whole. Prerequisites: 5 and 110.

5 units (Staff) MTWTh

115. Economic History of Western Europe — Historical trends in the Western European economy from 1750 to past the First World War. Emphasis upon the historical characteristics and economic development of Great Britain, France, and Germany. Prerequisites: 5 and 110.

5 units (Staff) MTWTh

116. Economic History of the United States — Historical trends in the American economy from the colonial period to the great Depression; special references to problems of national and regional industrial development, economic stability, and income distribution, including social and political influences thereon. Prerequisites: majors 5 and 10; non-majors 1.

5 units (Staff) MTWTh

117. The Postwar U.S. Economy in Historical Perspective — Analysis of selected aspects of U.S. economic experience since World War II, focusing on forces determining growth, stability and income distribution. References to postwar developments in other industrialized nations; primary emphasis on elements of historical continuity and recent departures in the functioning of the economy. Prerequisites: majors 5 and 10; non-majors 1.

5 units (Staff) MTWTh

118. Underdeveloped Economies — Characteristics of backward economies. Elements and mechanism of development. Emphasis on theory, but attention will be given to policy problems and case studies. (May be taken as 118A by graduate students.) Prerequisites: majors 5 and 10; non-majors 1.

5 units (Staff) MTWTh


5 units (Staff) MTWTh

121. Economic Development of China — 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 and Taiwan. Prerequisites: majors 5 and 10; non-majors 1 and consent of instructor.

5 units, Aut (Staff) MTWTh

122. Economic Development in East Asian Countries — A case study in the modernization and industrialization of non-Western countries. Social change and economic growth in modern Japan since Meiji Restoration. Special emphasis on the post-"takeoff" period and prediction. Prerequisites: majors 5, 10 and 121; non-majors: 1 and 121.

5 units, Win (Staff) MTWTh

123. Economic Development in Latin America — Emphasis on the application of modern economics in Latin America, including the policy implications of economic research. Prerequisite: 1 or the equivalent. Part lecture, part discussion sections.

5 units (Keesing) MTWThF

141. Public Finance and Fiscal Policy — Effects of government expenditure, borrowing, and taxation upon resource allocation, national income and employment, prices, and income distribution. Prerequisites: 5 and 10.

5 units (Staff) MTWTh


5 units (Staff) MTWTh

158. Organization and Social Control of Industry — Methods of evaluating economic efficiency; anti-trust laws and the attempts to preserve competition; economic regulation of public utilities, communications, and transportation. Emphasis on independent study. Prerequisites: 5 and 105, or consent of instructor.

5 units (Rosse) MTWTh

165. International Economics — Comparative advantage in production and trade among nations; international monetary mechanism; domestic monetary, fiscal and tariff policies and their relationship to foreign trade. Prerequisites: majors 5 and 10; non-majors 1.

5 units (Staff) MTWTh
170. Introduction to Econometrics I — Statistical methods of special application to economic problems and special statistical problems encountered in testing economic hypotheses with non-experimental data. Introduction to regression and correlation analysis. Prerequisites: 5, 7, 10 (or Statistics 50), Mathematics 41 or equivalent, or consent of the instructor.

5 units (Staff) MTWTh

171. Introduction to Econometrics II—Application of regression analysis to time series and cross-section data. Problems in the formulation of econometric models and introduction to simultaneous equations. Prerequisites: 5, 7 (or Statistics 50), 10, Mathematics 41 or equivalent, 170, or consent of instructor.

5 units (Staff) MTWTh

180. 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: 105 or 106 or equivalent, Statistics 7, and Mathematics 43 or equivalent.

5 units (Staff) MTWThF

190. Introduction to Accounting—An introduction to the principles and concepts underlying financial reports such as the income statement, statement of financial position, and the "funds" statement, and to the uses of such reports. No prior accounting is assumed. Students who have taken or are now taking a college-level accounting course may not enroll. For majors in Economics, this is considered a lower division course.

5 units, Aut, Win (Staff) MTWTh 8

191. Introduction to Cost Accounting—The use of internal financial data for managerial decision making. Students who have had or are now taking a college-level cost accounting course other than 190 may not enroll. For majors in Economics, this is considered a lower division course. Prerequisite: 190 or equivalent.

5 units, Win, Spr (Staff) MTWTh

199. Senior Seminar in Economics — Advanced specialized topics to be arranged with instructor. Required of all Honors students. Each section will meet throughout the year under the guidance of one instructor. Maximum number of students in each section is ten. Prerequisite: admission to Honors Program or seniors majoring in economics with a minimum grade point average in Economics of 3.0, or consent of instructor.

10 units (Staff)

COURSES PRIMARILY FOR GRADUATE STUDENTS


5 units (Lau, Lewis, Skinner) by arrangement


In each group below, courses marked (*) constitute continuous courses. Registration will be accepted and grades given only for the entire sequence.

Six seminars will be offered in any one year.

A. CORE THEORY CURRICULUM

(Professors Abramovitz, Hickman, Kolm, Kurz, Leland, McKinnon, Reder, Scadding, and Tarshis)

200. Topics in the History of Economic Thought—Landmarks in the development of classical, neo-classical and institutionalist economics; their relation to economic conditions in their time and to modern economics.

5 units (Reder)

*202. Price and Allocation Theory I—Perfect competition. Meaning, conditions of efficiency in economic organization. General and partial equilibrium. Open to advanced undergraduates with consent of the instructor. May be omitted by graduate students with adequate background in the subject. Prerequisite: consent of instructor.

5 units, Aut (Staff)

*203. Price and Allocation Theory II—Different forms of competitive and monopolistic behavior; their effect on efficiency of economic organization. Prerequisite: 202.

5 units, Win (Staff)
5 units, Spr (Staff)

210, 211, 212. The Theory of Income and Economic Fluctuations — Theory of money, employment, income considered from points of view of comparative statics, causes of instability and long-term change. 210 is prerequisite for 211; 210, 211 are prerequisites for 212. Consent of instructor required for 210, 211, 212.
210. 5 units, Aut (Staff)
211. 5 units, Win (Staff)
212. 5 units, Spr (Staff)

301A,B,C. Seminar in Microeconomics.
10 units (Staff) by arrangement

310A,B,C. Seminar in Macroeconomics.
10 units (Staff) by arrangement

B. ECONOMIC DEVELOPMENT
(Professors David, Despres, Keesing, Lau, Manne, and Taira)

215. Economic Development I—Comparative analysis of presently underdeveloped economies. The process of development. Alternative theories of growth. Prerequisites: consent of instructor and 202, 203, 204, 210, 211 and 212.
5 units, Aut (Staff)

5 units, Win (Staff)

218. Development Problems of Latin American Export Economies — (Enroll in Food Research 218.) Introduction to the theory of economic development of open economic systems. Analysis of the effects of integration of national and international markets during the process of economic development, with particular emphasis on post-Independence Latin America.
5 units, Win (Reynolds) WF 4:15–6:05

222. Economic Development in East Asian Countries — An analysis of development problems and policies common to East Asian countries. Emphasis is on agricultural and industrial policies, saving and investment techniques, foreign trade and aid and economic systems.
5 units, Spr (Gurley, Lau, Taira)

223. Economic Development in Latin America — Emphasis on issues of development policy in relation to individual countries in the area. Given seminar style with individual research papers.
5 units (Staff)

10 units (Staff) by arrangement

321. Seminar in Economic Growth — Prerequisite: consent of instructor.
5 units (Staff) 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 pre-industrial and industrializing economies in historical perspective.
5 units, Aut (Staff)

5 units, Win (David)


228. Postwar Growth in Industrialized Countries — Historical and analytic 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 inter-
connections of demand and potential output growth.

325A,B,C. Seminar in Economic History.
10 units (Staff) by arrangement

D. MONETARY THEORY AND INSTITUTIONS
(Professors Gurley and Kolm)

*230. Monetary Theory—Advanced topics in monetary theory with special reference to policy criteria and control techniques. Prerequisite: 211.
5 units, Spr (Kolm)

10 units (Staff) 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.

241. 5 units, Aut (Coen)
242. 5 units, Spr (Kolm)

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

341A,B,C. Seminar in Public Finance—Prerequisite: 241 or consent of instructor.
10 units (Staff) by arrangement

F. ECONOMICS OF LABOR
(Professors Reder and Taira)

5 units (Reder)

*248. Wages and Income Distribution — Wage levels, structure; income distribution, effects of education on earnings, special references to empirical data.
5 units (Reder)

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, Aut (Staff)

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 (Reder)

345A,B,C. Seminar in Labor Economics.
10 units (Staff) 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, Aut (Manne)

256. Economics of Industry II—Investment and growth of the firm; mergers; stochastic theories of industry structure; industry structure, innovation, and technological change;
location and transportation; public utilities; problems in the formation of public policy.

5 units (Rosse)


10 units, (Staff) by arrangement

H. INTERNATIONAL ECONOMICS

(Professors Despres, Keesing, McKinnon, and Tarshis)


5 units, Spr (Staff)

*266. International Trade Theory—Causes of trade and its effects on the allocation of resources, income distribution, growth and development, commercial policies.

5 units, Spr (Staff)

365A,B,C. Seminar in International Economics.

10 units (Staff) by arrangement

I. ECONOMETRICS

(Professors Amemiya, Anderson, Mitchell, and Statistics Department)

270. Theory of Probability—(Same as Statistics 116.) This course covers the material of Statistics 27 in more detail and with more emphasis on mathematical technique. Students are expected to have a good working knowledge of calculus, including infinite series and double integrals. The course is designed to provide an adequate background for all courses whose prerequisite is probability theory. Prerequisite: Mathematics 44 or equivalent.

4 units, Aut (Siegmund) MTWF 11
Win (Staff) MTWF 11
Spr (Miller) MTWF 9
Sum (Staff) MTWThF

271. Elementary Statistical Inference—(Enroll in Statistics 219.) Review of probability; distribution theory; sampling, sampling distributions; univariate, bivariate normal distribution; correlation, regression. Prerequisite: 270.

3 units, Win (Staff) MWF 9

*272. Econometrics I—First quarter of two dealing with the statistical methods of econometrics. Emphasis on multiple regression analysis, tests of linear restrictions, and other single-equation methods and problems. Selected applications in economics. Multivariate normal distribution. Introduction to maximum-likelihood methods. Prerequisites: 271, Mathematics 43, 113, or consent of instructor.

5 units (Amemiya)


5 units (Anderson)

370A,B,C. Seminar in Econometrics.

10 units (Amemiya, Anderson) by arrangement

J. MATHEMATICAL ECONOMICS

(Professor Kurz)

280. Linear Programming—(Enroll in Business 465A.) This course will survey linear programming, emphasizing standard model formulation, fundamental theorems, variations of the simplex method and parametric programs. Students will solve linear program on computer. Prerequisites: Mathematics 113 and 115.

4 units (Staff)

281. Mathematical Programming — Generalized programming, integer programming, decomposition methods, linearization of nonlinear problems, and discussion of current field developments and important applications. Prerequisite: Business 465B.

4 units (Staff)

282. Nonlinear Programming and Welfare Economics—Necessary and sufficient conditions for optima under inequality constraints. Methods of solution. Applications to optimization in economics at the levels
of the firm and of the economy. Prerequisites: Business 465A, Mathematics 113 and 115.

3 units (Staff)


3 units (Staff)

284. Advanced Dynamic Programming: Optimal Economic Growth—Current techniques for optimal policies of consumption and capital accumulation. Prerequisite: Operations Research 351 or consent of instructor.

3 units (Staff)

285. Special Topics in Mathematical Economics—The topics for 1969–70 will be announced. May be repeated for credit. Prerequisites: consent of instructor and working knowledge of differential calculus.

5 units (Staff)

385A,B,C. Seminar in Mathematical Economics.

10 units (Staff) by arrangement

ENGLISH

Emeriti: John W. Dodds, Herbert D. Meritt (Professors)

Chairman: Ian P. Watt

Director of the Creative Writing Center: Richard P. Scowcroft


Associate Professors: W. B. Carnochan, J. Martin Evans, Charles N. Fifer, H. Bruce Franklin, Albert J. Gelpi, Robert M. Polhemus, Fred C. Robinson, Lucio P. Ruotolo.

Assistant Professors: John B. Bender, Emerson L. Brown, Jr., William M. Chace, John Felstiner, Kenneth W. Fields, Patrick K. Ford, Larry Friedlander, David Halliburton, Dale Harris, Anne T. Kostelanetz, Diane W. Middlebrook, Nancy H. Packer, Ronald A. Rebholz, David R. Riggs, Jr., David W. Williams

Lecturers: Clark T. Brown, Barbara C. Gelpi, Edward P. McClanahan, Elizabeth C. Traugott, Helen P. Trimpi, Janet L. Winters, Al Young

The Department of English offers work in English and American Literature, English Philology, and Creative Writing. In connection with these programs, it maintains the William Dinsmore Briggs Memorial Library for the use of graduate students and the Jones Room in the University Library as a center for its work in Creative Writing. The Jones Room includes a library, records, and facilities for small meetings.

PROGRAMS OF STUDY

BACHELOR OF ARTS

The following Departmental requirements are in addition to the University's basic requirements for the Bachelor's degree. Only students who have achieved a C average in courses counting toward the Departmental major will be recommended for graduation.

1. Students majoring in English are required to take one course from each of the six divisions listed below; at least four divisions must be represented by starred courses.

a) Language: English 102*, 208, 209.


SCHOOL OF HUMANITIES AND SCIENCES

2. Students are required to take at least three additional courses (15 units) in English.
   a) All students (except those majoring in Creative Writing) may select their 15 units of electives from the six divisions above and from these other options: English 100, 155, 171, 172, 192, 196, 198, 199, 205, 251, 265, 272, 278, and 279. Strongly recommended are seminars in English and American literature (English 192 and 196) and Senior Independent Study (English 199).
   b) Students wishing to major in Creative Writing are required to take, in addition to the six courses in the six divisions, the following:
      for fiction writers, Narration (English 5), Development of the Short Story (English 198), plus 8 units of Directed Writing (English 133) or of a more advanced course, all with grades of B or better; for poets, Directed Writing of Poetry (English 134), The English Lyric (English 251), plus 8 units of the Writing of Poetry (English 201), all with grades of B or better.

3. Although no formal minor program is required of English majors, all students are strongly urged to take as many relevant courses as possible in other departments. Faculty advisers will assist students in determining the appropriateness of particular courses for individual major programs. Students intending to teach at a college or university should remember that most graduate schools require, for the doctorate in English, a reading knowledge of two or three foreign languages.

Honors Program in English

Students who wish to undertake a more intensive and extensive program of study, including seminars and independent work, are invited to apply for admission to the Honors Program, preferably during their sophomore year and no later than the autumn quarter of their junior year. Admission will be selective.

Students admitted to the program will be responsible for covering the works on an Honors Reading List comprising major works in five literary areas (see above: b, c, d, e, and f). They may do so either by taking equivalent courses in any or all of these areas or by studying the works independently and taking an examination on them at the end of their Senior year. The “equivalent courses” are as follows:

Medieval (area b)—141 and either 231 or 181
Renaissance (area c)—182, or 143A or B, or 236 and one other Renaissance course
Restoration and Eighteenth Century (area d)—183, or two other courses in the period
Nineteenth and Twentieth Century (area e)—184, or one nineteenth century and one twentieth century course
American Literature (area f)
   1. 1630–1855—177
   2. 1855–1969—178, or one other course in the period

Honors students may thus decide for themselves how many and which areas of the Reading List they are going to cover by means of courses, and by independent reading and examination. In their Junior year students in the program will take one of two Junior Honors Seminars (188A), focusing on the close reading of a literary text or series of texts chosen at the instructor’s discretion, and in their Senior year one of two Senior Honors Seminars (188B), focusing on fundamental questions of literary-critical theory and practice. In addition, students will take a course in the English language (102, 208 or 209), and two elective courses, one of which should be numbered 200 or above.

Finally, in their Senior year students will write a Senior Honors Essay (190). They should submit to the Honors Committee a detailed prospectus, a short annotated bibliography and a more extensive prospective bibliography at the beginning of the autumn quarter 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.

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'. They will have completed a minimum of 60 units of work in English and American Literature, as follows:

Area requirements (a through f) and elective courses—at least 40 units
Two Honors Seminars—10 units
Senior Essay—10 units

Note—Since the major in Creative Writing is limited to students with special aptitudes, it is also regarded as an Honors Program.

**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 Chairman of each of the departments concerned.

**HONORS PROGRAM IN HUMANITIES**

An Honors Program in Humanities is offered for majors of this Department who wish to supplement their Departmental major by a related and carefully guided program of studies. See the section “Humanities Special Programs” for a description of the Honors Program.

**TEACHERS' CREDENTIALS**

Students wishing to obtain the Standard Teaching Credential (Secondary) entitling them to teach in grades 7-12 in the public schools of California, or a Junior College Credential for grades 13 and 14, should consult the statement on credentials under “School of Education” in this bulletin and the Credential Secretary of the School of Education for the requirements.

1. General Secondary Credential. Candidates for the Stanford General Secondary Credential with a teaching major in English are required to take the following Departmental courses or their equivalents:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>English 1, 2, 3. Freshman English</td>
<td>9</td>
</tr>
<tr>
<td>One course in the English language, English 102 or 209</td>
<td>5</td>
</tr>
<tr>
<td>English 208. Introduction to Modern Linguistics</td>
<td>5</td>
</tr>
<tr>
<td>English 204. Advanced Exposition</td>
<td>3</td>
</tr>
<tr>
<td>English 143A, B. Shakespeare</td>
<td>5</td>
</tr>
<tr>
<td>English 182. Introduction to the Renaissance</td>
<td>5</td>
</tr>
<tr>
<td>English 183. Neoclassicism</td>
<td>5</td>
</tr>
</tbody>
</table>

Total. ........................................................................ 42

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 Grommon, School of Education and Department of English.

3. Master of Arts in Teaching. The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and wish further to strengthen their academic preparation. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education. Detailed requirements for the course are outlined in the School of Education section.

ADVANCED DEGREES

For University regulations governing advanced degrees see the section "Degrees" in this bulletin.

Eligibility — A student may enter upon graduate work toward an advanced degree in English at Stanford if he has received a Bachelor's degree of acceptable quality. (Formal application for candidacy is a separate step taken somewhat later.) Students whose previous preparation falls short of the requirements for the degree of Bachelor of Arts in English at Stanford must expect to spend more than the minimum time in residence. Credits for previous graduate work at Stanford or elsewhere more than five years old may be reevaluated or rejected.

Only candidates for the Ph.D., the Master of Arts in an approved Credential Program, the Master of Arts in Teaching (MAT), or the Master of Arts in Creative Writing, will be accepted as graduate students.

Candidates in an approved 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 qualify-
ing 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, insuring coverage in genres and periods.

3. A minimum of 48 additional units of graduate courses and seminars (200-399), distributed according to the adviser's judgment and the candidate's needs.

4. A written qualifying examination to be taken at the end of the summer after the first year of graduate work. This examination will be based largely upon a reading list supplied the student at the time of his acceptance at Stanford.

5. A university oral examination to be taken no later than the winter quarter of the student's third year of graduate work. This examination will cover (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 either 311 or 312, except that the candidate may omit 312 instead of 311 only if he has had a course in Chaucer or other Middle English writers.

2. A minimum of 28 units of graduate courses (200-399) in American literature and 28 units in English literature, including at least two seminars in each. The four seminars should be in different periods and genres as approved by the adviser; at least three must be taken at Stanford.

3. At least 8 units of electives to be distributed between English and American literature according to the adviser's judgment of the candidate's background.

4. A written qualifying examination to be taken at the end of the summer after the first year of graduate work. This examination will be based largely upon a reading list supplied the student at the time of his acceptance at Stanford.

5. A university oral examination to be taken no later than the winter quarter of the student's third year of graduate work. This examination will cover the period of the dissertation, together with plans for the dissertation itself based upon a prospectus approved by the adviser.

Requirements of the Ph.D. program in
English and comparative literature are as follows:

1. A knowledge of English literature since 1350 comparable to that demanded of candidates for the Ph.D. in English literature. Candidates will take the appropriate parts of the qualifying examination at the end of the summer after the first year of graduate work.

2. A knowledge of the basic structure of the English language (including the structure of Old English) and of Chaucer. This requirement may be met by examination, or by taking eight units of courses chosen from among those offered in linguistics, English philology, and early and middle English literature including Chaucer.

3. A knowledge of two foreign languages comparable to that demanded under the basic program and an advanced knowledge of a third language; or, an advanced knowledge of two foreign languages.

4. A minimum of 36 units in the history, thought, and literature of one period, in two or more languages, one of which must be English and one European. As much as 24 units of this requirement may be satisfied through courses in Reading and Research.

5. A minimum of four seminars, of which at least three must be in the English Department. No more than two of the four required may be in the same genre or period.

6. A university oral examination covering the period of the dissertation and plans for the dissertation itself. This examination, based on a reading list established by the candidate in consultation with his adviser, should be taken no later than the winter quarter of the third year of graduate study.

Language Requirements—All candidates for the Ph.D. degree (except those in English and comparative literature) must demonstrate a reading knowledge of Latin, German, and French. Another modern foreign language may be substituted for German or French if it is required for the student's projected research. The student will find it to his advantage if he arrives at Stanford with adequate training in at least two foreign languages.

Foreign language requirements for the Ph.D. may be fulfilled in 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.

The student must satisfy one foreign language examination during his first year; a second by the end of his second year; and a third by the end of his third year. Only students who have qualified in all three languages, and have also passed the oral examination, are eligible for dissertation fellowships.

Dissertation—As early as possible during his graduate study, a Ph.D. candidate will be expected to find a topic requiring extensive original research and to enlist the services of a member of the Department as his adviser. The adviser will request the 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
the candidate expects to receive his Ph.D. degree. Dissertations may not be submitted during the summer quarter.

GRADUATE PROGRAM
IN HUMANITIES

The Department of English participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in English and Humanities. For a description of the Humanities program, and fellowships offered in connection with it, see the section "Humanities Special Programs."

COURSES PRIMARILY FOR UNDERGRADUATES

#1, 2, 3. Freshman English—Writing, chiefly expository, emphasizing the control of meaning through critical and creative thinking, and through mastery of style. Introduction to the criticism of literature. (Rebholz, Director, Bender, E. Brown, Carnochan, Chace, Felstiner, Fields, P. Ford, Franklin, Friedlander, Harris, Middlebrook, Riggs, Williams, and Staff.)

1. Studies of the individual in modern society by essayists, fiction writers, and a few poets.
   3 units, Aut

2. An introduction to fiction, drama, and poetry as literary genres.
   3 units, Win

3. A variety of subjects of humanistic interest.
   3 units, Spr

#1A, 2A; 1B, 2B; 1C, 2C. Freshman English—These courses fulfill the Freshman English requirement and students are admitted upon application. The classes are taught by regular members of the English faculty and have seventy-five students each. They run for two quarters, carrying four units in the fall and five in the winter. Each course will focus on one theme. Students will have one lecture each week and spend the rest of the time in small groups or tutorial. The emphasis in these courses, as in regular Freshman English courses, will be on writing.

1A, 1B, 1C. 4 units, Aut
2A, 2B, 2C. 5 units, Win

#1F, 2F. Freshman English—For foreign students.

1F. A specially designed course in expository writing which undergraduate foreign students may substitute for 1.
   3 units, Win

2F. Continuation of 1F.
   3 units, Spr

#4. Freshman English (Seminars)—Open by invitation to a limited number of students of creative ability who have already shown (in English 1 or 2) the capacity to write lucid expository prose. There will be small groups devoted to various kinds of writing, including fiction and poetry. The seminar may replace, for those invited, one quarter of regular Freshman English.
   3 units, Win, Spr (Rebholz, Director, Staff)

5. Narration—Basic problems of narrative and imaginative writing. Prerequisite: 3 or 4.
   3 units, Aut (Moffat) (I) MWF 11; (Packer) (II) MWF 1:15; (Young) (III) MWF 1:15
   Win (Moffat) (I) MWF 11; (McClanahan) (II) MWF 1:15; (Young) (III) MWF 1:15
   Spr (Moffat) (I) MWF 11; (McClanahan) (II) MWF 11; (Young) (III) MWF 1:15
   Sum (Rosenberg) MWF 1:15

#7. Masterpieces of English Literature—Intensive study of a few masterpieces of English literature from various centuries, including poetry, drama, the essay, the novel.
   4 units, Spr (Riggs) MTWTh 10

#9. Masterpieces of American Literature—Intensive study of a few masterpieces of American literature, including poetry, drama, the essay, the novel.
   4 units, Win (Chace) MTWTh 1:15

#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 10
   Spr (Bender) 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 pre-
sent 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. Reading list: Don Quixote, Huckleberry Finn, As I Lay Dying, Felix Krull, Our Mutual Friend, The Secret Agent, The Lime Twig, Moby Dick

4 units, Spr (Harris) MWF 9

76. Introduction to Poetry—Prosody, poetic forms and types, critical theories regarding poetry. Masterpieces of English poetry will be studied in the light of these theories.

4 units, Aut (Stone) MTWF 11
Win (Middlebrook) MThW 11

77. Introduction to the Drama—Principal dramatic forms; development of dramatic art; masterpieces of the theater from various periods, countries.

4 units, Spr (Friedlander) MTWF 11


100. The English Bible as Literature—Readings in Old and New Testaments and selected books of the Apocrypha, with some attention to the history of the English Bible and use made of Biblical themes in English literature.

5 units, given 1970-71

102. Introduction to the English Language—Designed to give the student a knowledge of fundamental matters about the English language; to familiarize him with terminology, classification of language; to enable him to form standards of judgment about good English.

5 units, Win (Robinson) TThF 11
Spr (P. Ford) TThF 11

129. Scientific Writing — Advanced course in exposition especially for science engineering majors. Prerequisite: 3, or equivalent. Open to juniors and seniors only.

3 units, Spr (----) MWF 9

133. Directed Writing: Fiction—Intermediate course in which the student is to practice various forms of fiction on his own initiative. Open to sophomores so far as space permits.

May be repeated for credit. Prerequisite: 5.

3 to 5 units,

Aut (Packer) (I) MW 2:15-4:05; (Young) (II) MW 2:15-4:05; (----) (III) TTh 2:15-4:05
Win (Packer) (I) MW 2:15-4:05; (McClanahan) (II) MW 2:15-4:05
Spr (Rosenberg) (I) MW 2:15-4:05; (----) (II) TTh 2:15-4:05
Sum (Rosenberg) MW 2:15-4:05

134. Directed Writing: Poetry—Intermediate course in writing various types of verse. May be repeated for credit.

4 units, Aut (Fields) TTh 2:15-4:05
Spr (W. Trimpi) MWF 9

135. Fiction Writing—Designed for seniors in creative writing.

3 to 5 units, Spr (Rosenberg) TTh 2:15-4:05

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) MW 2:15-4:05

141. Chaucer — Enrollment in any given term limited to 70. Each student must sign up in the Department office during May pre-registration for a place in one of the sections taught the following year.

5 units, Aut (Ackerman) TThF 11
Win (E. Brown) MTWF 11
Spr (E. Brown) TThF 11

142. Spenser and the Renaissance Tradition.

5 units, Win (Bender) MTWF 11

143A. Shakespeare — Intensive study of eight plays. Selections will include histories, tragedies, and comedies from the major periods of Shakespeare’s art. Intended primarily for English majors and prospective majors. Either 143A or B satisfies the requirement for English majors in the Renaissance division.

5 units, Win (Rebholz) MTWF 11

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 9

144. Milton.

5 units, Win (Sensabaugh) TThF 9
145. Donne and Jonson.
5 units, Spr (W. Trimpi) MWTh 1:15

146. Swift and Pope.
5 units, Spr (Carnochan) MTWF 10

147. Johnson and His Circle.
5 units, given 1970-71

5 units, Win (N. Ford) MTWTh 10

149. Byron, Shelley, and Keats.
5 units, Aut, given 1970-71

150. Dickens and Trollope.
5 units, given 1970-71

151. Matthew Arnold.
5 units, given 1970-71

152. Browning and Tennyson.
5 units, Aut (Stone) MTWF 9

154. Modern British Comic Writers — The nature and uses of comic modes — Wilde, Shaw, Waugh and others.
5 units, Spr (Felstiner) MTWF 11

5 units, Aut (Guerard) MTWTh 11

171. Contemporary Drama.
5 units, Aut (Friedlander) MTWF 9

172. Forms of the Modern Novel—Studies in major English, American, and Continental novelists from 1850 to the present.
5 units, given 1970-71

173. Twentieth Century English Fiction.
5 units, Spr (Scowcroft) MTWTh 1:15

5 units, Aut (Levin) MTWF 9

175. Literature of Black America.
5 units, Spr (Chace) MWThF 1:15

177. American Literature to 1855.
5 units, Win (Levin) MTWF 9

178. American Literature, 1855 to the Present.
5 units, Spr (Simpson) MWF 9

181. The Earliest English Literature—Cultural backgrounds, reading (in translation), and critical analysis of Anglo-Saxon heroic legend, elegies, and other forms.
5 units, Aut (Robinson) MTWTh 1:15

181A. Introduction to Medieval Celtic Literature.
5 units, Win (P. Ford) TTh 1:15
and one hour to be arranged

182, 183, 184. English Literature—A basic survey. Students will attend two or three general lectures weekly and participate in a two-hour seminar.

182. Introduction to the Renaissance.
5 units, Aut (Rebholz) MWF 10; seminars by arrangement

183. Neoclassicism.
5 units, Win (Loftis) MWF 10; seminars by arrangement

5 units, Spr (Stone) 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
Spr (Chace) MW 4:15-6:05

188B. Senior Honors Seminar.
5 units, Win (Felstiner) (I) MW 4:15-6:05
Spr (Riggs) (II) by arrangement

189. Special Work—Under exceptional circumstances advanced undergraduate students may enroll for special work under supervision of some member of the Department for credit not to exceed five units a quarter.
Any quarter, by arrangement

190. Tutorial Work, Department Honors Program.
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 (Harris) MW 2:15-4:05;
Win (Carnochan) (I) TTh 2:15-4:05;
(N. Ford) (II) TTh 2:15-4:05
Spr (Halliburton) (I) MW 2:15-4:05;
(Williams) (II) MW 2:15-4:05
196. Seminar in American Literature.
5 units,
Aut (Halliburton) (I) MW 2:15-4:05;
(Chace) (II) MW 4:15-6:05
Win (Grommon) (I) MW 2:15-4:05;
(A. Gelpi) (II) MW 2:15-4:05
Spr (Middlebrook) (I) MW 2:15-4:05;
(Fields) (II) TTh 4:15-6:05

198. Development of the Short Story—Required of senior creative writing students in fiction. Open to others as space allows.
5 units, 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)

Undergraduate Special 103. Modern Thought and Literature: The Impulse To Confess—Interdisciplinary seminar. See instructor.
5 to 10 units, Win (Guerard)
See also Senior Colloquia.

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

Note — Though these courses are designed primarily for English majors, graduate students in other departments who wish to broaden their programs will find many of them useful on the same basis as the Graduate Division Special Courses. Graduate students enrolled in any of the 5-unit courses below will take them for 4 units.

201. The Writing of Poetry—Primarily for students seriously interested in the composition of poetry. First- and second-year students may be admitted to this course. Consent of the instructor required. May be repeated for credit.
2 to 5 units, Aut (Davie) MW 2:15-4:05
Win (Fields) 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 writing with the Creative Writing secretary at least ten days before the beginning of each quarter.
2 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 for professional purposes. Prerequisite: 3 or equivalent.
3 units, Aut (——) MWF 3:15
Sum (——) MTWThF 10

205. The History of Literary Theory.
5 units, given 1970–71

208. Introduction to Modern Linguistics—A survey of current developments in the study of Modern English with some attention to their applications in the teaching of English.
5 units, Aut (Traugott) MWF 2:15

5 units, Sum (Ackerman) MTWThF 11

230A. Medieval to Renaissance: The Development of Literary Forms.
5 units, given 1970–71

230B. Continuation of 230A.
5 units, given 1970–71

231. Medieval Literature—An introduction to the literature of medieval England, exclusive of Chaucer. The Anglo-Saxon poems are read in translation, the major poems of the fourteenth and fifteenth centuries in the original language. Prerequisite: 141 or equivalent.
5 units, Aut (E. Brown) MTWThF 1:15

5 units, Win (W. Trimpi) MWF 11

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 (Riggs) MTWTh 1:15
ENGLISH 201

   5 units, Spr (Sensabaugh) TWTTh 10

238. Drama of the Restoration and Eighteenth Century.
   5 units, given 1970–71

241. The English Novel through the Eighteenth Century—Study of the most significant novels, with emphasis on development of the form.
   5 units, Aut (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 (Stone) MTWTh 1:15

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, Win (Guerard) MTWTh 11

248. Poetry and Ideas: Johnson to Blake.
   5 units, Spr (Davie) MTWTh 11

251. The English Lyric—Historical examination of lyric poetry considered in respect to distinctions and historical relationships of schools and movements.
   5 units, given 1970–71

   5 units, given 1970–71

260A. The Poet in America: To 1910—260A may be taken independently of 260B.
   5 units, Win (A. Gelpi) MWF 10

260B. The Poet in America: Twentieth Century—260B may be taken independently of 260A.
   5 units, Spr (A. Gelpi) MWF 10

263. Emerson, Whitman, and Emily Dickinson.
   5 units, given 1970–71

   5 units, given 1970–71

265. Hawthorne and Melville.
   5 units, Aut (Franklin) MTWTh 1:15

266. Chief American Poets, from 1630 to the Present.
   5 units, Aut (Fields) MTWF 11

267. Emerson and Thoreau.
   5 units, Spr (Grommon) MTWTh 1:15

268. Narrative Prose in America—A study of most significant nonfictional narrative works, with emphasis on history and biography, including autobiography.
   5 units, Aut (Levin) MTWF 11

269. Twain, Howells, and James.
   5 units, Aut (Simpson) MTWF 9

270. Contemporary American Fiction—Study of representative novels and stories from Hemingway to Nabokov.
   5 units, given 1970–71

271. Modern Southern Writers.
   5 units, Aut (A. Gelpi) MTWTh 10

272. Twentieth Century British and American Poetry.
   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 1970–71

275. British Drama Since 1945.
   5 units, Win (Harris) MWF 11

279. Science Fiction.
   5 units, Spr (Franklin) MTWTh 10

280. Towards an Understanding of Modernism—Study of some major European writers from Kierkegaard to Rimbaud who helped shape the themes and forms of modern literature.
   5 units, Spr (Lindenberger) MTWTh 11

299. Advanced Work in Writing and Criticism.
   Any quarter, by arrangement

Curriculum and Instruction in Secondary School English I—See Education 262.

GRADUATE COURSES

Note—All graduate seminars are limited in enrollment. Students must obtain the approval of the instructor and sign his seminar list before registering.
300. Thesis.
   Any quarter, by arrangement

302. Introduction to Renaissance Bibliography—An introduction to tools and methods for graduate study in the Renaissance, especially historical and textual research. Recommended for students who expect to do advanced work in the Renaissance.
   1 unit, Spr (Rebholz) T 1:15

304. Seminar in Modern Literary Criticism—304A and B may be taken independently, but they are planned as a sequence and students intending to take both will be given priority in enrollment.
   304A. The Anglo-American Traditions.
       4 units, Aut (Lindenberger)
       TTh 2:15-4:05
   304B. The Continental Traditions.
       4 units, Win (Halliburton)
       TTh 2:15-4:05

305. Seminar in the History of Literary Theory.
   305A. The Classical and Medieval Backgrounds—305A may be taken independently of 305B.
       4 units, Win (W. Trimpi) MW 2:15-4:05
   305B. The Renaissance—Prerequisite: 305A.
       4 units, Spr (W. Trimpi) MW 2:15-4:05

306. Seminar in the Criticism of Poetry.
   4 units, given 1970–71

307. Seminar in the Novel—Prerequisite: the equivalent of 241, 242, 265, or 270.
   307A. Critical Analysis.
       4 units, Aut (Scowcroft) MW 2:15–4:05
   307C. Conrad.
       4 units, Win (Guerard) MW 4:15–6:05
       4 units, given 1970–71

   4 units, given 1970–71

309. Early Welsh.
   4 units, Spr (P. Ford) TWTWF 9

310. Old English—Elements of Old English grammar; reading exercises.
   4 units, Aut (P. Ford) (I) TWTWF 9;
      (Robinson) (II) MTWTWF 10
   Sum (Ackerman) MTWTWF 9

311. Beowulf—Prerequisite: 310 or equivalent.
   4 units, Win (Robinson) TWTWF 9

312. Middle English—History, dialects of Middle English; readings of representative selections from the literature. Prerequisite: 310 or equivalent.
   4 units, Win (Ackerman) MTWF 10

   4 units, given 1970–71

316. Seminar in Elizabethan Language—Vocabulary, pronunciation, grammar, orthography of the period. Prerequisite: 312 or equivalent.
   4 units, given 1970–71

318. Seminar in Middle English Literature—Prerequisite: 312 or equivalent.
   4 units, Aut (Ackerman) MW 2:15–4:05

319. Seminar in the Philological Study of Literary Texts.
   4 units, given 1970–71

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, Spr (E. Brown) TTh 4:15–6:05

321. English Literature of the Fifteenth Century.
   4 units, given 1970–71

322. Seminar in Medieval Drama.
   4 units, given 1970–71

323. Seminar in Medieval Latin.
   4 units, given 1970–71

325. Shakespeare Seminar—Prerequisites: the equivalent of 43 or 143A,B; 182 or 330; and 237.
   4 units, given 1970–71

327. Seminar in 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, Win (Lindenberger) TTh 2:15–4:05

   4 units, Spr (Ryan) MW 4:15–6:05
331A. Sir Philip Sidney and His Circle.  
4 units, given 1970–71

331B. Ben Jonson.  
4 units, given 1970–71

331F. English Poetry From 1590 to 1620.  
4 units, Spr (Rebholz) TTh 4:15–6:05

4 units, Aut (Kocher) TTh 4:15–6:05

332B. Francis Bacon and His Times.  
4 units, given 1970–71

332C. Marlowe and His Contemporaries.  
4 units, given 1970–71

334. Proseminar: Seventeenth Century  
4 units, Aut (Sensabaugh) TTh 2:15–4:05

335. Seminar: Forms of Renaissance Drama.  
4 units, Aut (Sensabaugh) TTh 2:15–4:05

4 units, given 1970–71

4 units, given 1970–71

4 units, Win (Carnochan) 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 1970–71

341B. Studies in Dryden, Swift, and Pope.  
4 units, given 1970–71

341C. Johnson and His Circle.  
4 units, given 1970–71

341D. Literature and Society in the Eighteenth Century.  
4 units, Spr (Carnochan) MW 2:15–4:05

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 1970–71

351C. Nineteenth Century Poetry.  
4 units, Sum (N. Ford) TTh 4:15–6:05

4 units, given 1970–71

354. Victorian Prose: Carlyle, Ruskin, and Arnold.  
4 units, Spr (Harris) MW 2:15–4:05

355. Pater and the Pre-Raphaelites.  
4 units, Spr (B. Gelpi) MW 4:15–6:05

358. Seminar: Literary Problems of the Nineteenth Century—Prerequisite: 184 or 350, or equivalent.

358A. Nineteenth Century Comic Fiction.  
4 units, Win (Watt) TTh 4:15–6:05

358B. Romanticism: Fact or Fiction?  
4 units, Spr (B. Gelpi) MW 4:15–6:05

361. Seminar in American Critics.  
4 units, given 1970–71

4 units, given 1970–71

371. Seminar in American Historians as Men of Letters—Prerequisite: 268 or equivalent.  
4 units, given 1970–71

4 units, Aut (A. Gelpi) TTh 2:15–4:05

377. Seminar in American Literature of the Colonial Period—Prerequisite: 177 or equivalent.  
4 units, Spr (Levin) MW 4:15–6:05

381. Seminar in Problems in American Literature of the Nineteenth and Twentieth Centuries.

381A. Studies in James, Conrad, and Ford.  
4 units, given 1970–71
381B. Studies in Realism and Naturalism.
4 units, Win (Simpson) MW 2:15-4:05

381C. Seminar in American Literature of the 1840's—Study of the major works of this decade (beginning with Emerson's *Essays* and *The Deerslayer* in 1841 and ending with *Moby-Dick* and *Uncle Tom's Cabin* in 1851-52) in relation to each other and to the major issues of the time.
4 units, given 1970-71

381D. Faulkner.
4 units, given 1970-71

381E. Ezra Pound.
4 units, Spr (Davie) TTh 2:15-4:05

381F. Modern Southern Fiction.
4 units, given 1970-71

381G. T. S. Eliot.
4 units, Spr (A. Gelpi) 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 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.
4 units, Win (Franklin) MW 2:15-4:05

383. The Existential Hero in Twentieth Century British and American Fiction.
4 units, given 1970-71

384. Literature of World War I.
4 units, given 1970-71

385. Modern Thought and Literature: Studies in Literature and Psychology—An interdisciplinary seminar. The initial seminar will consider, in addition to the announced topic, the implications of “Modern Thought and Literature” as a separate field.
4 units, Aut (Guerard) MW 2:15-4:05

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

399. Seminar in the Teaching of Composition—Open only by consent of the Director of Freshman English.
2 units, Spr (Rebholz) W 7-9 p.m.

The English Review Club meets twice quarterly to discuss recent publications and creative work of interest to graduate students in English.

**FRENCH and ITALIAN**

Emeriti: Georges E. Lemaitre, Roberto B. Sangiorgi, Stanley A. Smith (Professors); Jessie E. Smith (Assistant Professor)
Chairman: Raymond D. Giraud
Associate Professors: William C. Calin, Pauline Newman-Gordon, Ralph M. Hester
Assistant Professors: Marc Bertrand, Michael T. Cartwright. Acting: Charles Klopp, Michael Leone
Lecturers: John G. Barson, Marguerite Bauer, Chio P. Dorr, Leda S. Mussio, Jacqueline Ollivier, Jeanne-Françoise Rouffanges

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 54 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 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) offered in Italian and must show considerable language proficiency.

Candidates are expected to complete a minimum of 36 units, selected with the approval of their adviser, from courses numbered 100 or higher. These 36 units must include Italian 111, 112, 113, 130, 131, and 132, plus 18 additional units in literature to include Italian 150, 151, and 152. With the approval of their adviser, candidates may replace one or two courses with courses in related disciplines, such as History, Art History, and Classics.

**Teaching Credentials**

For information concerning the requirements for teaching credentials, consult the “School of Education” section of this bulletin and the Credential Secretary, School of Education.

**Master of Arts in Teaching**

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and wish further to strengthen their academic preparation. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education. Detailed requirements for the course are outlined in the School of Education section.

**Departmental Program in Tours — (For French majors only.)**

Each year French majors, in their sophomore or junior year, may apply for the Departmental program at the University of 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:

   a) Cours de style avancé French 210 3
   b) Three courses in philology French 310, 311, 312 9
   c) Five graduate courses in literature 15
   d) One seminar 3
   e) French 399 (thesis) or electives to be chosen with the approval of the graduate adviser 6

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 courses in literature (beyond those required for the A.M.) at the 300 level; four additional seminars in literature, at least two of which are to be outside the candidate's special field of interest. The total of literature courses and seminars must include at least six units of work in each major period.

3. Oral and written examinations. The student must pass, normally in the autumn quarter of the third year of graduate study, oral and written examinations in four fields of French literature, plus philology and the history of the French language, a field being defined as a century. For examination purposes, centuries are grouped as follows: I, Middle Ages, sixteenth and seventeenth century; II, eighteenth, nineteenth and twentieth century. Students will be examined in two centuries 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.

MASTER OF ARTS: ITALIAN

Applicants for the Master of Arts in Italian must have an undergraduate major in Italian with an average grade of B (or the equivalent).

1. Language requirements. Reading knowledge of a second Romance language, to be demonstrated by passing an examination. Recommended: French.

2. Course requirements:

   a) Six courses in Italian literature numbered 200 or higher 18
   b) Introduction to Romance Linguistics, 310 3
   c) Three courses selected from advanced undergraduate or graduate courses in Italian literature or in a related discipline (e.g., Art 210, 211, French 341, 342, etc.) 9
   d) Thesis 6

Total 36

GRADUATE PROGRAM IN HUMANITIES

The Department of French and Italian participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in French and Humanities. For a description of that program see the section “Humanities Special Programs.”

COURSES OPEN TO ALL STUDENTS

The courses in this section do not require a knowledge of any language other than English.

GENERAL COURSE

FRENCH

#50. Courtly Love in the Middle Ages — The development of courtly love as it is embodied in masterworks of medieval literature.

3 units, Win (Calin) MW 3:15
FRENCH AND ITALIAN

#60. Molière—Representative comedies of Molière in English translation.
3 units, Aut (Weinstein) TTh 1:15

#70. The Nineteenth Century French Novel in Translation—The “romantic realists”: Stendhal, Balzac, Flaubert, and Zola.
3 units, Win (Giraud) TTh 11

#71. Contemporary French Novelists — Significant authors of contemporary France: Proust, Gide, Malraux, Sartre, Camus, etc. Lectures, readings in English.
3 units (Cohn) given 1970–71

#90. The Committed Writer in France from Montesquieu to Sartre—Literary writers who have incorporated a political or social point of view in their fictional works.
3 units (Weinstein) given 1970–71

ITALIAN

#75. Dante in English—Reading, interpretation of The Divine Comedy in translation.
3 units, Win (Cecchetti) MF 3:15

#80. The High Renaissance—A study of the apogee and decline of the Renaissance in Italy in such authors as Machiavelli, Guicciardini, Ariosto, Tasso, and Giordano Bruno.
3 units, Spr (Klopp) MW 3:15

#140. The Contemporary Italian Novel in Translation—Reading, discussion of significant novels of such authors as Verga, Pirandello, Svevo, Vittorini, Pavese, Moravia.
3 units, Sum, given 1970–71

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 25, 29, October 1 and 6 (for autumn quarter); November 14, January 5 and 7 (for winter quarter); February 23, March 30, and April 1 (for spring quarter); May 18 (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

#5. Intensive French for Beginners — (Equivalent to 1 and 2.) Offers preparation in speaking, writing, and reading the language.
8 units, Sum (Staff) MTWThF

10. Elementary French—A reading course in French for students seeking to fulfill the University requirement of a reading knowledge for the Ph.D. degree. Open to seniors and graduate students only.
3 units, Aut, Win, Spr (Staff) MWF 8
Sum (Staff) MTWTh 8

#22. Second-Year French—Prerequisite: 3.
3 units, Aut, Win, Spr (Staff) MTWTh

#23. Second-Year French — Continuation of 22.
3 units, Aut, Win, Spr (Staff) MTWTh

#26. Intensive Second-Year French — (Equivalent to 22 and 23). Open only to transfer students and seniors. Prerequisite: 3 or equivalent. Enrollment limited to 15.
6 units, Spr (Staff) MTWThF 11 and one additional hour

30. Conversation française premier degré—Prerequisite: 3 or equivalent.
1 unit, Aut, Win, Spr, Sum (Staff) TTh 9 and TTh 1:15

31. Conversation française deuxième degré—Prerequisite: 23 or equivalent.
1 unit, Aut, Win, Spr (Staff) TTh 9 and TTh 1:15

#54. Cours pratique de littérature—Composition littéraire, lecture et explication de textes littéraires divers. Satisfies General Studies requirements under “C.” Prerequisite: 23 or equivalent.
4 units, Aut, Win, Spr (Staff) MTWThF

#82–86. Intensive French — Given only at Stanford in France.
6 units for any two quarters, Aut-Win, Spr-Sum (Staff) MTWTh, two hours daily

THIRD- AND FOURTH-YEAR

Language Courses
(Under the direction of Ralph M. Hester)

110. Cours de Phonétique—Prerequisite: 54 or equivalent.
3 units, Spr (Hester) MWF 10
111. Composition, grammaire et étude de textes I—Prerequisite: 54 or equivalent.
3 units, Aut (Barson) MWF 9
Win (Bauer) MWF 1:15
Spr (Barson) MWF 9

112. Composition, grammaire et étude de textes II—Continuation of 111.
3 units, Win (______) MWF 9
Spr (______) MWF 9

120. Séminaire sur les événements contemporains—Conversation et discussion sur des problèmes actuels à partir des journaux, revues ou films français. Prerequisite: 31 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: 54 or equivalent.
3 units, Aut (Calin) (I) MWF 1:15

#131. Introduction à la littérature française—17ème et 18ème siècles. Prerequisite: 54 or equivalent.
3 units, Aut (Bertrand) MTW 2:15
Win (Cartwright) MWF 11

#132. Introduction à la littérature française—19ème et 20ème siècles. Prerequisite: 54 or equivalent.
3 units, Win (Bertrand) MWF 1:15
Spr (Cartwright) 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 (Hester) given 1970–71

#141. Littérature de la Renaissance II—Montaigne, les poètes baroques; le théâtre.
4 units, Spr (Hester) MWF 11

#150. Le XVIIIème siècle I—Poésie et roman; les poètes baroques, Théophile de Viau, Saint-Amant, Tristan l’Hermite; les Fables de La Fontaine; Mme de La Fayette: La Princesse de Clèves.
4 units, Aut (Lapp) M 2:15 and T 2:15–4:05

#151. Le XVIIIème siècle II—La tragédie; Racine: Andromaque, Athalie, Britannicus; Iphigénie; Corneille: Horace, Cinna, Polyèctue, Nicomède.
4 units, Win (Lapp) M 2:15 and T 2:15

#152. Le XVIIIème siècle III — La Comédie: Corneille et Molière; Pascal, Pensées; La Rochefoucauld, Maximes.
4 units, Spr (Lapp)

4 units (Cartwright) given 1970–71

#161. Le XVIIIème siècle II — Roman et théâtre. Roman: Prévost, Manon Lescaut; Diderot, La Religieuse; Rousseau, La Nouvelle Héloïse. Théâtre: Lesage, Turcaret; Marivaux, Le Jeu de l’Amour et du Hasard; Beaumarchais, Le Barbier de Séville.
4 units, Aut (Cartwright) MWF 1:15

4 units, Aut (Giraud) MWF 11

4 units, Win (Weinstein) MWF 1:15

4 units, Spr (Giraud) MWF 1:15

#173. Symbolism — Lectures in English; readings in French.
4 units (Cohn) given 1970–71

#180. Le XXème siècle I—La Poésie française de Valéry au Surrealisme
4 units, Aut (Newman-Gordon) MWF 10

#181. Le XXème siècle II — Le Théâtre français de Giraudoux à Ionesco.
4 units, Win (Newman-Gordon) MWF 11

#182. Le XXème siècle III—Le Roman en France depuis 1898.
4 units, Spr (Newman-Gordon) MWF 11

#190. La Poésie française du Moyen Âge à nos jours.
4 units (Calin) given 1970–71

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

204. Etudes de style—Etude stylistique de œuvre de Céline.
3 units (Juilland) given 1970–71

205. Modern French—Phonology, morphology, and syntax.
3 units, Aut (Juilland) TTh 1:15

210. Problèmes de l’expression écrite—
Etude de textes et pratique de la composition.
3 units, Aut (Bertrand) MW 11

215. French Existentialist Writers—With special emphasis on Sartre, Camus, Gabriel Marcel, Merleau-Ponty, Malraux, and Simone de Beauvoir.
3 units, Spr (Juilland) TTh 1:15

225. Histoire de la langue française—
Designed primarily for advanced undergraduates and candidates for the Master of Arts in Teaching.
3 units, Win (Juilland) Th 4:15–6:05

GRADUATE COURSES

310. Introduction to Romance Linguistics—
Problems in historical and structural linguistics.
3 units, Aut (Juilland) M 2:15–4:05

3 units, Win (Calin) T 10 and F 4:15–6:05

312. Histoire de la langue française depuis le Moyen Age jusqu’à présent—Prerequisite: 311.
3 units, Spr (Juilland) TTh 11

315. Grammaire historique de la langue française.
3 units, Win (Juilland) M 2:15–4:05

325. Cours de méthode—Méthode critique et bibliographique, préparation de thèses.
3 units, Win (Lapp) given 1970–71

335. The Fifteenth Century—The novel; poetry and prose. Chartier, Charles d’Orléans, Villon. Les Quinze Joies de Mariage, La Farce de Maître Pathelin.
3 units, Spr (Calin) F 4:15–6:05

341. La Renaissance en France I—Les Prosateurs; Rabelais et Montaigne.
3 units, Aut (Lapp) TTh 11

342. La Renaissance en France II—Les poètes de la Pléiade et les poètes baroques de la fin du XVIème siècle.
3 units, Win (Lapp) TTh 11

350. Graduate Seminars.
The Chansons de Geste.
3 units, Spr (Calin) given 1970–71

Medieval Allegory: Le Roman de la Rose.
3 units, Aut (Calin) F 4:15–6:05

Montaigne.
3 units, Spr (Lapp) given 1970–71

Corneille.
3 units, Spr (Lapp) W 2:15–4:05

Molière.
3 units, Aut (Weinstein) given 1970–71

La Fontaine.
3 units, Spr (Lapp) given 1970–71

Le Roman au XVIIIème Siècle.
3 units, Win (Cartwright) given 1970–71

Flaubert.
3 units, Aut (Giraud) given 1970–71

Mallarmé.
3 units, Spr (Cohn) given 1970–71

Stendhal.
3 units, Spr (Weinstein) given 1970–71

Rimbaud.
3 units, Aut (Cohn) given 1970–71

Balzac.
3 units, Spr (Weinstein) T 2:15–4:05

353. Le Théâtre classique français—
Corneille, Molière, Racine.
3 units (Weinstein) given 1970–71

361. Rousseau—Lectures in French.
3 units, Spr (Cartwright) T 2:15–4:05

362. Diderot—Lectures in French.
3 units, Win (Cartwright) W 2:15–4:05

364. Le Théâtre au XVIIIème Siècle.
3 units, Spr (Cartwright) given 1970–71

3 units, Aut (Weinstein) F 2:15–4:05
371. Baudelaire.
3 units (Cohn) given 1970-71

372. The Symbolist Poets.
3 units (Cohn) given 1971-72

373. La Critique littéraire au XIXème siècle — Sainte-Beuve, Taine, Brunetièrè, and others.
3 units, Win (Weinstein) W 4:15-6:05

380. La “grande génération” — Proust, Gide, Péguy, Claudel, Romain Rolland, Valéry.
3 units (Newman-Gordon) given 1971-72

3 units (Giraud) given 1970-71

3 units (Newman-Gordon) given 1971-72

386. Giraudoux — Homme de théâtre: de Siegfried à La Folle de Chaillot.
3 units, Spr (Newman-Gordon) M 2:15-4:05

387. Jules Laforgue — Le Sanglot de la Pierre; Les Complaintes; L’Imitation de Notre-Dame la Lune; Derniers Vers.
3 units, Aut (Newman-Gordon) W 2:15-4:05

388. Apollinaire—Alcools et Calligrammes.
3 units, Win (Newman-Gordon) F 2:15-4:05

389. Points de vue critiques au XXème siècle—De Valéry à la Nouvelle Critique.
3 units, Spr (Bertrand) given 1970-71

3 units, Win (Bertrand) TTh 1:15

399. Individual Work — Exclusively for graduate students in French working on thesis or engaged in special work.
1 to 12 units, any quarter (Staff) by arrangement

ITALIAN COURSES

FIRST- AND SECOND-YEAR

Note—Students registering for the first time in a first- or second-year course must take a placement test if they have had any training in Italian before entering Stanford.

#1. First-Year Italian.
4 units, Aut, Win, Spr (Staff) MTWThF

#2. First-Year Italian.
4 units, Aut, Win, Spr (Staff) MTWThF

#3. First-Year Italian.
4 units, Aut, Win, Spr (Staff) MTWThF

#5. Intensive Italian for Beginners — Equivalent to 1 and 2. Offers preparation in speaking, writing, and reading the language.
5 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.
1 unit, Aut, Spr (Staff) TTh

#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

#131. Introduzione allo studio della letteratura italiana II—Pieno Rinascimento, età

3 units, Win (Klopp) MWF 1:15


3 units, Spr (Leone) MWF 1:15

#150. Dante, La Divina Commedia — Inferno.

3 units, Aut (Cecchetti) MWF 2:15

#151. Dante, La Divina Commedia—Purgatorio.

3 units, Win (Cecchetti) MWF 2:15

#152. Dante, La Divina Commedia—Paradiso.

3 units, Spr (Cecchetti) MWF 2:15

#161. Umanesimo e Rinascimento—La letteratura e la cultura italiana dal Petrarca a Lorenzo de’ Medici.

3 units, Win (Klopp) given 1970–71

#162. Il Pieno Rinascimento—La letteratura e la cultura italiana dall’Ariosto e il Machiavelli al Tasso.

3 units, Aut (Klopp) TTh 3:15

#163. L’Ottocento — Foscolo, Leopardi e Manzoni. Aspetti del romanticismo italiano.

3 units (Cecchetti) given 1970–71

#164. L’Ottocento — Da Nievo a Verga. Carducci e D’Annunzio. De Sanctis e la critica.

3 units (Cecchetti) given 1970–71


3 units (Cecchetti) given 1970–71

#166. Il Novecento—Poeti e romanziere dal 1920 a oggi, specialmente Ungaretti, Montale, Quasimodo, Bontempi, Bacchelli, Palazzeschi, Moravia, Vittorini, Pavese. La critica stilistica.

3 units, Aut (Cecchetti) MW 3:15

199. Individual Work—Open only to majors in Italian and with special permission of the Department. May be repeated for credit.

1 to 3 units, any quarter (Staff) by arrangement

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

291. Petrarcha.

3 units, Aut (Klopp) given 1970–71

293. Machiavelli.

3 units, Win (Klopp) given 1970–71

294. Foscolo e Leopardi.

3 units, Spr (Cecchetti) given 1970–71

399. Individual Work — Exclusively for graduate students in Italian working on thesis or engaged in special work.

1 to 6 units (Staff) by arrangement

LINGUISTICS AND PHILOLOGY COURSES

207. Old Italian — Phonology, morphology of Old Italian; preliterary linguistic monuments. Introduction to Italian dialectology.

3 units, Aut (Politzer) M 4:15–6:05

250. Seminar in Romance Linguistics—Prerequisite: 204 or equivalent.

3 units (Juilland) given 1970–71

270. Topics in Structural Linguistics.

3 units (Juilland) given 1970–71

TEACHER TRAINING COURSES

288. Methods of Teaching French—(Same as Education 288.)

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

See also Senior Colloquia.

GEOGRAPHY

Undergraduate courses in Geography will be offered by the Food Research Institute.
Associate Professor: A. Peter Foulkes
Assistant Professors: Gisela Luther, Peter C. Ober. Acting: John M. Flores, William C. Meads
Instructors: Margarete Eifler, Gertrude Mahrholz

Offerings and Facilities

The Department accepts candidates for the degree of Bachelor of Arts, Master of Arts, and Doctor of Philosophy. The requirements for these degrees are given below under Programs of Study.

Master of Arts in Teaching

The degree of Master of Arts in the Teaching of German is offered jointly by the School of Education and the Department. The program includes 25 units of German in courses selected in consultation with the Department adviser. For a statement of requirements other than German see the section "School of Education" in this bulletin.

Graduate Program in Humanities

The Department participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in German and Humanities. Students accepted for this program complete the requirements for a Ph.D. in German as given below as well as those described in this bulletin under "Humanities Special Programs."

Intensive Language Work Abroad

Each undergraduate student accepted by the Committee on General Studies for work at a Stanford center in Germany or Austria completes 12 units of German during the six months of his residence in Europe. The work is primarily designed to develop the student's ability to understand, speak, and read German, but courses are given at various levels. All German courses taken at a center are identified by the number 80 with a second digit indicating the level at which the 12 units were taken. Course identification may vary from 82, the lowest, to 86. A student majoring in German will have the work taken abroad evaluated on his return in terms of the specific degree requirements.

Stanford Hamburg Program

The University maintains a program in Hamburg, Germany, for the benefit of advanced students majoring in German or in 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

All candidates should normally complete the series of courses offered for first- and second-year students (1, 2, 3, 52, 53). Transfer students or students with several years of high school German will be given a placement test to determine which, if any, of these courses they should take. After completing the second-year series or its equivalent, all students majoring in German will include in their program 18 units consisting of two courses in composition (111, 112) and three courses (151, 152, and either 153 or 154) which present a general view of the history of German literature through the reading of major documents from the 18th century to the present day. The courses in literature may be taken in any order, but those in composition need to be in sequence. Students returning from Stanford in Austria or Stanford in Germany will be exempt from certain requirements if they have completed the equivalent of the work while overseas. For the balance of their work, majors may concentrate either on German language and literature or on German thought and culture. The following paragraphs describe the additional requirements.

The student in German language and literature will take 12 units of course work in listening and speaking, pronunciation, writing, and the history of the language (100, 110, 113, 185) as well as 12 units in literature which may be elected freely from the various courses in literature numbered 140-199.

The student in German thought and culture will take 9 units in courses (171, 172,
which are designed to introduce him
to the continuum of German intellectual and
cultural history; and 6 units in two seminars
(196, 197) in which particular problems, cul-
tural movements, or individual authors will
be studied. In addition, 12 units of electives
are required, of which at least 6 must be
taken outside the Department in support of
the major program.

Students with either concentration for
their major may take honors in German. For
this, a minimum G.P.A. of 3.0 is required.
The honors essay will be on a topic chosen
by the student, generally as a development
of work done either in a seminar or a liter-
ature course. It will represent 9 units of
academic work.

**Master of Arts**

To be accepted as a candidate for the de-
gree of Master of Arts a student needs to
establish that he has completed creditably
either an A.B. degree with a major in Ger-
man or an equivalent of this work. Knowl-
edge of Latin and of French is also desir-
able. Stanford University requires three full
quarters of graduate study (12 graduate
units per quarter) before any degree can be
granted. A student with graduate work taken
at another university, in this country or
abroad, is advised that this work will not re-
duce the three-quarter requirement; how-
ever, if he continues his studies, it will short-
en the time needed for completion of the
Ph.D. degree.

The requirements for the degree of Mas-
ter of Arts in German are:

1. 36 units of graduate work in the major
field, normally the following courses:
   
   200. Methods of Teaching German.
   201 and 202. Advanced Composition.
   205. Modern German Grammar.
   228. Middle High German.
   Two advanced courses in German liter-
   ature, one of them from the 230–280 se-
   ries.
   289. Proseminar.
   290 or 291. One seminar.
   Electives to bring the total number of
   graduate units to 36.

2. Students who have never studied French
   or Latin and who wish to go on to the
   Ph.D. are advised to enroll in either
   French 10 or Latin 5 as early as possible.

3. A Master's thesis is not required. How-
ever, students must give evidence in the
   seminar of their ability to write a scholarly
   essay based on independent work.

4. Students with an excellent command of
   German may be excused from taking 201
   and 202. Instead, they may take an addi-
tional elective.

**Doctor of Philosophy**

Students should read carefully the Uni-
versity regulations governing the conferring
of this degree as described in the section
"Degrees" in this bulletin.

The Master of Arts degree is a prerequi-
site for admission to the program. Excep-
tions are made only for those students who
have completed a substantial equivalent at
a foreign university.

Near-native proficiency in German is ex-
pected of all candidates irrespective of their
field of specialization. During the first year
at Stanford, all graduate students will be
given the MLA Foreign Language Profi-
ciency Test for Teachers and Advanced Stu-
dents to give them an indication of their
achievement in listening-comprehension,
speaking, reading, and writing.

The requirements for the degree of Doc-
tor of Philosophy in German are:

1. A working knowledge of Latin and a read-
   ing knowledge of one modern language
   other than English or German.

2. In addition to the course work listed un-
der the requirements for the Master of
   Arts degree, the student is expected to
   complete a program concentrating either
   in literature or in language. If a student
   is not taking a minor in another field nor
   participating in the Graduate Humanities
   program, he may satisfy all course require-
   ments for the Ph.D. degree by completing
   54 units of graduate work beyond the
   A.M. requirements. Since teaching assis-
tants and research assistants can enroll for
nine units per quarter, all students who
have completed the requirements for the
A.M. degree should be able to complete
the course work for the Ph.D. degree in
six quarters. Students able to enroll for
more than nine units per quarter should
be able to finish this course work during
their fifth post-A.M. quarter.

The special requirements for the do-
toral program in literature are as follows:
a) One course in each of the five areas of 280, with the exception of those already covered in the A.M. program.
b) Three graduate seminars.
c) A minimum of 4 units of philology: Gothic, Old Norse, Old High German and Old Saxon, or Advanced Middle High German.
d) Three units of Individual Work (course 299) to be used to read, under the supervision of the student's adviser, the works listed in the "Graduate Reading List for Ph.D. candidates in German." These three units may be distributed over several quarters.
e) Units of electives to complete the 54-unit post-A.M. requirement. These may be taken either in additional courses in the Department (200 or higher), in a complementary program such as Graduate Humanities, or in Individual Work.

The special requirements for the doctoral program in language are as follows:

a) Introductory work in each area not taken previously: applied linguistics, syntax of modern German, historical development of Germanic grammar, Gothic Old Norse, Old English, Old Saxon, Old High German, Middle High German.
b) Three seminars or advanced courses in Linguistics, Modern German, Early New High German, Middle High German, Old Icelandic or Old English. The choice will vary according to the field of specialization.
c) A minimum of three literature courses (230–280) in areas of special interest.
d) Three units of Individual Work (course 299) to be used to read, under the supervision of the student's adviser, the works listed in the "Graduate Reading List for Ph.D. candidates in German." These three units may be distributed over several quarters.
e) Units of electives to complete the 54-unit post-A.M. requirement. These may be taken either in additional courses in the Department (180 or higher), in a complementary program such as Graduate Humanities, or in Individual Work.

3. Whether candidates specialize in language or in literature, they will write a dissertation that embodies such results of research as would merit publication.

4. Teaching experience is required of all candidates as a condition of receiving the Ph.D. degree. Teaching assistantships are available to help candidates fulfill this requirement, which may be waived only for those students who have had teaching experience in other institutions. All prospective teachers are required to enroll in 200.

**General Courses (A)**

The courses in this section are given in English and do not require a knowledge of German. They are open to all students. When registering, students are advised to prefix the identifying letter A to the course number.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Credits</th>
<th>Term</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>#100</td>
<td>Goethe's Faust</td>
<td>3</td>
<td></td>
<td>Lohner</td>
</tr>
<tr>
<td>#140</td>
<td>Contemporary German Literature</td>
<td>3</td>
<td></td>
<td>Flores</td>
</tr>
<tr>
<td>#146</td>
<td>Kafka—A discussion of his works</td>
<td>3</td>
<td></td>
<td>Sokel</td>
</tr>
<tr>
<td>#156</td>
<td>Brecht—Representative works</td>
<td>3</td>
<td>Aut (Flores) MWF10</td>
<td></td>
</tr>
<tr>
<td>#181</td>
<td>Nietzsche—His major works considered in relation to contemporary thought and literature.</td>
<td>3</td>
<td></td>
<td>Sokel</td>
</tr>
<tr>
<td>#183</td>
<td>Thomas Mann</td>
<td>3</td>
<td>Spr (Flores) MWF 10</td>
<td></td>
</tr>
<tr>
<td>#185</td>
<td>The Existential Quest in the Continental Novel—Reading and discussion of works by Dostoevsky, Rilke, Kafka, Sartre, Camus, and Frisch.</td>
<td>3</td>
<td></td>
<td>Sokel</td>
</tr>
</tbody>
</table>

**German Courses**

**First- and Second-Year**

(under the direction of Walter F. W. Lohnes)

*Note—Students registering for the first time in a first- or second-year course must take a placement test if they have had any work in German before entering Stanford.*

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Credits</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>First-Year German</td>
<td>4</td>
<td>Aut, Win, Spr (Staff)</td>
</tr>
</tbody>
</table>
#2. First-Year German—Continuation of 1.
4 units, Aut, Win, Spr (Staff)

#3. First-Year German—Continuation of 2.
5 units, Aut, Win, Spr (Staff)

5. Intensive First-Year German — Equivalent to 1, 2, and 3 combined. Enrollment limited.

12 units, Sum (Staff) MTWThF 8:00–9:30 and 10:30–12:00

10. Elementary German — Accelerated course for beginners, particularly for those seeking to fulfill University requirement of reading knowledge for Ph.D. degree. Open to senior and graduate students only. No auditors permitted.

4 units, Aut, Win (Staff) MTWTh 8 or 9

#52. Second-Year German — Continuation of 3: 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)

#52H. Second-Year German — One or two special sections of 52 for exceptionally well-qualified students.

5 units, Aut, Win, Spr (Staff)

#53. Second-Year German — Continuation of 52 and 52H: This course broadens the scope of 52 by including poetry and expository prose.

5 units, Aut, Win, Spr (Staff)

60. Intensive Second-Year German—Equivalent to 52. Enrollment limited.

6 units, Sum (Staff) MTWTh 9–11

#82–86. Intensive German—Given only at Stanford in Austria and Germany.

6 units, any two quarters

90. 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: 52.

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

THIRD- AND FOURTH-YEAR

100. Practice in Listening and Speaking—Listening to original recorded material such as radio programs, plays, and lectures. Discussion and oral presentation of assigned topics. Course may be taken twice for credit. Prerequisite: 53 or equivalent.

3 units, Aut (Schipporeit) MWF 1:15
Spr (Staff) MWF 9

110. German Pronunciation — Prerequisite: 22.

3 units, Win (Luther) MWF 9

111. Third-Year German Composition — Prerequisite: 53 or equivalent.

3 units, Aut (Mahrholz) (I) TTh 9;
(Schipporeit) (II) 1:15

112. Third-Year German Composition — Continuation of 111.

3 units, Win (Mahrholz) (I) TTh 9;
(Staff) (II) TTh 11

113. Third-Year German Composition — Continuation of 112.

3 units, Spr (Mahrholz) TTh 9

#121. German Newspapers — This course is especially designed for students who want to keep their German alive. Current newspapers from East and West Germany will be read and discussed. This course may be repeated once. Prerequisite: 52.

2 units, Aut, Spr, (Staff) TTh 11;
Win (Staff) TTh 1:15

141–146. Courses in the 140-series introduce the student to German literature in the various genres. Prerequisite: 52.

#141. Poetry from Goethe to Nietzsche.
3 units, Spr (Luther) MWF 11

#142. Poetry from Nietzsche to the Present.
3 units, given 1970–71

#143. Drama from Storm and Stress to Expressionism.
3 units, given 1970–71

#144. Drama from Expressionism to the Present.
3 units, given 1970–71

#145. The Novelle—Shorter prose works from the Romantic Period to the 20th century.
3 units, Aut (Meads) MWF 11

#146. Modern Fiction.
3 units, given 1970–71

151–154. These courses acquaint the student with the development of German literature from the Enlightenment to the present. Significant works of each period are
studied intensively and related to their historical context.

151. The Classical Period — Prerequisite: 53 or consent of instructor.
4 units, Aut (Luther) MTWTh 10

152. Romanticism and Realism — Prerequisite: 53 or consent of instructor.
4 units, Win (Ober) MTWTh 10

153. From Naturalism to the Present—Prerequisite: 53 or consent of instructor.
4 units, Spr (Meads) MTWTh 10

154. Major Works in Contemporary German Literature—Given only in Hamburg.
4 units, Spr, Sum (Staff) by arrangement

171–173. These courses introduce the student to the continuum of German intellectual and cultural history, 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: 53 or consent of instructor.

171. Deutsche Geistesgeschichte I — Von der Aufklärung zur Romantik.
3 units, Aut (Staff) MWF 11

172. Deutsche Geistesgeschichte II — Von der Romantik bis Nietzsche.
3 units, Win (Staff) MWF 11

3 units, Spr (Staff) MWF 11

ADVANCED AND GRADUATE
With the exception of 185 and 190, these courses are given in German.

181. Thomas Mann.
3 units (Foulkes) given 1970–71

182. Brecht.
3 units, Win (Luther) MWF 10

183. Hölderlin.
3 units, Win (Lohner) MWF 2:15

184. Goethe’s Faust.
3 units, given 1970–71

185. History of the German Language.
3 units, Win (Schuelke) MWF 9

187. Deutsch Literatur in Ost und West—Eine vergleichende Betrachtung.
3 units, Spr (Flores) MWF 1:15

189. Kafka.
3 units (Foulkes) given 1970–71

190. German Applied Linguistics — (Same as Education 287.) Phonology and morphology.
2 units, Win (Politzer) TTh 10

192. Grabbe and Büchner.
3 units (Mueller-Vollmer) given 1970–71

193. Rilke.
3 units (Staff) given 1970–71

194. Novalis.
3 units (Staff) given 1970–71

196–197. Senior Seminars—May be elected by non-majors who have completed three German literature courses.

196. Senior Seminar: Sigmund Freud.
3 units, Win (Flores) T 2:15–4:05

197. Senior Seminar: Das Werk C. G. Jungs.
3 units, Spr (Foulkes) T 2:15–4:05

199. Individual Work—Open only to German majors and to students who are working on special projects. Students taking honors in German will use this number for the honors essay. May be repeated for credit.
1 to 15 units, each quarter (Staff) by arrangement

199H. Individual Work — Exclusively for Hamburg University courses completed by undergraduate students in the Stanford Hamburg Program.
1 to 8 units, Spr, Sum (Staff) by arrangement

GRADUATE COURSES

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

201. Advanced Composition and Grammar—Prerequisite: qualifying examination.
2 units, Aut (Lohnes) TTh 11

202. Advanced Composition and Grammar—Continuation of 201.
2 units, Win (Lohnes) TTh 11

205. Modern German—The syntax of modern German.
3 units, Win (Strothmann) MWF 11

221. Gothic and Historical Germanic Grammar—Development of Germanic languages;
reading of selected texts from the Gothic Bible.

223. Old Norse.
   4 units (Schuelke) given 1970–71

224. Old Icelandic Sagas.
   4 units (Schuelke) given 1970–71

225. Old Saxon.
   2 units, Win (Schuelke) MT 10

227. Old High German.
   2 units, Win (Schuelke) WTh 10

228. Middle High German.
   4 units, Spr (Schuelke) MTWTh 10

229. Advanced Middle High German.
   4 units, Spr (Schuelke) TTh 2:15–4:05

231. Das mittelhochdeutsche Epos — Prerequisite: 228.
   4 units, Aut (Ober) MWF 11

233. Die mittelhochdeutsche Lyrik — Prerequisite: 228.
   4 units (Schuelke) given 1970–71

235. Die Mystik des Mittelalters—Prerequisite: 228.
   4 units, given 1971–72

241. Drama des Barock.
   4 units (Lohner) given 1970–71

242. Lyrik des Barock.
   4 units, given 1971–72

245. Lessing, Wieland und die Aufklärung.
   4 units (Mueller-Vollmer) given 1970–71

246. Herder und der Sturm und Drang.
   4 units (Sokel) given 1970–71

   4 units (Lohner) given 1971–72

252. Herder und der Sturm und Drang.
   4 units, Spr (Mueller-Vollmer) MWF 2:15

254. Die Klassik Goethes und Schillers.
   4 units (Lohner) given 1971–72

256. Der späte Goethe.
   4 units, Win (Lohner) MWF 2:15

261. Die Romantik.
   4 units, Spr (Mueller-Vollmer) MTTh 1:15

262. Heine und das Junge Deutschland.
   4 units (Mueller-Vollmer) given 1970–71

   4 units, Win (Sokel) MWF 3:15

   4 units (Sokel) given 1970–71

   4 units (Sokel) given 1971–72

   4 units (Mueller-Vollmer) given 1971–72

   4 units (Sokel) given 1971–72

   4 units, Spr (Sokel) MWF 2:15

   4 units, Aut (Mueller-Vollmer)
   T 2:15–4:05 and F 3:15

   4 units, Aut (Lohner) W 4:15–6:05

290. Seminars—

Jean Paul.
   5 units, Aut (Mueller-Vollmer)
   Th 2:15–4:05

Goethes Wanderjahre.
   5 units, Win (Lohner) W 4:15–6:05

Heine.
   5 units, Spr (Foulkes) W 4:15–6:05

299. 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

299H. 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

HISTORY

Chairman: George H. Knoles
Professors: William C. Bark, Gordon A. Craig (on leave 1969–70), Carl N. Degler, Don E. Fehrenbacher, John J. Johnson,

Associate Professors: Barton J. Bernstein, Gavin I. Langmuir, Mark I. Mancall, Rixford K. Snyder, Peter Stansky, David B. Tyack, Lyman P. Van Slyke

Assistant Professors: Frederick P. Bowser, Philip Dawson, Terence Emmons (on leave 1969-70), Kennell A. Jackson, Jr., G. Wesley Johnson, David Kennedy, Paul Robinson, Paul S. Seaver, John D. Wirth (on leave 1969-70)

Lecturers: Phyllis Auty, Rebecca Bergstrom, Margot Drekmeier, George S. Rentz

Instructors: The Staff of the History of Western Civilization

The Department of History offers to all students of the University courses of general cultural and educational value. It seeks not only to provide knowledge in special fields, but also to equip the student for his duties as a citizen and to give him instruction which will aid him in law, journalism, library work; in local, state, and national public service; and in business where a knowledge of domestic and foreign affairs is desirable.

The course in the History of Western Civilization, which surveys the development of the Western world from earliest times to the present, is required by the University of all students as a necessary part of a liberal education, and supplies a foundation for the other work in the Department.

PROGRAMS OF STUDY

BACHELOR OF ARTS

The Department adopted early in 1967 a new program for the undergraduate major in history which will lay emphasis upon a broad and comparative approach to historical studies, and one which will stress independent study and integration of the work accomplished in the major.

As a foundation requirement, each candidate for the A.B. in History: (1) should be enrolled in the Department for six quarters (counting the quarter in which the registration takes place), (2) should complete, if possible in the junior year, a basic seminar which serves as an introduction to the principles of historical study, (3) and should complete at least ten courses in history numbered 20 or higher, with an average grade not below C, and with a minimum of three units each. (The basic seminar is counted as one of these ten.)

To emphasize broad coverage in space and time, it is required that at least two courses must be completed in each of the following three fields: (a) Western Europe (including Britain) and North America (especially the colonial and national history of the present United States), all since 1700; (b) Africa and the Middle East, Asia, Latin America, Russia, and Eastern Europe; (c) the period before 1700, with at least one course in the field of Western Europe before 1700. No single course may be counted to fulfill more than one of these three fields. The Department issues a detailed list indicating how each specific course is classified as to field.

To emphasize comparative study, integration of knowledge from various fields, and independent work, the A.B. program requires the completion of History 200: Comparative Studies in History. This is a program of independent reading which the student may elect to take in either his junior or senior year. It will count as two of the ten required courses, but does not count toward any of the three fields. This program will consist of designated reading on some given broad historical theme, which will vary from year to year and be announced in the preceding spring quarter. It will lead to a four-hour written examination on the designated reading to be passed as a requirement for graduation. Such examinations will be given each year at the end of winter quarter and at the end of spring quarter. Credit will be awarded only on the basis of the examination.

Also, all History majors will complete, under the general studies requirements of the University, History 1, 2, 3: Western Civilization, and the foreign language option in the "Basic Requirements" of the General Studies Program Bulletin. There will be no minor requirement for the A.B. in History.

(Note—The Cory and Roiote scholarships are available for women students in the Department.)
Honors in History

For a limited number of undergraduate majors, the Department offers a special program of senior research leading to Honors in History. Students accepted for this program, in addition to fulfilling the general requirements stated above, will complete a 15-unit senior essay, the work for which will normally begin in spring quarter of the junior year and be completed by the end of winter quarter of the senior year. Much of the work of the first quarter will be of the nature of directed reading under the guidance of an essay adviser to provide an opportunity for background reading and formulation of the essay topic. To enter this program the student must be accepted by a member of the Department who will agree to advise him on the essay. In considering an applicant for such a project, the adviser and the director of the Honors Program will take into account the student’s general preparation in the field of the project and will expect at least a B average in the student’s previous work, both in history and in the University. For more detailed information, apply to Professor Barton J. Bernstein, Director of the Honors Program.

The James Birdsall Weter scholarships in History are available to a limited number of honors students; and the Weter prizes may be awarded each year to students who submit outstanding essays.

Graduate Study

A student who has been admitted to graduate standing does not automatically become a candidate for a graduate degree, but when he is admitted, it is with the expectation that he will be working toward a Doctor of Philosophy degree, and that he may become a candidate to receive a Master of Arts degree at the end of his first or second year of graduate study.

Master of Arts

The Department requires the completion of nine courses (totalling not less than 36 units) of graduate work; at least 35 units of this work must be in History Department courses. A candidate whose undergraduate training in history is inadequate, however, must complete 45 units of graduate work in the History Department. The candidate’s program must include at least two graduate seminars involving the preparation of research papers and a total of at least 15 units in graduate seminars and graduate colloquia. A reading knowledge of one modern foreign language is required. The Department will not recognize for credit toward the A.M. degree any work that has not received the grade of A, B, or plus.

Master of Arts in Teaching (History)

The Department cooperates with the School of Education in offering the Master of Arts in Teaching degree. For the general requirements, see description under section “School of Education” in this bulletin. For certain additional requirements made by the Department of History, inquiry should be made to the History Department Office. Note that this program is open only to those with at least one year’s teaching experience. Candidates must have a teaching credential.

Doctor of Philosophy

Students planning to work for the doctorate in history should be familiar with the general degree requirements of the University outlined in the section “Degrees” in this bulletin. Upon enrollment in the graduate program in History, the student will have a member of the department designated as his adviser and he should plan his program in consultation with this adviser. During the first two years of graduate study, the student will spend much of his time taking courses, but he should be aware from the outset that
the ultimate objective of his work is not merely the completion of courses, but the preparation for general examinations and for writing a dissertation.

The student's admission to the History Department in the Graduate Division does not establish any rights respecting candidacy for an advanced degree, and application must be made separately for admission to candidacy for the A.M. (not later than the end of the first four weeks of the quarter preceding the one at the end of which the degree is to be awarded) and also for the Ph.D. An applicant for the doctoral program must proceed by two steps: First, he must apply for admission to (not candidacy in) the Ph.D. program. Students seeking admission to the program should file application during their third quarter of enrollment in graduate work at Stanford. (Applicants who have already received the A.M. elsewhere should apply as soon as feasible after completion of one quarter at Stanford.) A committee of the Department will then determine either that the applicant shall be admitted to the Ph.D. program or that he must terminate his work in History at Stanford.

Second, after admission to the program and after the completion of certain further requirements, the student must apply for acceptance for candidacy for the doctorate. He does this (a) after further course work, (b) after demonstrating proficiency in one European language which is relevant to his research program, by passing (during the first year of graduate study) an examination administered by the appropriate foreign language department, and (c) after choosing a dissertation field in consultation with and with the approval of his adviser. This application is made by filing formal papers at the Graduate Study Office in the Registrar's Office.

After acceptance in candidacy, the student must meet the following requirements:

(1) He must select, in consultation with his adviser, a major field of study from the list below in which he will concentrate his study and in which he will later take a general examination consisting of a four-hour written comprehensive examination, followed, within the same quarter, by the University oral examination. The major fields are:

Europe, 300–1400
Europe, 1400–1789

Europe Since 1700
Russia and East Central Europe
The Near and Middle East
Africa
The Far East
Britain and the British Empire Since 1460
Latin America
The United States (including Colonial America)

For procedural information concerning this examination and the one in the secondary field (3, below), which are scheduled in advance for stated dates, please apply to the Department.

(2) For work in his major field, the student may be required to meet additional foreign language requirements. His adviser will inform him of such requirements.

(3) He must select, in consultation with his adviser, one secondary field, which must be outside the major field, though it may partially overlap the major field. In this secondary field, he must pass a four-hour written comprehensive examination not later than one year after admission to the Ph.D. program, and before taking the examination in the major field. The secondary fields are as follows:

The Ancient Greek World
The Roman World
Europe, 300–1000
Europe, 1000–1400
Europe, 1400–1600
Europe, 1600–1789
Europe, 1700–1871
Europe Since 1848
Russia
East Central Europe
Russia and East Central Europe to 1800
Russia and East Central Europe Since 1800
Near East
Middle East
Near and Middle East to 1800
Near and Middle East Since 1800
Africa
Far East to 1800
Far East Since 1800
China
Japan
England, 450–1460
Britain and the British Empire, 1460–1714
Britain and the British Empire Since 1714
Latin America to 1825
Latin America Since 1810
The United States (including Colonial America) to 1865
The United States Since 1850

(4) In his program of courses, the student must include at least one graduate seminar in his major field and one graduate seminar in his secondary field; a graduate course in general historiography, and, if his major field is the United States, a graduate course in American historiography; a course in methods of teaching history, given by the student's adviser, or by some other member of the Department designated by the adviser. (Students who have served as teaching assistants may present such experience in lieu of this requirement.)

(5) The student must also complete at least one of the following:

a. A supporting program of 20 units of history in one of the Ph.D. major fields (but outside the student's major and secondary fields), including at least one graduate seminar or graduate colloquium.

b. A supporting program of 20 units in another discipline relevant to the candidate's special interest.

c. A formal minor in another discipline.

d. A supporting program of 20 units in a second foreign language, including at least one course in literature; or demonstration of proficiency in a second foreign language, plus one course in literature. Proficiency may be demonstrated in either of two ways: 1) by passing an examination administered by the appropriate foreign language department; 2) by certification from a member of the History faculty that the student has written a seminar paper for which at least half of his research was done in a foreign language.

(6) He must complete and submit a dissertation which is the result of independent work and is a contribution to knowledge. It should evidence the command of approved techniques of research, ability to organize findings, and competence in expression. For details and procedural information, please apply to the Department.

JOINT PH.D. IN HISTORY AND HUMANITIES

The Department of History participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in History and Humanities. For description of that program, and of fellowships offered in connection with it, see the section “Humanities Special Programs” in this bulletin.

RESEARCH AND TRAINING ASSISTANTSHIPS

The Department has about fifteen student assistantships and several research assistantships and teaching assistantships which are customarily held by candidates for advanced degrees.

RESOURCES FOR GRADUATE STUDY

The above section relates to formal requirements, but the success of a student's graduate program depends in large part upon the quality of the guidance which he receives from the faculty and upon the library resources available to him. Prospective graduate applicants are advised to study closely the list of History faculty and the course work which this faculty offers. As to library resources, no detailed statement is possible in this bulletin, but areas in which library resources are unusually strong include the following:

The rich, and in some respects unique, collections of the Hoover Institution on the causes, conduct, and results of World War I are being augmented for World War II and the period between these two wars. The materials include government documents, newspaper and serial files, and organization and party publications (especially British and German labor movements and the German Socialist parties). There are also important manuscript collections, including unpublished records of the Paris Peace Conference of 1919 and the Herbert Hoover archives, which contain the records of the Commission for Relief in Belgium; the American Relief Administration; the various technical commissions established at the close of World War I for reconstruction in Central and Eastern Europe; the personal papers of Herbert Hoover as United States Food Administrator; and the personal papers of other important individuals. Other important materials for the period since 1914 relate to revolutions and political ideologies of international importance; colonial and minority problems; propaganda and public opinion; military occupation; peace plans and movements; international relations; international organization and administration, including the publications of the League of Nations, the World Court, the
International Labor Office, and the United Nations, as well as the principal international conferences.

The Hoover Institution also possesses some of the richest collections available anywhere on the British labor movement, on Eastern Europe, including the Soviet Union, on East Asia (runs of important newspapers and serials and extensive documentary collections, especially for the period of World War II) and on Africa since 1860, including especially French-speaking Africa, the former British colonies, and South Africa.

The University Library maintains strong general collections in almost all fields of history. It has a very large microtext collection, including, for instance, all items listed in Charles Evans’ *American Bibliography*, and in the *Short-Title Catalogues* of English publications, 1475–1700, and virtually complete microfilmed documents of the Department of State to 1906. It also has a number of valuable special collections in the Bender Room, including the Borel Collection on the History of California, many rare items on early American and early modern European history, the Brasch Collection on Sir Isaac Newton and scientific thought during his time, and other such materials.

I. INTRODUCTORY COURSES

The Department offers three course sequences providing general overviews of African Civilizations, East Asian Civilizations, and of Western Civilization. Western Civilization is required of all students under the General Studies requirements. East Asian Civilizations is recommended for students, both undergraduate and graduate, with broad humanistic interests and especially for those who are studying any aspect of Asian culture. 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.

Since Western Civilization is a General Studies requirement, it is not specifically counted as units toward the History major. Since African Civilizations and East Asian Civilizations are optional, they are counted toward the History major.

#1. History of Western Civilization—Western Civilization to circa A.D. 1000; prehistoric man; ancient Orient; Greece, Rome, early Middle Ages.

4 units, Aut (Staff)

#2. History of Western Civilization—Major developments in Western Civilization in later Middle Ages, Renaissance, seventeenth and eighteenth centuries.

4 units, Win (Staff)

#3. History of Western Civilization—Nineteenth, twentieth centuries.

4 units, Spr (Staff)

47. African Civilizations.

5 units, Win (Jackson, G. W. Johnson) MTWThF 1:15


5 units, Spr (Jackson, G. W. Johnson) MTWThF 1:15

91. History of East Asian Civilizations — Origin and development of the civilizations of China and Japan.

4 to 5 units, Aut (––)


4 to 5 units, Win (––)

93. History of East Asian Civilizations — The recent period.

5 units, Spr (––)

II. INTERMEDIATE AND ADVANCED COURSES

Courses numbered 100 through 103 (basic seminars and colloquia) are open only to juniors and seniors majoring in history. Requests for admission to basic seminars and colloquia are submitted to the Department office and involve permission of the instructor.

Courses in senior research are intended primarily (though not exclusively) for Honors candidates engaged in writing senior theses.

A. UNDERGRADUATE SEMINARS AND COLLOQUIA

100. Basic Seminar—An introduction to the method and problems of historical research and writing. Required of undergraduate majors in history.

5 units, Aut, Win, Spr, Sum (Staff)
101A. Undergraduate Colloquium: Religion and Revolution in Early Modern England.
5 units, Spr (Seaver)

101B. Undergraduate Colloquium: Twentieth Century France.
5 units, Spr (Wright)

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 1970–71

101E. Undergraduate Colloquium: German History.
5 units, Win (Paret)

101F. Undergraduate Colloquium: Race and Sex in the United States.
5 units, Win (Degler)

101G. Undergraduate Colloquium: Revolution.
5 units, Win (Mancall)

5 units, Win (Van Slyke)

101I. Undergraduate Colloquium: European Intellectual History.
5 units, Aut (Robinson)

102A. Undergraduate Colloquium: Ideas and Society in the Progressive Period.
5 units (Knoles) given 1970–71

102B. Undergraduate Colloquium: The Russian Revolutionary Movement.
5 units (Emmons) given 1970–71

102C. Undergraduate Colloquium: Brazil.
5 units, Spr (Bergstresser)

102D. Undergraduate Colloquium: Social Classes in Modern History.
5 units, Win (Smith)

102E. Undergraduate Colloquium: The Cultural Dilemma of Modern Africa.
5 units, Spr (G. W. Johnson)

102F. Undergraduate Colloquium: Topics in Byzantine Civilization.
5 units (Vucinich) given 1970–71

102G. Undergraduate Colloquium: Soviet Foreign Policy.
5 units, Win (Lederer) 1970

103A. Undergraduate Colloquium: Religion and Revolution in Early Modern England.
5 units, Win (Bowser)

103B. Undergraduate Colloquium: The Church in Latin America.
5 units, Win (Bowser)

103C. Undergraduate Colloquium: Reconstruction.
5 units, Win (Potter)

103D. Undergraduate Colloquium: African History.
5 units, Win (Jackson)

103E. Undergraduate Colloquium: Communism and Nationalism.
5 units (Vucinich) given 1970–71

103F. Undergraduate Colloquium: English Society and the Novel.
5 units, Win (Stansky)

103G. Undergraduate Colloquium: Shaping of Twentieth Century America.
5 units, Spr (Bernstein)

200. Reading Course in Comparative History.
5 units each for two quarters; Aut, Win, Spr (Kennedy)

B. THE ANCIENT WORLD

See Classics, Section V, Courses 101, 102, 103, 111, 112, 113, 201, 202, all of which are accepted for credit toward a major in history.

C. MEDIEVAL AND RENAISSANCE EUROPE

104. Medieval Europe, 300–1400—Emphasis on transition from ancient Mediterranean to European civilization, development of medieval social, cultural institutions and ideas.
5 units, Aut (Bark) MTWTh 9

105. The Emergence of Medieval Europe—Genesis of European civilization from end of Roman political unity through Carolingian period.
3 units, Win (Bark) MWF 9

107. The High Middle Ages—Such aspects of European civilization in twelfth, thirteenth centuries as papacy and Holy Roman Empire, French and English monarchical states, Crusades, medieval towns, rise of universities, scholasticism, Gothic art.
3 units (Bark) given 1971–72

108. Medieval Antisemitism — An inquiry into the causes of antisemitism in the period
in which intense anti-Jewish feeling first developed and many of the characteristic beliefs of modern antisemitism were formulated. Considerable use will be made of sociological theories about ethnic prejudice.

5 units (Langmuir) given 1970–71


5 units, Aut (Spitz) MTWTThF 10

110. Age of the Reformation — Europe in early modern times with special emphasis on the Protestant Reformation and Catholic reform.

5 units, Win (Spitz) MTWTThF 10

115. Senior Research in Medieval History.

1 to 5 units (——) by arrangement, given 1970–71

117. Senior Research in Renaissance-Reformation History.

1 to 5 units (Spitz) by arrangement, given 1969–70

118. The Byzantine Empire.

3 units (Vucinich) given 1970–71

D. MODERN EUROPE

120A. Muscovite Russia to 1613.

4 to 5 units (Emmons) given 1970–71

120B. Russia, 1613–1801.

4 to 5 units (Emmons) given 1970–71

120C. Russian Foreign Relations, 1801–1917.

4 to 5 units (Emmons) given 1970–71

121. Twentieth Century Russia.

4 to 5 units, Spr (Lederer) MTWTThF 11

122A. Russian Foreign Relations, 1700–1917.

4 to 5 units (Lederer) given 1970–71

122B. Russian Foreign Relations Since 1917.

4 to 5 units, Win (Lederer)

123. Non-Russian Peoples of the Soviet Union.

3 units (Vucinich) given 1970–71

124. Modern Eastern Europe Since 1914.

4 to 5 units, Aut (Auty) MTWTThF 10

126. History of the Balkan Peoples Since 1914.

4 to 5 units (Vucinich) given 1970–71

128. Germany in the Nineteenth Century.

4 to 5 units (Craig) given 1970–71

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, Aut (Paret) MTWTThF 9

129. Germany in the Twentieth Century.

4 to 5 units (Craig) given 1970–71

129A. Topics in German History from the Reformation to the Third Reich.

5 units, Spr (Paret) MTWTThF 9

130. The Ancien Régime in France (1589–1789).

4 to 5 units, Aut (Dawson) MTWTThF 9

131. The Age of Revolution in Europe, 1780–1840.

4 to 5 units, Win (Dawson) MTWTThF 9

134. Intellectual History of Europe in the Seventeenth and Eighteenth Centuries.

4 to 5 units, Aut (Drekmeier) MTWTThF 10


4 to 5 units (Craig) given 1970–71

136. Twentieth Century Europe.

4 to 5 units, Aut (Wright) MTWTThF 10

136A. European Intellectual History: Nineteenth Century.

4 to 5 units, Win (Robinson) MTWTThF 11

136B. European Intellectual History: Twentieth Century.

4 to 5 units (Robinson) given 1970–71

137. Twentieth Century Diplomacy.

5 units, Aut (Lederer) MTWTThF 11

139. Senior Research in Modern European History.

1 to 5 units (Dawson, Lederer, Paret, Robinson, Wright) by arrangement

E. THE BRITISH COMMONWEALTH AND EMPIRE

140. England to 1460.

5 units (Langmuir) given 1970–71


4 to 5 units, Aut (Seaver) MTWTThF 10

142. Stuart England.

4 to 5 units, Win (Seaver) MTWTThF 10

143. Britain, 1688–1867—Emphasis on do-
mestic political, economic and social history, but foreign and imperial affairs will be included as they influenced the country's general development.

4 to 5 units, Win (Stansky) MTWTh 11

144. Britain Since 1867—See description of 143 (above).

4 to 5 units, Spr (Stansky) MTWTh 11

146. Senior Research in British History.
1 to 5 units (Seaver, Stansky)

F. AFRICA

147A. The History of Africa to 1800 — Geography and peoples of Africa, traditional African society and culture, early Sudanic empires, Islamic and Arabic impact, European explorations, the slave trade, later African states, missionaries and commerce, and early European colonial expansion.

4 to 5 units, Aut (Jackson) given 1970–71


4 to 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.

4 to 5 units (G. W. Johnson)
given 1970–71

148B. Expansion of Europe Overseas—History of political, economic, and cultural imperialism of European nations from the Renaissance to the twentieth century. Emphasis on reaction of non-European societies to Western culture; problems of acculturation, assimilation, and institutional transfer. Special attention is paid to Africa.

4 to 5 units (G. W. Johnson)
given 1970–71

148C. The History of East Africa.
5 units, Aut (Jackson) MTWTh 10

149B. Senior Research in African History.
1 to 5 units (G. W. Johnson)

G. THE UNITED STATES

150. The Colonial Period.
4 units, Aut (Miller) MTWTh 9

151. The Revolution, Confederation and Constitution.
5 units, Win (Miller)

152. United States Constitutional History, Revolution to the Civil War.
4 units, Spr (Fehrenbacher)

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.

4 to 5 units, Win (Degler)

158. The Trans-Mississippi West Since 1846 — Political, social, and economic development, with attention to twentieth century aspects.

4 to 5 units (Fehrenbacher) given 1970–71

160. History of the American South—The rise and decline of southern separateness. Emphasis on social and economic history.

4 to 5 units (Degler) MTWTh 9

162. Nineteenth Century America.
4 units, Aut (Fehrenbacher) MTWThF 8

163. The American Character.
4 to 5 units, Aut (Potter) MTWThF 1:15


4 to 5 units (Knoles) given 1970–71

167. American Intellectual History: Twentieth Century—American thought and expression during twentieth century; influences acting upon intellectual, cultural development.

4 to 5 units, Win (Knoles)

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 cul-
ture; 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 (Bernstein) given 1970–71

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, Spr (Bernstein) MTWThF 11

170. The United States, 1890–1929.

4 to 5 units, Aut (Kennedy) MTWThF 11

171. The United States, 1929–Present.

4 to 5 units, Win (Kennedy) MTWThF 11

172. The Era of the Civil War, 1846–1865.

4 to 5 units, Spr (Potter) MTWThF 8


4 to 5 units (Potter) given 1970–71

175. Senior 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, Aut (Bouwer) MTWThF 11

177. Modern Latin America—Political, social, economic institutions in leading republics since independence.

4 to 5 units, Win (J. Johnson) MTWThF 11

180. History of Brazil to 1870 — Survey of Brazil from colonial times to 1870.

4 to 5 units, Win (Bergstresser) MTWF 9

181. History of Brazil Since 1870—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 (Bergstresser) MTWF 9

182. The Black in Latin America.

4 to 5 units, Spr (Bouwer) MTWThF 11

185. Senior Research in Latin American History.

1 to 5 units, Spr (Bouwer, J. Johnson) by arrangement

I. MIDDLE EAST


4 to 5 units (Vucinich) given 1970–71


3 units, Spr (Rentz) given 1970–71

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 1970–71

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, Spr (Rentz) MWF 11

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) MWF 11

192. Modern China — 1800 to the present. Emphasis on rebellions, reforms, revolutions, and resistance to changes.

4 to 5 units, Spr (Van Slyke) MTWThF 1:15

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 (Van Slyke) given 1970–71
194A. Japan, 1600–1890 — Development of institutions and thought; early relations with the West; the Meiji Restoration and the beginnings of modernization. Emphasis on latter half of the period.

3 to 5 units, Win (Smith) MTW 10

194B. Japan Since 1890 — Japan's development as a modern nation; industrialization; urbanization; political and constitutional development; relations with the West; World War II; the Occupation; post-occupation Japan.

3 to 5 units, Spr (Smith) MTW 10

195. History of Sino-Soviet Relations.

4 units (Mancall) given 1970–71

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, Win (Van Slyke) MTWTh 1:15

199. Senior Research in Far Eastern History.

1 to 5 units (Mancall, Smith, Van Slyke) by arrangement

III. GRADUATE COURSES

Courses numbered 200–299 are intended primarily for first-year graduate students, but more advanced graduate students may be admitted by consent of the instructor.

210. Graduate Seminar: Europe.

10 units, Win, Spr (Spitz)

221. Graduate Seminar in Russian History.

10 units (Emmons) given 1970–71

225. Graduate Seminar in Eastern Europe and Near East History.

5 units (Vucinich) given 1970–71

228. Graduate Seminar: Intellectual History of Austria and Germany, 1815–1830.

5 units (Craig) given 1970–71

231. Graduate Seminar: The Ancien Régime in France.

10 units, Aut, Win (Dawson)


5 units, Win (Paret)

233. Graduate Seminar: German History.

5 units, Spr (Paret)

235. Graduate Seminar: Europe Between the Wars 1918–1939.

5 units, Win (Wright)

240. Graduate Seminar in Medieval History.

3 to 5 units (Langmuir) given 1970–71


10 units, Win, Spr (Seaver)


5 units, Spr (Stansky)

247. Graduate Seminar on Oral Tradition.

5 units, Spr (Jackson)

248. Graduate Seminar: Topics in African History.

5 units, Aut (G. W. Johnson)


5 units, Aut (Miller)

252. Graduate Seminar: Nineteenth Century United States History.

5 units, Win (Fehrenbacher)


5 units (Kennedy) given 1970–71

254. Graduate Seminar: American Liberalism from Progressivism to the Cold War.

5 units, Aut (Bernstein)


5 units (Knoles) given 1970–71

260. Graduate Seminar in History of the South.

5 units, Spr (Degler)

263. Joint Graduate Colloquium: Problems in American History.

5 units (Staff)

280. Graduate Seminar in Modern Latin American History.

5 units, Aut (J. Johnson)

282. Graduate Seminar in Modern Brazilian History.

5 units (Wirth) given 1970–71


5 units, Win (Bowser)
290. Graduate Seminar in the History of Modern China.
   5 units, Spr (Van Slyke)

292. Graduate Seminar in the History of Japan.
   5 units, Spr (Smith)

IV. ADVANCED GRADUATE COURSES

Courses numbered 300-399 are intended primarily for second- and third-year graduate students, but first-year graduate students may be admitted by consent of the instructor.

300. Historiography—Writings, influence of great historians, Herodotus to present. Required of all doctoral candidates in history.
   5 units, Win (Robinson)

301. American Historiography—Main currents in historical research and writing relevant to United States from earliest days.
   5 units, Spr (Knoles)

302. The Teaching of History—Methods of teaching history at the college level.
   1 unit, Aut, Win, Spr (Staff)
   by arrangement

   5 units, Win (Lau, Lewis, Skinner, Van Slyke) by arrangement

304. Latin American Historiography.
   5 units, Aut (Bowser)

308. Graduate Colloquium: Topics in Medieval History.
   5 units (Langmuir) given 1970-71

314. Directed Reading in Medieval History.
   Units by arrangement (Staff)

315. Graduate Research in Medieval History.
   Units by arrangement (Staff)

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, Aut (Seaver)

321A. Graduate Colloquium: Britain 1867-1939.
   5 units, Aut (Stansky)

322. Graduate Colloquium: Nationalism and Eastern Europe in the Nineteenth and Twentieth Centuries.
   5 units, Aut (Auty)

   5 units (Emmons) given 1970-71

324. Graduate Colloquium: Modern Russia, Nineteenth and Twentieth Centuries.
   5 units, Aut (Lederer)

325. Graduate Colloquium: Eastern Europe and Near East History.
   5 units (Vucinich) given 1970-71

326. Graduate Colloquium: Twentieth Century Diplomacy.
   5 units (Lederer) given 1970-71

327. Graduate Colloquium: The Origins of the Cold War.
   5 units (Lederer) given 1970-71

328. Graduate Colloquium: Topics in Modern European History.
   5 units (Craig) given 1970-71

   5 units, Spr (M. Drekmeier)

331. Graduate Colloquium: Seventeenth and Eighteenth Century Europe.
   5 units, Win (Dawson)

335. Graduate Colloquium: Nineteenth Century France.
   5 units, Spr (Wright)

337. Graduate Colloquium: Modern European Intellectual History.
   5 units, Aut (Robinson)
338. Directed Reading in Modern European History.
   Units by arrangement (Dawson, Lederer, Wright)

339. Graduate Research in Modern European History.
   Units by arrangement (Dawson, Lederer, Wright)

345. Directed Reading in British History.
   Units by arrangement (Seaver, Stansky)

346. Graduate Research in British History.
   Units by arrangement (Seaver, Stansky)

348. Graduate Colloquium: Historians of Tropical Africa.
   5 units, Win (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)

   5 units (Miller) given 1970–71

   5 units (Knoles) given 1970–71

363. Graduate Colloquium: Modern America, 1890–1950.
   5 units (Bernstein) given 1970–71

374. Directed Reading in United States History.
   Units by arrangement (Bernstein, Degler, Fehrenbacher, Kennedy, Knoles, Miller, Potter)

375. Graduate Research in United States History.
   Units by arrangement (Bernstein, Degler, Fehrenbacher, Kennedy, Knoles, Miller, Potter)

382. Graduate Colloquium: Brazilian History.
   5 units, Win (Bergstresser)

   5 units, Spr (Bower)

384. Directed Reading in Latin American History.
   Units by arrangement (Bower, J. Johnson)

385. Graduate Research in Latin American History.
   Units by arrangement (Bowser, J. Johnson)

389. Directed Reading in Far Eastern History.
   Units by arrangement (Mancall, Smith, Van Slyke)

390. Graduate Colloquium: Topics in Modern Chinese History.
   5 units, Aut (Van Slyke)

   5 units, Aut (Smith)

Emeritus: John W. Dodds (Professor)

Chairman: William A. Clebsch

Professors: Robert M. Brown (Religion) (on leave 1969–70), William A. Clebsch (Religion and Humanities), Paul H. Kocher (English and Humanities), B. Davie Napier (Religion), Philip H. Rhinelander (Philosophy and Humanities)

Associate Professors: Lawrence V. Berman (Religion), Edwin M. Good (Religion and Hebrew) (on leave autumn, spring quarters), Jeffery Smith (Humanities and Philosophy)

Assistant Professors: Jerry A. Irish (Religion), Alan L. Miller (Religion), Lee H. Yearley (Religion)

Humanities Special Programs include:

1. Humanities Honors Program.
2. Graduate Program in Humanities.
HUMANITIES HONORS PROGRAM

Committee in Charge: William A. Clebsch (Director), Philip Dawson, John W. Dodds, J. Martin Evans (on leave 1969-70), David M. Kennedy, George F. Sensabaugh, Jeffery Smith (Associate Director), Walter F. Sokel

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 required for admission to the Program and for graduation with Honors in Humanities.

Freshmen and Sophomores interested in the Program should consult with the Director or Associate Director of the Humanities Honors Program. The consultation should take place at the earliest opportunity, preferably before the end of the Freshman year, and in every case early enough to make such scheduling adjustments as may be necessary.

The Program is open to majors in every field, and is normally taken in addition to a departmental major. In some cases, however, the student may enroll as a Humanities major:

1. If he is taking the pre-medical curricular,
2. If he chooses a major in Humanities with concentration in Religious Studies,
3. If he is permitted, upon petition granted by the Honors Committee, to plan a 40-unit concentration of interdepartmental course work constituting a unified program of study. Examples: American Studies, Classical Studies, East Asian Studies, Latin American Studies, Medieval Studies, the Modern Novel, and Renaissance Studies.

Students who wish to major in Humanities should consult with the Director before registering for the first quarter of the Junior year.

REQUIREMENTS OF THE PROGRAM

1. World Literature—Humanities 61, 62, 63—15 units, Sophomore year.
2. Humanities Seminars 191 and 192 or 193—10 units, Junior year.
3. Honors Essay—A critical essay, usually centered in the departmental field, but not confined to it (2 units spring, Junior year; 5 units autumn and 5 units winter, Senior year). A grade of at least B is required on the essay for graduation with Honors in Humanities.

Each student should plan a program that will give him a substantial background for his prospective Honors Essay. This is especially important for students majoring in the social, biological, or physical sciences.

UNDERGRADUATE COURSES

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) MWF 11

#61, 62, 63. World Literature and the History of Ideas—An introduction to fundamental ideas of the past; lectures, discussions, reading of selected masterpieces of literature. The course is conceived as a unity; it is strongly recommended that students take all three quarters in sequence. Honors students who attend a Stanford Overseas Campus may be excused from either 62 or 63 at the discretion of the Director.


5 units, Aut (Otis, Staff) TWTh 11 and two hours by arrangement

#62. Medieval and Renaissance Literature — Boethius, Arthurian romance, Dante, Castiglione, Marlowe, Montaigne, Cervantes.

5 units, Win (Ryan, Staff) TWTh 11 and two hours by arrangement

#63. Literature of the Enlightenment and the Modern World—Narrative Literature from Romanticism to Joyce—Gee-
the, Blake, Scott, Balzac, Flaubert, Dostoievsky, Kafka, Proust.

5 units, Spr (Sokel, Staff) MWF 11 and two hours by arrangement

101, 102, 103. Europe as Seen Through Travel Literature — Travel literature as a means of perceiving the physical and spiritual development of the regions of the world; the uniqueness of literary and historical form produced by the perception of cultures by outsiders; emphasis upon European regions and cultures. Each student selects, with the advice of the instructor, one book for careful analysis. Since the books vary constantly, the course may be repeated for credit. Students wishing to take the course to satisfy the language requirement should select a book in their special language and sign up for four units.

3 to 4 units, Aut, Win, Spr (Hilton) TTh 10

175. Individual Work — For students with definite objectives not met by current course offerings.

2 to 5 units, any quarter (Staff) by arrangement

191, 192, 193. Interdepartmental Seminars on the Nature of the Humanities — Students in the Humanities Honors Program are required to complete 191 and either 192 or 193. These seminars are open to a limited number of other students only by permission of the Director, Humanities Honors Program.

191. Principles and Methods of Humanistic Study.

5 units, Aut (Halliburton, Smith) by arrangement

Win (Halliburton) by arrangement

Spr (Rhinelander) 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, Spr (Smith) by arrangement

193. Philosophy and History as Humanities — Prerequisite: 191.

5 units, Win (Clebsch) by arrangement

Spr (Kennedy) by arrangement

30. Honors Essay — A critical essay of about 15,000 words. Limited to Humanities Honors students.

12 units (Staff) by arrangement

HUMANITIES SPECIAL PROGRAMS

GRADUATE PROGRAM


The Graduate Program in Humanities supplements the doctoral programs of certain departments (Classics, English, French and Italian, German, History, Philosophy, Slavic Languages and Literatures, Spanish and Portuguese, Speech and Drama), with an interdepartmental program devoted to the study of the Western tradition as a whole. The degree offered is a joint Ph.D., awarded in “History and Humanities,” “Philosophy and Humanities,” “French and Humanities,” etc.

Because the Graduate Program in Humanities is designed as a supplement to, and not as a substitute for, departmental specialization, its courses may be taken only by students who have been accepted for graduate work by a Ph.D.-granting department and whose applications have been approved by the Committee in Charge.

Application for entrance into the Program should be made to the Director. The number of students entering the Program each year is limited to 18, and selections are made to give broad representation to the participating Departments.

Students entering the Program should expect to take one Humanities course in each of six successive quarters. Therefore they should consult both with their Departmental advisers and with the Director about this Program’s articulation with their Departmental studies.

REQUIREMENTS

1. Continued satisfactory work in the student’s major field, in accordance with Departmental requirements.

2. Completion of the six courses (Humanities 301-306) in the Western Traditions series.

3. Regular attendance and active participation in the bi-weekly, informal Humanities Colloquium for at least one academic year.

4. Some formal training, preferably in high school or college, in an ancient as well
as a modern foreign language, is strongly recommended.

5. Passing the University Oral Examination, with a 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.

**GRADUATE COURSES**

251. Basic Humanistic Problems—Open to graduate students and to advanced undergraduates on consent of the instructor; required of M.A.T. candidates whose teaching field is Humanities.

4 units, Win (Rhinelander) TTh 2:15–4:05

301, 302, 303, 304, 305, 306. The Western Traditions — Required of and restricted to students in the Graduate Program in Humanities.

301. The Classic Period: Greece.

4 units, Aut (Rhinelander) TTh 4:15–6:05

302. The Roman and Patristic Periods.

4 units, Win (Raubitschek) TTh 4:15–6:05

303. The Middle Ages.

4 units, Spr (Calin) TTh 4:15–6:05

304. The Renaissance.

4 units, Aut (Kocher) TTh 4:15–6:05

305. The Eighteenth and Nineteenth Centuries.

4 units, Win (Goheen) TTh 4:15–6:05

306. The Modern Period.

4 units, Spr (Mueller-Vollmer) TTh 4:15–6:05

353. The Functions of a University and the Meaning of Education.

4 units, given 1970–71

**RELIGIOUS STUDIES PROGRAM**

The Religious Studies Program provides the student with knowledge of religion as a phenomenon of human life. As one of the humanities, the study of religion aims to understand religious works of literature, historical developments of religious tradition and practice, modes of religious thought, and varieties of world views in and among religions. Certain of the offerings are more fully described in the General Studies Bulletin, to which reference should be made.

**CONCENTRATION IN RELIGIOUS STUDIES**

A 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 religion, 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 (Senior 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 hu-
manistic study of religions in the following fields of concentration: classical religious literature, New 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 canonical texts; the history of religious thought; the religious philosophy of two major writers, ancient or modern; the comparison of religions. Prior to these examinations the student submits to his adviser the body of canonical writings 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 tradition 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 graduate student in other departments of the University.

Graduate Program in Humanities

The Program in Religious Studies participates in the Graduate Program in Humanities leading to the degree of Doctor of Philosophy. For a description of that program see the section of "Humanities Special Programs" in this Bulletin.

Courses Primarily for Undergraduates

81. The Comparative Study of Religions—The nature and variety of religion; interpretations by certain formative comparativists, such as Rudolf Otto, G. van der Leeuw, and Mircea Eliade.

5 units, Aut (Miller) MTWTh 10


5 units, Aut (Napier) MW 2:15-4:05


5 units, Spr (Staff) MTWTh 9

105. The Prophets of Israel—One or more of the most significant Hebrew prophets as
poets and thinkers. Prerequisite: consent of instructor.

5 units, Aut (Staff) MTWTh 9

106. Wisdom in the Ancient Near East — Self-conscious intellectuality in the wisdom literature of Mesopotamia, Egypt, and Israel, such as Job, Ecclesiastes, and similar works. Prerequisite: consent of instructor.

5 units, Win (Staff) TTh 4:15-6:05

107. Old Testament Poetry — The use of poetry as a vehicle for religious thought and expression in Old Testament religion. Consideration of styles and techniques in representative poetry chosen from the Psalms, the Song of Songs, or other works. Prerequisite: consent of instructor.

5 units, Win (Good) TTh 2:15-4:05

120. Religion in the Ancient Near East — Types of religious thought and practice in Sumerian, Babylonian, Assyrian, Canaanite, Hittite, and Israelite cultures.

5 units, Aut (Staff) MTWTh 10

#121. History of Classical Christian Thought—The theological history of Christianity in ancient times; representative theologians and the relation of their thought to classical, Byzantine, and early medieval culture.

5 units, Spr (Staff) given 1970-71

#122. History of European Christian Thought—The theological history of Christianity in the Europe of the Middle Ages, Renaissance, and Reformation; representative theologians and the relation of their thought to imperial and national European culture.

5 units, Win (Yearley) MTWTh 11


5 units, Spr (Irish) TTh 2:15-4:05

124. Islamic Theology and Philosophy — The thought of leading theologians and philosophers with consideration of the influence of the Greek philosophical tradition.

5 units, Aut (Berman) given 1970-71

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) given 1970-71

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) given 1970-71

127. Aquinas — The thought of Thomas Aquinas in its historical setting.

5 units, Win (Yearley) given 1970-71

128. Augustine — The thought of Augustine in its historical setting.

5 units, Win (Yearley) TTh 4:15-6:05

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) MW 4:15-6:05

131. Religious Thought in England and America—Leading religious thinkers representing such movements as Reformation, Puritanism, rationalism, pietism, romanticism; their relation to historical, intellectual, and literary developments. Prerequisite: permission of instructor.

5 units, Spr (Clebsch) given 1971-72

132. American Religion — Religious movements and thinkers of various periods; the rise of religious pluralism.

5 units, Spr (Clebsch) MTWTh 10

134. 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, Win (Berman) MTWTh 10

135. Islam — The fundamental elements of Islamic thought: analysis of the Koran; the traditional literature; basic concepts of law; sects; theology and philosophy; mysticism.

5 units, Aut (Berman) MTWTh 11

136. Judaism and Islam—Historical study of Jewish influence on Muhammad and the Koran; attitude to Judaism in the Koran and traditional literature; medieval influences in
language, philosophy, and mysticism. The contemporary scene. Structural comparison of the two religions.

5 units, Spr (Berman) MW 4:15-6:05

141. Contemporary Trends in Religious Thought — Examination of the thought of present-day theologians such as Barth, Bultmann, Buber, Tillich, Teilhard de Chardin, Bonhoeffer, and others, through study of their own writings.

5 units, Aut (Irish) MTWTh 9

145. The Ecumenical Movement — The development of ecumenical concern in the twentieth century in both Protestantism and Roman Catholicism. Particular attention will be given to the World Council of Churches, the Second Vatican Council, and post-Vatican II developments. Prerequisite: one course in Religious Studies.

5 units, Aut (Brown) given 1970-71

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, Berdiaev, Farrer, and others.

5 units, Aut (Yearley) MTWTh 11

151. Uses and Abuses of the New Testament — Consideration of Christological themes during the past century; the historical Jesus, the centrality of Jesus in the “death of God” movement, and Jesus Christ as symbolic form.

5 units, Spr (Irish) given 1970-71

154. Christian Ethics — Contemporary problems of ethics such as race, war, political decision, sex and marriage, examined from the perspective of writings drawn from both historical and contemporary sources.

5 units, Win (Irish) MTWTh 10

161. Christian Theology — A systematic examination of the major topics of Christian thought, presented in ecumenical perspective.

5 units, Spr (Irish) MTWTh 9

162. Problems in Christian Theology — Historical and systematic analyses of one or more major subjects of Christian theology, such as creation, original sin, atonement, and Christology. Prerequisite: 161 or consent of instructor.

5 units, Aut (Yearley) TTh 2:15-4:05


5 units, Win (Irish) TTh 2:15-4:05

165. Major Catholic Theologians — The thought of one or more significant Catholic thinkers; 1969-70: John Henry Newman on the nature of faith, the distinctiveness of Christianity, and the development of doctrine. Prerequisite: consent of instructor.

5 units, Spr (Yearley) TTh 4:15-6:05

166. Reason and Revelation in Islamic Thought — Symbolic representation of truth and myth. Law and society. Theories of illumination and organized religion. Analysis of selections from the writings of representative thinkers in English translation.

5 units, Aut (Berman) TTh 2:15-4:05

167. Islam and Society — Analysis of Ibn Khaldun’s philosophy of history and its relation to the course and development of Islamic civilization. Comparison and contrast with traditional Islamic theories of state and society.

5 units, Spr (Berman) TTh 2:15-4:05

172. Theology and Contemporary Literature — Theological issues raised by contemporary writers, both Christian and non-Christian. Consideration of Auden, Beckett, Camus, Greene, Silone, Warren, and others.

5 units, Spr (Brown) given 1970-71

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 4:15-6:05


5 units, Aut (Yearley) given 1970-71


5 units, Win (Miller) given 1970-71

183. Confucianism and Taoism

5 units, Spr (Yearley) given 1970-71

184. Classics of Religious Thought — One
major thinker or controversy will be studied in religious and historical setting and for its permanent significance.

5 units, Aut (Staff) given 1970–71

185. Mythology in the Ancient World—Cultural and religious uses of mythological texts and motifs, such as creation, death and resurrection, fertility, cosmic struggle, as they appear in various types of literature. Material from Near Eastern, Israelite, Anatolian, Greek, and Christian settings. Prerequisite: junior or senior standing, and consent of instructor.

5 units, Spr (Staff) TTh 4:15–6:05

186. Hinduism and Buddhism in India — The two “great traditions” of India in mutual relation and within the context of Indian culture and history. Close reading of the Bhagavad Gita and selected early Buddhist writings.

5 units, Win (Miller) MTWTh 9

187. Buddhism in China—The introduction of Buddhism into China and the development of this “great tradition” in its interaction with the indigenous religions of China. The rise of Ch' an Buddhism and of Neo-Confucianism.

5 units, Spr (Miller) given 1970–71

188. Religion in Japan — The relation between religion and culture in Japanese history from the introduction of Buddhism to the rise of the new religions.

5 units, Aut (Miller) MW 4:15–6:05

190. Senior Seminar in Religion—Required of majors in Humanities with concentration in Religious Studies. Limited to 15 students. Prerequisite: consent of instructor.

5 units, Spr (Staff)


5 units, Spr (Miller, Yearley) given 1970–71

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) MTWTh 11


5 units, Spr (Miller, Yearley)

199. Individual Work.

(Staff) by arrangement

GRADUATE COURSES

201. Graduate Seminar: The Exegesis of Texts—Required of all doctoral students in Religious Studies; may be repeated for credit.

4 units, Aut (Good) given 1970–71

203. Directed Reading in Ancient Near Eastern Religious Texts. (Good) by arrangement, given 1970–71

205. Directed Reading in Old Testament Interpretation. (Good, Napier) 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. (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. Topic 1969–70: Soteriology in early Christianity.

4 units, Aut (Clebsch) MW 2:15–4:05

228. Graduate Research in Medieval Religious Thought and Movements. (Berman, Yearley) by arrangement

231. Directed Reading in English and American Religious Thought. (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.

4 units, Win (Brown) given 1970–71

243. Graduate Research in Modern Theology.
   (Brown) by arrangement, given in 1970–71

246. Graduate Research in Medieval Islamic Thought.
   (Berman) by arrangement

247. Graduate Research in Medieval Jewish Thought.
   (Berman) by arrangement

249. 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. Topic 1969–70: Soteriology as a category of religion, from primitive, tribal religion to classical Buddhism.

4 units, Win (Miller) MW 2:15–4:05

263. Directed Reading in Ancient Near Eastern Religions.
   (Good, Napier) by arrangement

265. Graduate Research in Islam and Judaism.
   (Berman) by arrangement

272. Directed Reading in Buddhism.
   (Miller) by arrangement

273. Graduate Research in Buddhism.
   (Miller) by arrangement

277. Directed Reading in Far Eastern Religions.
   (Miller) by arrangement

299. Directed Reading for Graduate Students.
   (Staff) by arrangement

CENTRAL FOR LATIN AMERICAN STUDIES

Committee in Charge: The Committee of Latin American Studies, a subcommittee of the Committee on International Studies.

Chairman of the Committee and Director of the Center: John J. Johnson (Professor, History)

The Center for Latin American Studies administers the A.M. program in Latin American Studies, which provides an interdisciplinary approach to the study of Latin America. The Departments of Anthropology, Economics, History, Political Science, Sociology, 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.

Inquiries concerning this program 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) Th 4:15-6:05

199. Independent Research—Restricted to students in Latin American Studies Undergraduate Summer Program.

3 to 5 units, Aut (Staff) by arrangement

250, 251, 252. Core Seminar in Latin American Studies—Introduction to methodolo-

gies 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) T 2:15-4:05

Summer Intensive Language Program in Spanish and Portuguese—See Spanish and Portuguese.

**LINGUISTICS**

Committee in Charge: Charles A. Ferguson (Chairman), Robert W. Ackerman, Joseph H. Greenberg, Dorothy A. Huntington, Alphonse Juilland, Phillip B. Petersen, Robert L. Politzer, Joseph A. Van Campen

Professor: Charles A. Ferguson

Associate Professor: Clara N. Bush

Assistant Professors: Andrew M. Devine.

Acting: Timothy A. Shopen

Lecturers: Elaine Kaufman, Dinguri N. Mwaniki, Elizabeth C. Traugott

Acting Instructor: Mohamed Accra Tairu

English for Foreign Students:

Director: Clara N. Bush

Instructors: R. Elizabeth Cecchetti, Frieda Politzer

**PROGRAMS OF STUDY**

Note—The courses offered by the Committee are primarily intended to prepare candidates for advanced degrees in Linguistics. The undergraduate related courses will give students some acquaintance with the methods, insights, and findings of linguistics, but there is no undergraduate major in Linguistics, and students who wish to enter the field are advised to major in Anthropology or one of the language departments.

**MASTER OF ARTS**

Candidacy—Candidates for the degree of Master of Arts in Linguistics must have completed an equivalent of the training represented by an A.B. or B.S. degree. The candidate must have completed, with a grade of B or better, the equivalent of at least 9 quarter units of university-level work in each of the following: (a) linguistics; (b) foreign language (above elementary) or English (exclusive of literature and composition
courses); (c) social science (e.g., anthropology, sociology, psychology), or mathematics (incl. statistics and computer science), or philosophy. In special cases the requirements may be waived by the Committee, but in no case will credit toward the A.M. be given for elementary linguistics courses taken to fulfill (a). The student's program should be prepared in advance in consultation with the Chairman of the Committee.

Requirements

1. Language. Candidates must demonstrate, by written examination, their ability to read linguistic research in two foreign languages, normally chosen from French, German, and Russian.

2. Course. 40 units of graduate work, selected among courses listed below, and distributed approximately as follows:
   a) 15 units in general linguistics;
   b) 15 units in a particular language or group of languages (graduate courses of the chosen language department);
   c) 10 units in a particular field of specialization (anthropological linguistics, applied linguistics, child language, comparative Indo-European, computational linguistics, dialectology, 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.

200. Historical Linguistics—Introduction to the principles and methods of historical linguistics; the development of modern schools and trends of historical linguistics in the nineteenth and twentieth centuries.

3 units, Aut (Traugott) MWF 2:15-3:45, alternate years, given 1969-70

201. Introduction to Comparative Linguistics (Indo-European)—The emphasis is on phonology and special attention is paid to the development of English.

3 units, Aut (Devine) 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 1969-70

212A,B. Second-Year Sanskrit — Grammar and reading of texts.

5 units, Aut, Win (Devine) MWF 2:15-3:45 alternate years, given 1970-71

214. Comparative Indo-European Morphology — Study of the development and functioning of Indo-European noun and verb morphology. Prerequisite: some knowledge of Sanskrit and one other of the older Indo-European languages.

3 units, Spr (Devine) by arrangement

261. Phonetic Theory — (Same as Speech and Hearing 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 Speech and Hearing 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

266. Transformational Grammar I — Introduction to the transformational theory of linguistic competence. Practical experience in forming and testing linguistic hypotheses.

4 units, Aut (Shopen) MW 11:00-12:30 and F 11

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: 268 or consent of instructor.

4 units, Spr (Shopen) MWF

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 Bantu language-group. Prerequisites: 200 and 266, or consent of the instructor.

3 units, Win (Traugott) MW 1:00-2:30

301, 302, 303. Seminar in Structural Linguistics — Lectures, readings, and reports on the principles, methods, and techniques of the structural approach to language.

301. The Structure of Linguistic Theory.
3 units, Aut (Juilland) by arrangement

302. The Concept of Word.
3 units, Win (Juilland) by arrangement

303. Linguistics and Statistics.
3 units, Spr (Juilland) by arrangement


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, Win, Spr (Devine) by arrangement

315. Seminar on Syntax — Topics in the theory of syntax, including the relationship of syntax and semantics. Material from English and other languages. Prerequisite: 266.

3 units, Spr (Shopen) MWF 1:15-2:05

316. Seminar on Historical Linguistics — Historical linguistics in the perspective of generative grammar; emphasis on syntactic and semantic change in English and in the Bantu language-group. Prerequisites: 200 and 266, or consent of the instructor.

3 units, Win (Traugott) MW 1:00-2:30

321. Linguistics and the Teaching of English — (Same as Education 282.) 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: 267 or English 208.

3 units, Win (Shopen) MW 3:15-4:05

#332A,B,C. Beginning Hausa.
5 units, Aut, Win, Spr (Kaufman) given 1969-70

#333A,B,C. Intermediate Hausa.
5 units, Aut, Win, Spr (Shopen) given 1970-71

#334A,B,C. Beginning Swahili.
5 units, Aut, Win, Spr (Mwaniki)

#335A,B,C. Intermediate Swahili.
5 units, Aut, Win, Spr (Mwaniki)

336A,B. Survey of Swahili Literature — History and present status of Swahili literature with reading of texts. Current problems in the use of Swahili.

3 units, Aut, Win (Mwaniki)

342A,B,C. Beginning Yoruba.
5 units, Aut, Win, Spr (——) given 1970-71

343A,B,C. Advanced Yoruba.
5 units, Aut, Win, Spr (Oyelaran)

365. Phonology — Field-oriented training in linguistic analysis as applied to the sound systems of languages. Lecture-discussion and laboratory. Prerequisite: elementary linguistics course or consent of instructor.

4 units, Win (Ferguson) TTh 9

370. Child Language — A review of present knowledge of the process of language acquisition, from a linguistic point of view. Emphasis will be on first-language acquisition by normal children. Prerequisite: elementary linguistics course or consent of instructor.

4 units, Win (Ferguson) TTh 11


4 units, Aut (Ferguson) TTh 9, given 1969-70

372. Sociolinguistics — Selected topics on language and society, including language and social stratification, language standardization, language and national development.

4 units, Spr (Ferguson) TTh 11

373. Languages of the Middle East — Structural sketches and sociolinguistic background information on the major contempo-
rary languages of Southwest Asia and North Africa.

4 units, Aut (Ferguson) TWTh 11,
given 1969–70

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 the 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 work in spoken English with emphasis on comprehension and intelligibility. Course also includes the use and comprehension of written English.

6 units, Aut (Staff) MTWThF 9 and one hour by arrangement

48. Spoken English II—Intermediate work in spoken English with emphasis on comprehension and intelligibility. Prerequisite: 47 or consent of instructor.

4 units, Aut, Win (Staff) MWF 9 and one hour by arrangement

49. Spoken English III—For students with some facility in spoken English. Emphasis on fluency, idiom, and current usage. Upon recommendation of the adviser, the course may be repeated for a total of 6 units. Prerequisite: consent of instructor.

1 to 3 units, Aut, Win, Spr (Staff) MWF 11

GENERAL COURSES

ANTHROPOLOGY
167. Language and Culture.
261. Linguistic Field Methods.
263. Grammatical Theory.
264. Typology and Universals of Language.
265. Introduction to Linguistics.

COMMUNICATION
211. Theory of Communication I.
212. Theory of Communication II.

EDUCATION
281. Linguistics for Teachers of Modern Languages.
283. Spanish Linguistics (Same as Spanish 190.)
287. German Applied Linguistics (Same as German 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
185. History of the German Language.
190. German Applied Linguistics.
205. Modern German.
221. Gothic and Historical Germanic Grammar.
223. Old Norse.
224. Old Icelandic Sagas.
225. Old Saxon.
227. Old High German.
228. Middle High German.
229. Advanced Middle High German.

ROMANCE LINGUISTICS AND PHILOLOGY
(See French and Italian)
204. Etude de style.
207. Old Italian.
250. Seminar in Romance Linguistics.
270. Topics in Structural Linguistics.

PHILOSOPHY
157A. Introduction to Logic.
157B. Intermediate Logic.
181. Philosophy of Language.
202. Seminar in Theories of Language.
245. Seminar in Foundations of Psycholinguistics.

PSYCHOLOGY
146. Language and Thought.

SLAVIC
196. Russian Pronunciation—Problems of theoretical and applied phonology.
197. Russian Syntax and Lexicology—Introduction to problems of advanced grammar and usage.
201. Synchronic Morphology of Russian: Conjugation and Declension.
211. Introduction to Old Church Slavonic.
212. Advanced Old Church Slavonic. Prerequisite: 211.
228. Divergence of Slavic Languages.
251. Examination of the Structure of non-Russian Slavic Languages.

SPANISH
181. History of Linguistic Thought.
190. Spanish Linguistics.
204. Modern Spanish I—The phonology of modern Spanish.
205. Modern Spanish II—The syntax of modern Spanish.
260. History of the Spanish Language.
261. Old Spanish.
263. Historical Spanish Linguistics I.
264. Historical Spanish Linguistics II.
266. Hispanic Dialectology.
299. Individual Work.

SPEECH AND HEARING SCIENCES
212. Phonetic Theory.
220. Psychology of Speech.
223. Speech and Language Development.
230. Speech Science I.
231. Speech Science II.
252. Aphasia.
253. Aphasia in Children.
310. Experimental Phonetics I.
311. Experimental Phonetics II.
312. Experimental Phonetics III.

MATHEMATICS
Emeriti: Stefan Bergman, William A. Manning, George Polya, Gabor Szegö (Professors)
Chairman: David Gilbarg
Vice Chairman: Paul W. Berg
Assistant Professors: Lawrence G. Brown, Hubert Goldschmidt, C. Denson Hill, Paul
OFFERINGS AND FACILITIES

The Department of Mathematics offers programs leading to the degrees Bachelor of Science, Bachelor of Science with Departmental Honors, and Doctor of Philosophy. (The Department does not offer a separate program for the Master of Science degree, but this degree may be awarded for a portion of the Doctor's work.)

For undergraduates there are five introductory courses of which four are alternative sequences in analytic geometry and calculus (10, 11, 21, 22, 23, 44, 45, 46, or 41, 42, 43, 44, 45, 46, or 41A, 42A, 43A, 44, 45, 46 or 41, 52, 53, 54, 55). These courses are provided for students who wish to graduate with a major in mathematics and for students in other departments who need or desire mathematics above the level of secondary school mathematics. A general introductory course (31, 32, 33, 34, 35) is offered for students who will not need detailed technical knowledge of calculus. Students electing one of the above series are expected to complete the work in that series. Changes from one series to another are permitted only by special arrangement.

Honors sequence Mathematics 52, 53, and 54, 55, 56 is an honors course in calculus for students intending to major in mathematics or the physical sciences. These courses cover the material contained in Mathematics 42, 43, and 44, 45, 46, but students who take this sequence need to spend less time on drill, and consequently it is possible to explore some of the interesting implications of calculus in science, engineering, and mathematics. 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 in 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 and credit must be made during the first two weeks of the student's first quarter of attendance at Stanford University, or earlier, or the privilege will lapse. Advisers on advanced placement are currently Professors 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). These courses should be started during the first year. (Course 117 may be substituted for 46.) Students intending to major in mathematics are advised to begin or continue the study of French, German, or Russian in the first year.

2. Three quarters of Algebra (113, 114, 120); two quarters of Differential Equations (130, 131); two quarters of Fundamental Concepts of Analysis (115, 116) (see description of course 54 below); one quarter of Introduction to Functions of a Complex Variable (106); one quarter selected from Higher Geometry (142), Non-Euclidean Geometry (157), Introduction to Topology (159), Differential Geometry (217A).

3. Nine units of courses in mathematics numbered above 100 in addition to those selected to fulfill requirement "2." The average grade point ratio in these courses and the courses chosen under "2" above must be not less than 2.0. 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 22, or Russian 52.

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 Master's Thesis is optional: If a thesis is presented, the candidate's program must contain 15 units of 200-level courses (in addition to the thesis). If no thesis is to be presented, the candidate's program must include 24 units of courses numbered 200 or above. The candidate must have a B average over all course work taken in Mathematics, and a B average in the 200 level courses considered separately. Certain exceptions to the 45 unit requirement above are possible. In particular, a student will be recommended for the M.S. degree upon completion of an approved program of 36 units of 200 level
Mathematics courses with grades of B or better.

For the degree of Master of Science in Computer Science, see Computer Science Department material in this bulletin.

**Doctor of Philosophy**

The University's basic requirements for the doctorate (residence, dissertation, examination, etc.) are discussed in the section "Degrees" in this bulletin. The following are Departmental requirements:

In order that a student be admitted to candidacy for the Ph.D. degree, he must have successfully completed 45 units of graduate courses (i.e., courses numbered 200 and above). These courses should include Mathematics 205A, B, C, 206A, B, C, 210 A, B. In addition he must pass qualifying examinations given by the Department and demonstrate the ability to read French, German, or Russian.

Beyond the requirements for candidacy, the student must complete a course of study of at least 30 units approved by the Graduate Study Committee of the Department of Mathematics. This program must either display sufficient breadth in mathematics outside the student's field of specialization, or fulfill the requirements for a minor in another department. In addition, the student must pass his second language examination and the University oral examination, and submit an acceptable dissertation. A student must receive a grade of B or better in a course in order that it satisfy a requirement for the Ph.D. degree.

A candidate for the Ph.D. degree in Mathematics may specialize in computer science and submit his dissertation in this area. He must satisfy the usual requirements for the degree as established by the Mathematics Department. Since he must also be expert in certain areas of computer science he should confer early with the Computer Science Department in planning his program. In view of the necessary work in computer science, consideration will be given to a reduction in the variety of other mathematics courses required for the degree.

For the degree of Doctor of Philosophy in Computer Science, see the Computer Science Department material in this bulletin.

For further information concerning degree programs, requirements for a Ph.D. minor in mathematics, fellowships, and assistantships, inquire of the 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 courses numbered 100 or above, and in addition, 15 units selected from courses numbered 100 or above or in courses in other departments requiring extensive application of mathematics. Thirty-six quarter units must be in upper division or graduate standing. Candidates for the General Secondary Credential may count courses 45, 46 and 55, 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."
INTRODUCTORY AND UNDERGRADUATE COURSES

Introductory courses will be offered only if ten or more students enroll.

0. Algebra and Trigonometry—Fundamental laws; linear and quadratic equations; inequalities; logarithms; binomial theorem; trigonometric functions, identities, and equations; solution of right and oblique triangles; complex numbers; De Moivre’s theorem.

4 units, Aut (——) MTWThF 10 or 2:15
Win (——) MTWThF 10

#1. Elementary Mathematical Analysis I—Structure of the real number system; logic of algebra; fundamental concepts of geometry and trigonometry. No credit allowed if taken after courses numbered 10 or higher.

3 units, Win (Bacon) MWF 8

#2. Elementary Mathematical Analysis II—Introduction to the basic ideas of analytic geometry and calculus; applications. No credit allowed if taken after courses numbered 10 or higher. Prerequisite: 1.

3 units, Spr (Bacon) MWF 8

#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. 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, 10, or 2:15
Win (——) MWF 10, 12, or 2:15

#11. Analytic Geometry and Calculus—Continuation of 10: Translation and rotation of coordinate axes, conics, curve sketching, families of curves, trigonometric and inverse trigonometric functions and their derivatives, exponential, hyperbolic and logarithmic functions and their derivatives, trigonometric integrals. Prerequisite: 10.

3 units, Win (——) MWF 8, 10, or 2:15
Spr (——) MWF 10, 12, or 2:15

#21. Analytic Geometry and Calculus—Continuation of 11: 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 (——) MWF 8 or 3:15
Spr (——) MWF 10, 12, 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 (——) MWF 9, 11, or 1:15
Win (——) MWF 8 or 3:15


3 units, Aut (——) MWF 12
Win (——) MWF 9, 11, or 1:15
Spr (——) MWF 8 or 3:15

#31. Introduction to Mathematics—Mathematics 31–35 is intended for students whose major area of specialization does not require detailed technical knowledge in mathematics. The series does not serve as a prerequisite to 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 to-

3 units, Aut (McGregor) MWF 11

#32. Introduction to Mathematics—Continuation of 31.

3 units, Win (McGregor) MWF 11

#33. Introduction to Mathematics—Continuation of 32.

3 units, Spr (McGregor) MWF 11

#34. Introduction to Mathematics—Continuation of 33.

3 units, Aut (Hawley) MWF 11

#35. Introduction to Mathematics—Continuation of 34.

3 units, Win (Hawley) MWF 11

#41. Analytic Geometry and Calculus—41 and 42 together cover the same subjects as 10, 11, 21, and part of 22. Requirements for admission to 41 same as for 10.

5 units, Aut (Sunseri) MTWThF 8;
(Bacon) MTWThF 9;
(____) MTWThF 10
Win (____) MTWThF 12

#41A. Calculus—41A, 42A, 43A together cover the same topics in the calculus as 41, 42, 43, but topics in plane analytic geometry are omitted. Requirements for admission to 41A are the same as for 10, but in addition the student must have had substantial course work in analytic geometry in high school or college. Admission to 41A will be restricted to students who pass a qualifying examination in analytic geometry to be given during the first week of the quarter. Details of this examination will be explained at the first meeting of the class. This examination will be waived only for those who present transfer college credit in analytic geometry.

5 units, Aut (Sunseri) MTWThF 9

#42. Analytic Geometry and Calculus—Continuation of 41.

5 units, Win (Sunseri) MTWThF 8;
(Bacon) MTWThF 9
Spr (____) MTWThF 12

#42A. Calculus—Continuation of 41A.

5 units, Win (Sunseri) MTWThF 9

#43. Analytic Geometry and Calculus—Continuation of 42: Improper integrals, Simpson’s rule, determinants, simultaneous equations, hyperbolic functions, inverse hyperbolic functions, polar coordinates, polar curves, angle between radius vector and tangent line, areas, parametric equations, vector components, differentiation of vectors, tangential and normal acceleration, space coordinates, vectors, scalar product, planes and lines in space, space curves, cylinders and quadric surfaces, functions of several variables, partial derivatives, tangent plane, chain rule for partial derivatives, differential equations of first order (homogeneous, linear), special second order differential equations, l'Hospital’s rule. Prerequisite: 42.

5 units, Aut (____) MTWThF 12
Spr (Sunseri) MTWThF 8;
(Bacon) MTWThF 9

#43A. Calculus—Continuation of 42A. Concurrent registration in 44 is permissible.

2 units, Spr (Sunseri) TTh 9

#44. Advanced Calculus I—Infinite series, convergence tests, parallel topics on improper integrals. Uniform convergence. Power series. Prerequisite: 23 or 43, or concurrent registration in 23 or 43 and consent of instructor.

3 units, Aut (____) MWF 9, 11, or 1:15
Win (____) MWF 12
Spr (____) MWF 9 or 11

45. Advanced Calculus II—Vectors and curves in the plane. Functions of two variables, directional derivatives, 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 9 or 2:15

#52. Honors Calculus—Honors version of 42, with greater emphasis on the fundamental concepts and rigorous development of the calculus and more extensive discussion of its applications. Prerequisites: 41 or equivalent, and consent of instructor.

5 units, Win (-) MTWThF 10

#53. Honors Calculus—Continuation of 52.

5 units, Spr (-) MTWThF 10

#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, 117. Students majoring in mathematics who complete this sequence may be permitted to substitute six elective units for the requirement of 115, 116.

3 units, Aut (Osserman) MWF 10

55. Honors Calculus—Continuation of 54.

3 units, Win (Osserman) MWF 10

56. Honors Calculus — Continuation of 55.

3 units, Spr (Osserman) MWF 10

COURSES FOR UNDERGRADUATE AND GRADUATE STUDENTS

Prerequisites for the courses below may be waived with the consent of the instructor.

105. Introduction to Computer Science — (Enroll in Computer Science 50A.)

106. Introduction to Theory of Functions of a Complex Variable — Complex numbers, analytic functions, Cauchy-Riemann equations, complex integration, Cauchy formula; elementary conformal mappings. Prerequisite: 45.

3 units, Aut (-) MWF 11, 1:15, or 2:15
Spr (-) MWF 2:15
Sum (-)

113. Linear Algebra and Matrix Theory—The study of the algebraic properties of matrices and their interpretation in geometric terms. The relationship between the algebraic and geometric points of view and matters that are fundamental to the study and solution of linear equations are dealt with.

Topics include: linear equations, vector spaces, linear dependence, bases and coordinate systems; linear transformations and matrices; similarity and eigenvalues; reduction of quadratic forms.

3 units, Aut (-) MWF 9, 10, or 1:15
Win (-) MWF 10 or 1:15
Sum (-)

113H. Linear Algebra and Matrix Theory (Honors).

3 units, Aut (-) MWF 9

114. Linear Algebra and Matrix Theory—Continuation of 113: A deeper study of certain of the topics indicated as well as additional topics chosen among the following: invariant subspaces, canonical forms of matrices, minimal polynomials and elementary divisors; vector spaces over arbitrary fields; inner products; Hermitian and unitary matrices; multilinear algebra.

3 units, Win (-) MWF 9 or 1:15
Spr (-) MWF 10

114H. Linear Algebra and Matrix Theory (Honors).

3 units, Win (-) MWF 10

115. Fundamental Concepts of Analysis—A rigorous development of real analysis in Euclidean space: basic point set topology, limits, continuous functions. Especially recommended for students who intend to take graduate work in mathematics. Prerequisite: 45.

3 units, Aut (-) MWF 11
(-) MWF 2:15
Win (-) MWF 11;
(-) MWF 2:15


3 units, Win (-) MWF 11
(-) MWF 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 (-) MWF 2:15
Spr (-) MWF 1:15
121. Modern Algebra—Continuation of 120.
   3 units, Spr (——) 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, Aut (Chung) 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, Win (Chung) 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 10
   Sum (——)

130H. Ordinary Differential Equations (Honors).
   3 units, Aut (——) MWF 11

   3 units, Win (——) MWF 8, 11, or 2:15
   Spr (——) MWF 10

131H. Partial Differential Equations (Honors).
   3 units, Win (——) MWF 11

   3 units, Spr (——) MWF 8, 11, or 2:15

137. Numerical Analysis — (Enroll in Computer Science 137.)
   3 units, Aut (Bacon) MWF 8

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 (Bacon) MWF 8

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 (——) MWF 9

150. Combinatorial Analysis — (Enroll in Computer Science 150.)

152A. Elementary Theory of Numbers —
   Euclid's algorithm, fundamental theorems on divisibility; prime numbers; congruence of numbers; theorems of Fermat, Euler, Wilson; congruence of first and higher degrees; Lagrange's theorem, its applications; residues of power; quadratic residues; introduction to theory of binary quadratic forms.
   3 units, Win (——) MWF 2:15

   3 units, Aut, alternate years, given 1970–71

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, alternate years, given 1970–71


161. Introduction to Set Theory—(Enroll in Philosophy 161.) Intuitive justification of the axioms. Operations on sets, relations and functions. Equivalence and ordering rela-
tions. Equivalence of sets and cardinal arithmetic. Topics on ordinal numbers and axiom of choice as time permits. Prerequisite: 160A or equivalent.


195. Undergraduate Colloquium—Based on reading and discussion of topics in history and philosophy of mathematics. Prerequisite: consent of instructor.

3 units, Spr (Hawley) by arrangement

196. Problem Seminar—Designed to introduce the students to independent work. The problems will deal with infinite series and sequences, definite integrals, or the elements of complex variables, and will be selected to satisfy the needs and preferences of the students.

3 units, Spr (Polya) by arrangement

198. Independent Work.
(Staff) by arrangement

COURSES INTENDED PRIMARILY FOR GRADUATE STUDENTS


206A,B,C. Theory of Functions of a Complex Variable—Complex integration. Cauchy’s theorem, calculus of residues; power series, infinite products, entire functions, Picard’s theorem; Riemann mapping theorem. Prerequisite: 116 or equivalent.

206A. 3 units, Aut (Zalcman) MWF 11
206B. 3 units, Win (Zalcman) MWF 11
206C. 3 units, Spr (Osserman) 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 (——) MWF 1:15
210B. 3 units, Win (——) MWF 1:15
210C. 3 units, Spr (——) MWF 1:15

217A,B. Differential Geometry — Classical differential geometry of curves and surfaces; surfaces of constant curvature, connections with non-euclidean geometry; minimal surfaces. Intrinsic geometry, parallel transport, geodesics; geometry on a surface.

217A. 3 units, Aut (Hawley) MWF 2:15
217B. 3 units, Win (Hawley) 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 (Schiffer) TTh 11:00-12:15
220B. 3 units, Win (Schiffer) TTh 11:00-12:15
220C. 3 units, Spr (Schiffer) 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, Spr (——) MWF 2:15

224A, B. Integral Equations — Singular types and methods for their solution; alternative integral equation reformulation of boundary value problems, dual equations and affiliated variational principles.

224A. 3 units, Win (Levine) MWF 1:15
224B. 3 units, Spr (Levine) MWF 1:15


229C. Dynamic Optimization (Deterministic)—(Enroll in Operations Research 348.)
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 (——) MWF 1:15
230B. 3 units, (——) MWF 1:15

232A,B. Diffusion Processes—Basic properties of Brownian motion in one and more dimensions and the potential theory connected with them. Construction of diffusion processes by stochastic differential equations. Extensions and applications. Prerequisite: 230 or equivalent, with consent of instructor.

232A. 3 units, Aut (Chung) MW 3:15-4:30
232B. 3 units, Win (Chung) MW 3:15-4:30

237A,B,C. Advanced Numerical Analysis—(Enroll in Computer Science 237A,B,C.)

245A,B,C. Theory of Functions of Several Complex Variables — Hartog's theorem; Weierstrass preparation theorem and the local theory; integral representations and the residue calculus; domains of holomorphy and their cohomology, pseudoconvexity; additive and multiplicative Cousin problems; coherent analytic sheaves, Cartan's theorems A and B.

245A. 3 units, Aut (Hill) MWF 12
245B. 3 units, Win (Hill) MWF 12
245C. 3 units, Spr (Hill) MWF 12


3 units, Spr (Zalcman) by arrangement

252A,B. Total Positivity and Applications—An introduction to the concept and theory of total positivity. Applications include analysis of certain integral and differential operators, variation diminishing transformations, theory of constructive approximations, parametric statistical decision theory and stochastic processes of diffusion type.

252A. 3 units, Aut (Karlin) by arrangement
252B. 3 units, Win (Karlin) by arrangement

254A,B. Ordinary Differential Equations—Fundamental existence theorems, stability and asymptotic behavior of nonlinear systems, Poincaré-Bendixson theorem, linear systems and Sturm-Liouville eigenvalue problems; selected topics from equations in the complex domain; Fuchian theory, Hamiltonian systems, existence of periodic solutions and orbital stability.

254A. 3 units, Win (Schiffer) MWF 11
254B. 3 units, Spr (Schiffer) MWF 11


256A. 3 units, Aut (Gilbarg) TTh 11:00-12:15
256B. 3 units, Win (Gilbarg) TTh 11:00-12:15
256C. 3 units, Spr (Gilbarg) TTh 11:00-12:15


261A. 3 units, Aut (Phillips) MWF 10
261B. 3 units, Win (Phillips) MWF 10
261C. 3 units, Spr (Phillips) MWF 10

265A,B. Selected Topics in Abstract Analysis.

265A. 3 units, Aut (de Leeuw) MWF 3:15
265B. 3 units, Win (de Leeuw) MWF 3:15

274A,B. Asymptotic and Geometric Methods in Wave Propagation—Geometric optics and geometric theory of diffraction, asymptotic expansions, asymptotic solutions of differential equations; caustics, shadow boundaries, boundary layer theory, etc.

274A. 3 units, Win (——) TTh 2:15-3:30
274B. 3 units, Spr (——) TTh 2:15-3:30
279A. Mathematical Genetics—Mathematical models in population genetics, ecology, population growth, and epidemiology. The first part of the course deals mainly with deterministic models in population genetics. Prerequisite: consent of instructors.

3 units, Spr (Bodmer, Karlin) by arrangement, alternate years, given 1969–70


281A. 3 units, Aut (Samelson) MWF 9
281B. 3 units, Win (Samelson) MWF 9
281C. 3 units, Spr (Samelson) MWF 9

283A,B,C. Selected Topics in Topology — Topics from: fiber spaces and fiber bundles, characteristic classes, cohomology operations, sheaves, homology of groups. Prerequisite: 281 or equivalent.

283A. 3 units, Aut (Samelson) MWF 9
283B. 3 units, Win (Samelson) MWF 9
283C. 3 units, Spr (Samelson) MWF 9

285A,B. Global Analysis—The recent work of Smale and others on differentiable dynamical systems, including the study of generic properties of diffeomorphisms, the zeta function of a diffeomorphism, the spectral theorem for diffeomorphisms and the relations to ordinary differential equations.

285A. 3 units, Aut (Tromba) MW 3:15–4:30
285B. 3 units, Win (Tromba) MW 3:15–4:30

291A,B,C. Set Theory — Full development of set theory on an axiomatic basis. Discussion of various axioms of infinity. Problems of consistency and independence. Prerequisites: 160A,B, and 161 or equivalent.

291A. 3 units, Aut (Scott) by arrangement
291B. 3 units, Win (Scott) by arrangement
291C. 3 units, Spr (Scott) by arrangement

292A,B,C. Metamathematics — Formalized theories and their models. Validity and definability. Complete and decidable theories; applications to algebra. Recursively axiomatizable theories; incompleteness of elementary number theory; Gödel's theorems. Introduction to Hilbert's consistency problem; proof theory and questions of constructivity. Prerequisites: 160A,B, and 161 or equivalent.

292A. 3 units, Aut (Feferman) MW 3:15–4:30
292B. 3 units, Win (Feferman) MW 3:15–4:30
292C. 3 units, Spr (Friedman) MW 3:15–4:30


Alternate years, given 1970–71

295. Advanced Automata Theory—(Enroll in Electrical Engineering 484.)

296A,B,C. Algebraic Number Theory — Basic algebraic and analytic facts of local and global class field theory. Special topics.

296A. 3 units, Aut (Wyman) MW 1:15
296B. 3 units, Win (Wyman) MW 1:15
296C. 3 units, Spr (Wyman) MW 1:15

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. Burbery, Jr. (Major, Artillery), Harry J. Brunner, Jr. (Captain, Signal Corps), Thomas E. Casey (Captain, Artillery)

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 re-
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 lab 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.

**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 lab fee of $100 and an allowance of $50 per month for the two years.

**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**

**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.

2 units, Aut (Staff) MW 8, 2:15 or TTh 11

12. World Military History—Continuation of 11.

2 units, Win (Staff) MW 8, 2:15 or TTh 11


2 units, Spr (Staff) MW 8, 2:15 or TTh 11

**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.

2 units, Aut (Staff) MW 10, 2:15 or TTh 10
   2 units, Win (Staff) MW 10, 2:15 or TTh 10

   2 units, Spr (Staff) MW 10, 2:15 or TTh 10

THIRD-YEAR
131. Principles of War, Military Leadership and Tactics—Study of the principles of war, military leadership, and tactics.
   2 units, Aut (Burbery) T 9–11, T 1:15–3:05, Th 9–11 or Th 1:15–3:05

   2 units, Win (Burbery) T 9–11, T 1:15–3:05, Th 9–11 or Th 1:15–3:05

133. Principles of War, Military Leadership and Tactics—Continuation of 132.
   2 units, Spr (Burbery) T 9–11, T 1:15–3:05, Th 9–11 or Th 1:15–3:05

FOURTH-YEAR
141. Command and Staff — Study of the principles of command and staff organization and functioning for the control and employment of military forces.
   3 units, Aut (Staff) TWTh 9, 11 or 12

142. Command and Staff—Continuation of 141.
   3 units, Win (Staff) TWTh 9, 11 or 12

143. Command and Staff—Continuation of 142.
   3 units, Spr (Staff) TWTh 9, 11 or 12

MUSIC
Emeritus: Putnam C. Aldrich (Professor)
Chairman: William L. Crosten
Associate Professors: Imogene Horsley, George L. Houle
Assistant Professors: Arthur P. Barnes (Director of Bands), John M. Chowning
Senior Lecturer: Marie Gibson (Voice)
Lecturers: Adolph Baller, Earle Blew, (Piano), Kenneth Goldsmith (Violin), Lloyd Gowen (Flute), Raymond H. Duste (Oboe), Donald O’Brien (Clarinet), . . . . . . . . . . . . . . . . . (Bassoon), Charles R. Babb (Brass Instruments), Marjorie Chauvel (Harp), Stanley Buetens (Lute), . . . . . . . . . . . . . . . . . . . (Viola da Gamba), Pamela Goldsmith (Viola), Margaret Fabricio (Harpischord)

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. Supplemented this is the Stanford Memorial Library of Music, which is an invaluable collection of musical manuscripts and first editions.

The Music Department has access to large digital computers on which work is being done in sound synthesis, acoustical analysis, and composition. Advanced composition students interested in electronic music and use of the computer in composition, and students with a particular interest in acoustics are encouraged to make use of this facility.

PROGRAMS OF STUDY
BACHELOR OF ARTS
Undergraduate major — May be planned in one of three ways depending on whether the student wishes:
1) A concentration in composition, performance, or music history.
2) Preparation for secondary school teaching by way of the Stanford Internship Program.
3) A general program of studies without special emphasis on any particular branch of music.

The specific details of each plan will be worked out by the student and his adviser, taking into account the individual's particular talent and interest. Preliminary to that, each prospective major is asked to demonstrate his performing ability in the medium of his choice.

To insure a strong foundation for the individually designed concentrations, all students are required:

A. To include the following courses in their programs:
   1. Music 21–22 (Elements of Music)
   2. Music 11A, B, C (Basic Repertory)
   3. Music 100, 101, 102, 103 (Music History and Theory)
   4. Ensemble: six quarters of work in one or more departmental organizations or in chamber music.

B. To demonstrate a minimum proficiency in piano, which will include sight-reading 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 General Studies requirements may be distributed so as to permit substantial work in music from the beginning of the Freshman year.

**SAMPLE SCHEDULE FOR FOUR-YEAR A.B. PROGRAM WITH MAJOR IN MUSIC**

(Note—Where the word Music appears below without a number, the specific courses taken will depend upon the type of music program the student has chosen to follow.)

**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>English 1, 2, 3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Language 1, 2, 3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Music 21, 22</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

(This two-quarter sequence may begin autumn or winter quarter. In the remaining quarter, substitute a General Studies course or an elective)

| Music 11A, B, C | 2 | 2 | 2 |
| Music | 2-3 | 2-3 | 2-3 |

**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>Language 22, 23, and over 100 reading requirement</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>History 1, 2, 3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Music 101, 102</td>
<td>5</td>
<td>5</td>
<td>Elect.</td>
<td></td>
</tr>
<tr>
<td>Music</td>
<td>4-5</td>
<td>4-5</td>
<td>4-5</td>
<td></td>
</tr>
</tbody>
</table>

**Third Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science (Biology 4, 5 or Physical Sciences 1, 2, 3)</td>
<td>3-4</td>
<td>3-4</td>
<td>0-3</td>
<td></td>
</tr>
<tr>
<td>Social Science</td>
<td>5</td>
<td>5</td>
<td>Elect.</td>
<td></td>
</tr>
<tr>
<td>Music 100, 103</td>
<td>5</td>
<td>Elect.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Music</td>
<td>3-4</td>
<td>3-4</td>
<td>3-4</td>
<td></td>
</tr>
</tbody>
</table>

**Fourth Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional Science Requirement</td>
<td>3-5</td>
<td>3-5</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Senior Colloquium</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Music and/or Electives</td>
<td>10-12</td>
<td>10-12</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

**TEACHING CREDENTIAL (SECONDARY)—INTERNERNSHIP 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. Ap-
Applicants must have completed the Stanford A.B. degree in music or its equivalent. Undergraduate preparation should include the foundation courses in music listed above under A.B. Major, plus the following:

Music 172. Individual instruction in performance (6 quarters)
Music 127. Orchestration
Music 130, 131. Conducting (9 units)
Music 72B,C,D. Voice and instrumental classes (3 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 must pass a comprehensive examination. No more than 6 of these 42 units may be earned in ensemble. In addition to the work specifically related to the student's concentration, the study program will include: Music 200; Music 301 (1 quarter); ensemble performance (3 quarters); Master of Arts Project (1 or 2 quarters). Depending on the concentration, the latter will be an investigative essay, a composition, or a demonstration of performance supported by a written commentary. In any case, the A.M. Project should be completed during the last quarter of residence.

DOCTOR OF MUSICAL ARTS

The purpose of the Doctor of Musical Arts program is to offer advanced training in the practice and pedagogy of music. Students may concentrate in composition, conducting, music education, or performance practice—the latter being taken to cover the study of modes of performance from medieval to modern times. Each concentration, however, will be given breadth through collateral studies in other branches of music and in relevant fields outside music as seems desirable.

Enrollment is limited and, except in the field of music education, preference will be given to applicants who are not over thirty years of age.

Admission—In addition to completing the entrance test, an applicant will be asked to submit evidence of accomplishment in his proposed field of concentration. Applicants in music education must have had at least two years of successful teaching experience.

Residence—If there are no deficiencies to be made up, this program may be completed in a minimum of two years of full-time study following the Master's degree. The work must be done entirely in residence at Stanford and at least three of the quarters 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;
MUSIC 319

(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: (a) a reading knowledge of one foreign language chosen from French, German, or Italian; (b) a knowledge of the common musical terms in all three of the above languages. Concentrators in conducting and performance practice are further required to demonstrate reading ability in a second language chosen from the three listed above. This proficiency must be certified by the end of the first year of doctoral study.

Departmental examinations—(1) An advisory examination to be taken toward the end of the 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 the departmental entrance test, an applicant is asked to submit some evidence of his work in the field of music history such as a term paper or a Master's thesis.

Residence—The candidate must spend at least three consecutive quarters beyond the Master's degree as a registered student at Stanford, and must devote at least one quarter in residence to work on his dissertation.

Basic requirements—In addition to his dissertation, each candidate must complete a minimum of 60 units of study beyond the Master's degree. The program will normally include: (1) readings in music theory; (2) seminars in musical notation, analysis and performance practice; (3) independent research 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 of Doctoral study, to explore the strengths and weaknesses of his preparation; (2) a qualifying examination to be taken prior to enrolling in dissertation work.
COURSES
FOR GENERAL STUDIES

Any of the following courses may be used as partial fulfillment of the Humanities requirement in the General Studies Program:

#1. Introduction to Music — Musical expression, style, structure explained, illustrated for the listener.
   3 units, any quarter (Staff)

#5. Baroque Music.
   3 units, Win (Houle)

#6. The Music of Beethoven.
   3 units, Aut (Salgo)

#8. New Music—Instrumental, vocal and electronic music since 1950. New forms and performing media in relation to contemporary aesthetics.
   3 units, Spr (Chowning)

#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. 2 units, Aut (P. Goldsmith)
   11B. 2 units, Win (P. Goldsmith)
   11C. 2 units, Spr (P. Goldsmith)

21, 22. Elements of Music—Exploration of the elements of sound and time and their organization into musical forms. Development of notation as a means of representing and controlling sound in various media. Ear-training, beginning with acoustical phenomena, will underlie all written work. Lectures and laboratory sections. Open to all students desiring basic technical knowledge of music. No prerequisite for 21 except ability to read music.
   21. 4 units, Aut (Barnes, Smith);
       Win (Chowning, Nanney)
   22. 4 units, Win (Barnes, Smith);
       Spr (Chowning, Nanney)

100. Music History and Theory (I)—Music in the system of ecclesiastical modes. Prerequisites: 11A,B,C, 21, 22.
   5 units, Spr (Houle)

   101. 5 units, Win (Horsley)
   102. 5 units, Spr (Horsley)

   5 units, Aut (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, Aut (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.
   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. Individual Computer Projects.
   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)

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)

72. Group Instruction — For music majors and non-majors who are members of Departmental performing groups.

1 unit, Aut, Win, Spr (Staff)

72B. Voice Class.

(Gibson)

72C. Stringed Instruments Classes.

(K. Goldsmith, Hampton)

72D. Wind Instruments Classes.

(Staff)

72E. Renaissance Wind Instruments Class (Houle)

72F. Viola da Gamba Class. (——)

72G. Lute Class.

(Buetens)

72H. Percussion Class.

(Chowning)

Note — A special fee of $25 per quarter is charged for enrollment in any branch of 72.

172, 272. Individual Vocal and Instrumental Instruction.

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

172A, 272A. Keyboard Instruments (piano, organ, harpsichord).

172B, 272B. Voice.

172C, 272C. Stringed Instruments (violin, viola, violoncello, contrabass, harp, viola da gamba).

172D, 272D. Wind Instruments (flute, oboe, clarinet, bassoon, trumpet, horn, trombone, Renaissance and Baroque instruments).

Note — A special fee of $50 per quarter for majors and $100 per quarter for non-majors is charged for enrollment in any branch of 172 or 272.

130. Orchestral Conducting—Prerequisite: 127.

130A. 3 units, Win (Salgo)

130B. 3 units, Spr (Salgo)

131. Choral Conducting.

131A. 3 units, Aut (Schmidt) given 1970–71

131B. 3 units, Win (Schmidt) given 1970–71

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) given 1970–71

252. Choral Repertory (1750 to Present).

4 units, Aut (Schmidt)
269. Seminars in Performance Practice —
Lectures on methods of analysis appropriate
to the music of the period, with emphasis on
the relation of analysis to performance. Practice sessions directed toward the principles discussed in the lectures, development of special rehearsal techniques, and preparation of concerts. 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)


3 to 4 units, Aut, Win, Spr (Salgo, Staff)

ENSEMBLE
All courses listed in this section may be repeated for credit, with a maximum of 24 units allowed toward graduation. Membership in these organizations is not limited to students who register in the courses for credit, and unless otherwise stated, is open to both men and women. An audition, however, is required for admission to any University musical organization. Audition schedules will be announced in advance of each registration period.

160. University Orchestra.
1 to 2 units, Aut, Win, Spr (Salgo) M 7:30 p.m. and Th 7:15 p.m.

161. University Bands.
161A. Concert Band.
1 unit, Aut (Barnes) T 7:15 p.m.
Win (Barnes) MWF 4:15-5:30 p.m.
Spr (Barnes) MWF 4:15-5:30 p.m.

161B. Studio Band.
1 unit, Aut, Win, Spr (Barnes) by arrangement

161C. Sports Activity Bands—Men only for autumn quarter.
1 to 2 units, Aut (Barnes) MWF 4:15-5:30
1 unit, Win, Spr (Barnes) by arrangement

162. University Chorus.
1 to 2 units, Aut, Win, Spr (Schmidt)
M 7:30-9:30 p.m. and W 4:00-5:30

163. University Choir — Official choir of Memorial Church, which furnishes music for Sunday services 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) (1)
MTh 12; (II) TF 12

166. Chamber Orchestra — Open to advanced players who have had orchestral experience.
1 to 2 units, Aut, Win, Spr (Salgo) TF 12

1 to 2 units, Aut, Win, Spr (MacKinnon) T 4:15-5:45 MTh 12; and Th 7:15-8:15

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 to 2 units, Aut, Win, Spr (Staff)

171. Performance Special — For students who take part in performances while not enrolled in 269 or a regular performing organization.
1 to 2 units, Aut, Win, Spr (Staff)

MUSIC EDUCATION

265A. 3 units, Sum (Kuhn) MThWTh 3:15
265B. 1 unit, Aut (Kuhn) T 4:15-5:05
265C. 1 unit, Win (Barnes) T 4:15-6:05
265D. 1 unit, Spr (Kuhn) T 4:15-6:05
280. Seminar in Music Education.
   4 units, Aut (Kuhn)

281. Administration and Supervision of Public School Music.
   4 units, Spr (Kuhn)

GRADUATE RESEARCH AND SPECIAL STUDIES

200. Music Bibliography — Use of bibliographical materials in graduate study; introduction to methods of research.
   3 units, Win (Colby)

299. Master of Arts Project.
   4 units, any quarter (Staff)

300. Seminar in Musical Notation.
   300A. 4 units, Aut (Horsley)
   300B. 4 units, Win (Horsley)
   300C. 4 units, Spr (Horsley)

301. Seminar in Music History and Analysis.
   301A. 4 units, Aut (Horsley)
   301B. 4 units, Win (Crosten)
   301C. 4 units, Spr (——)

302. Research in Musicology.
   Aut, Win, Spr (Crosten, Horsley) by arrangement

303. Research in Music Education.
   Aut, Spr, Sum (Kuhn) by arrangement

304. Seminar in the Editing of Music — Problems of transcribing music of various periods and preparing it for publication in a form intelligible to modern performers.
   304A. 4 units, Aut (——)
   304B. 4 units, Win (——)

311. Readings in Music Theory.
   3 units (Horsley)

321. Readings in Music Theory.

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

380. D.M.A. Term Projects in Music Education.
   4 units, Aut, Spr, Sum (Kuhn)

399. D.M.A. Final Project.
   Any quarter (Staff) by arrangement

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.

Two-Year Contract NROTC students are selected normally from applicants in their sophomore year; however, students beyond the sophomore class level who have at least two years remaining in school and graduate school students with two years of school remaining may apply. Candidates selected will attend a six-week summer training session prior to enrollment. Two-Year Contract students receive an allowance of $50 per month. Applications are accepted by the
Professor of Naval Science between January 1 and March 15.

Upon successful completion of the required courses in Naval Science, together with the University requirements for a baccalaureate degree, NROTC students are appointed Ensigns and serve on active duty with the Fleet as commissioned officers. Qualified students who so desire may pursue Marine Corps professional studies during the last two years of attendance. Upon completion they may be appointed Second Lieutenants.

Regular Midshipmen must complete three summer cruises with Fleet units. Contract students must complete two such cruises, normally during their last two summers.

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 50A, 107

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
   - Biological Science 4, 5

   Physical Science 1, 2, 3
   - An approved Earth Science sequence
   - 3. Computer Science 5 or 50A
   - 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.
   - 3 units, Aut (Bowman) MWF 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. 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, Aut (Staff) MWF 8 or 2:15; lab. Th 8 or 2:15

212. 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.

2 units, Win (Staff) MW 8 or 2:15; lab. Th 8 or 2:15

213. American Military Affairs—Continuation of 212.

2 units, Spr (Staff) MW 8 or 2:15; lab. Th 8 or 2:15


3 units, Aut (Clark) MWF 10 or 12; lab. Th 10 or 12

311A. Evolution of Warfare I—Development of the art of warfare through consideration of historical examples of evolutionary and technical trends in strategy and tactics.

3 units, Aut (Varney) MWF 10 or 2:15; lab. Th 10 or 2:15

312. Navigation and Introduction to Naval Operations—Continuation of 311: Rules of the road, lights, signals, and navigational aids including inertial systems.

3 units, Win (Clark) MWF 10 or 12; lab. Th 10 or 12

312A. Evolution of Warfare II—Continuation of 311A.

3 units, Win (Varney) MWF 10 or 2:15; lab. Th 10 or 2:15

313. Naval Operations—Tactical formations and dispositions, relative motion, maneuvering board, tactical plots are analyzed for force effectiveness and unity.

3 units, Spr (Clark) MWF 10 or 12; lab. Th 10 or 12

411. Naval Engineering — Application of thermodynamics to design, installation and operation of naval propulsion plants. Introduction to principles of nuclear reactor, problems of radiation shielding and instrumentation. Principles of stability, experimental determination of righting moment, metacentric height, list and trim.

3 units, Aut (Staff) MWF 11 or 1:15; lab. Th 11 or 1:15

412. Naval Engineering and Introduction to Naval Leadership—Continuation of 411: Stress on preparation of Midshipmen for immediate assumption of command responsibilities upon graduation and commissioning.

3 units, Win (Staff) MWF 11 or 1:15; lab. Th 11 or 1:15

412E. Introduction to Naval Leadership—Stress on preparation of Midshipmen for immediate assumption of command responsibilities upon graduation and commissioning. (Open to Engineering majors only.)

1 unit, Win (Staff) by arrangement

413. Naval Leadership — Management principles governing the administration of large complex organizations. Purposes and administration of UCMJ. Psychological, sociological, and anthropological factors underlying leadership in the naval environment.

3 units, Spr (Staff) MWF 11 or 1:15; lab. Th 11 or 1:15

Naval Science Laboratory — Two hours a week of Naval Science Laboratory required of all NROTC students. Monday session held on Drill Field at 3:15 p.m. Thursday session practical work conducted in regular classroom. Sophomores attend a seminar in Sea Power and Maritime Affairs.

PHILOSOPHY

Chairman:
Director of Graduate Study: David S. Nivison
Director of Undergraduate Study: John D. Goheen


Associate Professors: Jeffery Smith, Joseph D. Sneed. Visiting: Dag Prawitz

Assistant Professors: Harvey Friedman, 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 groups of courses: Group A: 3, 157, 160, 161, 181; Group B: 2, 170, 172, 174, 177, 179; Group C: 164, 168, 169, 178, 180, 182, 184, 189; and Group D: 100, 101, 102, 103, 104. Majors who do not take senior tutorial will select, in consultation with their Departmental advisors, a program of courses emphasizing one of the major areas of philosophy indicated by the four groups of courses. All majors will select, in consultation with their Departmental advisors, programs of courses outside the Department which will complement their major programs or enable them to further an interest in some other area of knowledge.

Philosophy courses taken in fulfillment of General Studies requirements may also be counted in fulfillment of Departmental requirements. Majors in Philosophy must maintain at least a C average in their work in the Department.

Tutorial Work

The Honors Program in Philosophy is an integral part of a Tutorial Program. Both juniors and seniors may apply for individual tutorial with a member of the Department. Junior Tutorial will occupy 12 units (4 units each quarter) of the student's academic program and will be devoted to a course of study and research designed in consultation with his instructor. Juniors may, if this is a preferred type of instruction, apply for group tutorial to be conducted by a member of the Department.

Tutorial in the senior year will occupy 15 units (5 units each quarter) of the student's academic program, and will be devoted to research on a topic resulting in a Senior Tutorial Essay. All students accepted for Senior Tutorial automatically become candidates for Departmental Honors. To achieve Departmental Honors, the Senior Essay must be distinguished. Failing to attain Departmental Honors, a student may nevertheless qualify for Senior Tutorial credit.

Combined Major in Classics and Philosophy

Students may, with the consent of the 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

An Honors Program in Humanities is offered for philosophy majors who wish to supplement their Departmental work for the A.B. degree by a related carefully guided program of studies. See the section “Humanities Special Programs” for a description of the Honors Program.

ADVANCED DEGREES

The members of the Department are prepared to direct and supervise individual study and research to supplement instruction offered in courses listed below. In addition, advanced seminars, unlisted in the catalog, are frequently organized in response to student interest. Candidates for advanced degrees are urged to discuss their entire program of study with their Departmental adviser as early as possible.

Applicants for admission to graduate standing in the Department of Philosophy should apply to the Director of Admissions. Applicants are requested to take, in their senior year or later, the Graduate Record Aptitude Test.

The Department will not ordinarily admit students who wish to become candidates for the Master's degree only.

MASTER OF ARTS

The University's basic requirements for the Master's degree (residence, thesis, etc.) are discussed in the section “Degrees” in this bulletin. The following are Departmental requirements:

1. Completion of a total of at least 36 units of graduate work in the Department with grades no lower than C and an average grade of B or better. Course work shall include one or two quarters in Philosophy 250.

2. Completion of a thesis acceptable to the Department. Credit will be allowed for the thesis to a maximum of 9 units toward the 36 units required for the degree.

3. Satisfactory performance on the preliminary examinations described below under “Doctor of Philosophy.”

MINOR IN PHILOSOPHY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Each student shall take 30 units of work within the Department to be chosen according to the student's interests in consultation with a Departmental adviser. Departmental approval of the program of studies is required. One hour of the doctoral oral examination is ordinarily devoted to the minor subject.

DOCTOR OF PHILOSOPHY

The University's basic requirements for the doctorate (residence, dissertation, examination, etc.) are discussed in the section “Degrees” of this bulletin. The following are Departmental requirements:

Courses—There are no fixed course requirements, but the Department reserves the right to prescribe the courses a student takes in preparation for the preliminary examinations. The program of courses for this purpose will depend on the preparation of the individual student and is decided in consultation with his Departmental adviser.

GENERAL GRADUATE PROGRAM

Preliminary Examinations

1. All first-year graduate students will take a three-hour written examination during the winter quarter of their first year of graduate study at Stanford. It is expected that this examination will ordinarily be given in the last week in January. A student is required to pass this examination in order to continue as a second-year student in the Department.

2. Written preliminary examinations are set for all students in the middle of their second year of graduate study. These examinations are offered in the following four areas: logic and philosophy of science, epistemology and metaphysics, ethics and the theory of value, the history of philosophy. The examinations must be passed as a group, subject to the modification described in the next paragraph. It is expected that a student must pass these examinations in order to continue as a graduate student. In special circumstances a student may be permitted to take these examinations a second time. The second-year examinations will ordinarily be set in the middle of February. If they so desire, first-year students may ask the Department for the option of taking the second-year examinations.

A student may substitute a group of courses for at most one of the four examinations. Such a group consists of at least four courses in each of which the student has a mark of
B or better. Courses taken at another university cannot be included. The following groups of courses satisfy the present requirement:

**Logic and Philosophy of Science:** 157A, 157B, 164, and 166.

**Epistemology and Metaphysics:** 184 plus three additional courses from the following: 181, 182, 189, and 202.

**Ethics and the Theory of Value:** 148, 156, 170, and two of the following: 172, 174, 177.

**History of Philosophy:** 100, 101, 102, 103.

In each area, more advanced courses or seminars may be substituted for the recommended courses with Departmental permission.

On or before February 1 of the first year in which a student plans to take the preliminary examinations he must file with the Departmental secretary a declaration of his intention to take the examinations. This should include a statement of the examination (if any) for which courses are to be substituted, and a list of the courses the student wishes to substitute. If this list differs from that given above, it must be approved by the Department. Courses may not be offered in lieu of an examination in an area in which the student has already taken the preliminary examination but failed, and the area in which exemption is requested cannot be changed if the examinations are taken a second time. The four courses offered in substitution for one examination must be completed before the student's formal candidacy for the Ph.D. degree is accepted, and generally no later than the end of the second year of graduate work. The courses need not be completed prior to taking the written preliminary examinations.

**Language Requirements**—Candidates for the Ph.D. must demonstrate a reading knowledge of French and German. When it is relevant to a proposed dissertation topic, the department will give permission to substitute other modern languages, or ancient languages, for one or both of the required languages.

**Dissertation**—Upon passing the preliminary examinations the candidate will submit a brief written statement of his dissertation topic to the Department, and a committee will be appointed to direct the research for and writing of the dissertation. Departmental approval of the dissertation topic is required for formal admission to candidacy for the doctoral degree.

The dissertation must be submitted to the committee in substantially final form at least four weeks before the University deadline in the quarter during which the candidate expects to receive his degree.

Dissertations must be completed and approved within five years from the date of that application. A candidate taking more than five years will be required to 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 dissertation, but it may range over related topics as well.

**Special Graduate Programs in Logic, Philosophy of Language, and Philosophy of Science**

Recognizing the interests of students in more technical areas of Philosophy, the Department offers programs allowing the student to concentrate in one of three fields. The difference between these special programs and the general graduate program in Philosophy lies in the course requirements and the written preliminary examination. The student need not declare his intention to participate in a specialized program until February 1 of the first year in which he plans to take the preliminary examination. Even at that time he does not have to commit himself to the particular field but must do so before he takes the second part of the examination as explained below.

**Courses**—All students in these programs are required to take 160A,B (Symbolic Logic), 161 (Introduction to Set Theory), 164 (Philosophy of Science), 166 (Probability and Induction), 181 (Philosophy of Language), 184 (Theory of Knowledge). In addition a student is required to take one course or seminar in the general area of history of philosophy and one course or seminar in the general area of ethics and value theory (the courses are to be chosen in consultation with the student's adviser). These course requirements must be completed by the end of the third year of the student's residence in graduate school. In lieu of these courses equivalent or more advanced course work may be offered subject to 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 graduate students will take the three-hour written examination administered to all first-year students in Philosophy (see above).

2. Ph.D. candidates in these programs will take two written preliminary examinations, each lasting three hours. The first examination, of a general nature, will be taken by all students, and will be given in February of the second year. The second examination will be devoted to one of the three specialties chosen by the student and will be given at the beginning of the third year of graduate study. The student must declare his choice prior to the examination at a time to be specified by the Department. It is expected that the student will pass these examinations in order to continue as a graduate student. When circumstances warrant, however, a student may be permitted to take the examination a second time.

GRADUATE PROGRAM IN HUMANITIES

The Department of Philosophy also participates in the Graduate Program in Humanities leading to the joint Ph.D. degree in Philosophy and Humanities. For a description of that program, and fellowships offered in connection with it, see the section "Humanities Special Programs."

GRADUATE FELLOWSHIPS AND ASSISTANTSHIPS

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 not 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, utilitarianism, the emotive theory, and various forms of relativism, subjectivism, and absolutism. Among the topics discussed are: How are moral judgments related to scientific judgments? How are moral judgments justified? Are all human acts fundamentally selfish? Can morality be based on some conception of what is natural? What is the relation between value in general, the highest good, and obligation? Are the notions of freedom and responsibility meaningful if human actions are determined? What is the relation between personal value and social value? There are four lectures a week; a fifth hour is given to discussion sections.

5 units, Aut (Schwartz) MTWTh 1:15 and Th or F section
Win (Waks) MTWTh 2:15 and Th or F section

#3. Introduction to Logic—An introduction to the methods and principles of formal logic. Exploration of modern techniques of deduction. Applications to philosophy and the exact sciences. This is not a General Studies Humanities course.

5 units, Aut (Sneed) MTWTh 2:15 and Th or F section
Spr (Friedman) MTWTh 2:15 and Th or F section

#5. Introduction to Philosophy—This is a general introduction to the problems with which philosophers are and always have been concerned, the conflicts in point of view that have arisen in the attempts that
have been made to solve these problems, and the practical consequences of adopting any of these points of view. The course also strives to enlarge the intellectual horizon of students by making them familiar with concepts which everyone needs if he is to deal adequately with fundamental beliefs, and to clarify the often highly ambiguous terminology that is associated with these concepts. The course meets five times a week.

5 units, Win (Moravcsik) MTWTh 10 and Th or F section

Sum (——) MTWTh F 1:15 and one hour by arrangement

#6A,B. Problems of Good and Evil—The problem posed in the Book of Job is taken as central, and various attitudes toward this problem are considered in chronological order. In the first quarter the works covered include the Old Testament, several Greek tragedies, selections from Plato, Aristotle, the Stoics, Lucretius, New Testament, and Dante’s Divine Comedy. In the second quarter, authors covered covered Montaigne, Shakespeare, Leibnitz, 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

#8. Philosophy of Art — Nature and function of artistic creation and expression. Unique and common characteristics of various arts. Relation of arts to other human interests.

4 units, Aut (Smith) MTWF 9

#10. Introduction to Philosophical Analysis — An analysis of selected philosophical problems. Readings will include important historical texts as well as contemporary writers.

5 units, Spr (——) TTh 11:00-12:30

#27. Sophomore Seminar in Philosophy of Religion—Critical examination of some central problems in philosophy of religion. Attention will center upon (1) the traditional arguments for the existence of God; (2) the problem of evil as an argument for atheism; (3) psychological accounts of religious belief; (4) the relevance of evidence to religious belief; (5) the distinction between theology and philosophy of religion. There will be two separate sections; enrollment in each will be limited to 20.

3 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 1970-71

COURSES FOR ADVANCED UNDERGRADUATE AND GRADUATE STUDENTS

I. HISTORY OF PHILOSOPHY FROM ANCIENT TIMES TO THE PRESENT

100. Greek Philosophy — Characterization of historical situation in which Western science and philosophy began. Rise of critical thought. Early metaphysical speculation. Sophists and Socrates. Post-Socratic ethical schools. Philosophies of Plato, Aristotle, the Epicureans, the Stoics, the Skeptics, and Neo-Platonism. Prerequisite: some general course in philosophy, such as 2, 5, 6A, or 10.

4 units, Aut (Goheen) MTWTh 11


4 units, Aut (Goheen) MTWTh 11


4 or 5 units, Spr (Goheen) 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 (Mothershead) MTWTh 9, given 1970–71

104. Contemporary Philosophy—Some principal developments in contemporary philosophical thinking. Prerequisite: a total of two philosophy courses.

4 units, Spr (Goheen) MTWTh 9, given 1970–71

106. Introduction to Philosophy—For graduate students. Lectures same as 5.

4 units, Win (Moravcsik) MTWTh 10 and Th or F Section
4 units, Sum (——) MTWThF 1:15 and Th or F Section

110. History of Scientific Concepts—A survey of the historical development of selected concepts in the physical sciences oriented toward consideration of philosophical problems associated with them and general questions about concept formation in science.

4 units, Win (Sneed) TTh 3:15–5:05, given 1970–71

120. Ancient Chinese Philosophy—Examination of the major Chinese philosophers and schools of thought from the sixth century through the third century B.C., in the context of the history of the late Chou Dynasty. (This course replaces Philosophy 4.)

4 units, Aut (Nivison) MTWTh 11

122. Chinese Philosophy Since Classical Times—The major philosophers since the third century B.C. with emphasis on the period from Sung through middle Ch'ing. Buddhism will be reviewed but not treated in depth in this course. Prerequisite: 4, 120, or equivalent.

4 units, Spr (Nivison) MTWTh 11

II. COURSES IN THE PHILOSOPHY OF A PERIOD AND IN INDIVIDUAL PHILOSOPHERS

The following courses will be offered in 1969–70 or 1970–71. 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, given 1970–71

137. Philosophy of Aristotle—Prerequisite: 100 or equivalent.

4 units, Spr (Moravcsik) MTWTh 10

142. Seminar in the Philosophy of Descartes—Prerequisite: 102 or equivalent.

3 units, Aut (Howell) M 4:15–6:05

144. Seminar in the Philosophy of Spinoza—A study of the basic works of Spinoza.

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

145. Seminar in the Philosophy of David Hume—A selection of representative problems in Kant's philosophy are discussed in the light of recent developments.

3 units, Spr (Hintikka) M 4:15–6:05

147. The Philosophy of Kant—A selection of representative problems in Kant's philosophy are discussed in the light of recent developments.

3 units, Aut (——) by arrangement, given 1970–71

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, Aut (Schwartz) MTWTh 1:15 and Th or F section
Win (Woks) MTWTh 2:15 and Th or F section

157A. Introduction to Logic—For graduate students. Lectures same as Philosophy 3.

5 units, Aut (Sneed) MTWTh 2:15 and Th or F section
Spr (Friedman) MTWTh 2:15 and Th or F section
Sum (——) MTWThF 11 and Th or F section

157B. Intermediate Logic—Continuation of 157A: Discussion of axioms and rules of in-

3 units, Win (Friedman) MWF 11

160A,B. Symbolic Logic—Thorough treatment of validity, provability, consistency, completeness, definability and decision problems for logical calculi, and axiomatic theories.

160A. 3 units, Win (Friedman) TTh 11:00-12:15
160B. 3 units, Spr (Friedman) TTh 11:00-12:15

161. Introduction to Set Theory—Intuitive justification of the axioms. Operations on sets, relations and functions. Equivalence and ordering relations. Equipollence of sets and cardinal arithmetic. Topics on ordinal numbers and axiom of choice as time permits. Prerequisite: 157B or 160A or equivalent.

3 units, Aut (Friedman) 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) MW 1:15 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, Spr (Kreisel) by arrangement

163B. Modal Logic — Semantics and axiomatizations for several modal propositional and predicate calculi. Discussion of deontic and tense logics. 163A is not prerequisite to 163B. Prerequisite: 157B or 160A or equivalent.

3 units, Spr (Scott) MWF 1:15

164. Philosophy of Science—Detailed analysis of the structure and methods of empirical science with emphasis on set-theoretical models, probability, induction, causality and the testing of theories.

4 units, Win (Sneed) MWF 2:15 and one hour by arrangement

165. Philosophy of Logic—Some or all of the following topics will be discussed from a semi-formal point of view: Platonism versus nominalism, relation between logic and mathematics, epistemological implications of Gödel's and Church's theorems, counterfactuals, necessity and possibility, extensional and intensional contexts, synonymy, intuitionism, constructivity.

3 units, Spr (——) 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

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 (Schwartz) MTWTh 1:15, given 1970–71

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 moral obligation mean?”

4 units, Win (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

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, tyrannicide and other forms of civil disobedience.

3 units, Win (Schwartz) MWF 11

177. Political Philosophy—An analysis of fundamental political conceptions and problems: State, law, natural law, rights, natural rights, political obligations, and others.

4 units, Aut (Sneed) MTWTh 3:15


3 units, Sum (Follesdal) MWF 10

179. Philosophy of Law—The nature and function of law, the relation of law to ethics, and the judicial process.

3 units, Aut (Rhinelander) MWF 10

180. Philosophy of Religion—Critical enquiry into the nature and validity of religious experience, its unity and variety, its relation to other human interests.

4 units, Spr (Smith) MTWF 9

181. Philosophy of Language—Nature and uses of language. Concepts of meaning, reference, truth, name, syntax, metaphor, ambiguity, vagueness, definition. Comparison and study of scientific, poetic, philosophic, legal, other uses of language. Applications in the fields of psychology, linguistics, anthropology, literary criticism. Prerequisite: 3 or consent of instructor.

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

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
192. Philosophy in Literature—(For Juniors and Seniors.) A study of the philosophic content of literary works by Dostoevsky, Kafka, Gide, Hesse, Sartre, Camus, and others.

3 units, Win (——) MWF 3:15

193. Formal Aspects of Social Decision Making — The following topics to be discussed: relation between individual values and social policy; critique of logical basis of democracy; relations between political theory and recent work in welfare economics; political and social values in light of general theory of value. Prerequisite: 3 or consent of the instructor.

3 units, Spr (Schwartz) MWF 1:15

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: Historical Explanation.
3 units, Win (Nivison) Th 4:15-6:05

Topic: To be announced.
3 units, Aut (Waks) T 7-9 p.m.

Topic: Philosophy of Religion.
3 units, Spr (Tooley) T 4:15-6:05

Courses Intended Primarily for Graduate Students

201. Formal 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. Recommended: 162 but not required.

3 units, Win (Suppes) MW 1:15


3 units, Win (Moravcsik) W 3:15-5:05

203. Seminar in Ethical Theory—Analysis of selected writings in contemporary ethical theory. Emphasis will be placed on the possibility of constructing a naturalistic theory that will provide guidance in decision-making (first person) and standards enabling justification or lack of justification for the decisions and actions of others (third person). Prerequisite: 2, 170, or consent of the instructor.

3 units, Spr (Mothershead) T 2:15-4:05, alternate years, given 1970-71

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) W 8 p.m., given 1970-71

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 1970-71

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 1970-71

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, Spr (Waks) T 7-10 p.m.

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

230. Seminar in the Philosophy of Aristotle
—Reading (in English translation) and class discussion of a number of basic philosophical writings of Aristotle. Prerequisite: 100 or equivalent.

3 units, Win (Hintikka) M 4:15–6:05

232. Seminar in the Philosophy of Kant
—Detailed analysis of the Critique of pure reason.

3 units, Spr (Howell) M 4:15–6:05

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 (Hintikka, Suppes) W 4:15–6:05

1 to 6 units, Spr (Hintikka, 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 3:15–5:05

242C. 3 units, Spr (——) M 3:15–4:05

244. Seminar in Metaphysics.

3 units, Spr (Moravcsik) W 3:15–5:05

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

291A,B,C. Set Theory — (Enroll in Mathematics 291A,B,C.)

292A,B,C. Metamathematics — (Enroll in Mathematics 292A,B,C.)

293A,B,C. Recursion Theory — (Enroll in Mathematics 293A,B,C.)


3 units, alternate years, given 1970–71

295. Advanced Automata Theory — (Enroll in Electrical Engineering 484.)

299. Advanced Seminar in Recent Philosophical Literature.

Topic: Reference and Intensionality.

3 units, Aut (Schwartz) Th 4:15–6:05

Topic: Some Philosophical Problems in Logic.

3 units, Sum (Follesdal) by arrangement


391A. Aut (Friedman) Th 4:15–6:05, units by arrangement

391B. Win (——) T 4:15–6:05, units by arrangement

391C. Spr (Kreisel) T 4:15–6:05, units by arrangement

PHYSICAL SCIENCES

(GENERAL PROGRAM)

Professor: Claudio Alvarez-Tostado
Associate Professor: Julien A. Ripley, Jr.
Lecturer: William A. Perkins

Physical Sciences Subcommittee: Richard H. Eastman (Chairman), Robert R. 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.

A reading knowledge of a modern foreign language, preferably French or German. This will normally mean the completion of a course numbered 23 in one of the modern languages.

Programs of study must be approved by an adviser appointed by the chairman of the Physical Sciences Subcommittee. The average grade for the science and mathematics courses specified above must be at least C.

MASTER OF SCIENCE

Candidates for the degree of Master of Science in Physical Sciences (General Program) are expected to complete, in addition to the general residence and other requirements of the University for that degree, a program of study approved by an adviser assigned by the chairman of the Physical Sciences Subcommittee. A reading knowledge of French or German is required. The program of study will include (1) an acceptable thesis; (2) the satisfactory completion of at least 30 units of advanced work in physics, chemistry, mathematics, geology, or related fields; and (3) such other advanced work in the University, making a total of at least 45 units, as may be approved by the adviser.

COURSES

#1, 2, 3. Physical Science—Survey of physical sciences as an expanding field of knowledge. Lectures, demonstrations, 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 (Alvarez-Tostado) TTh 8 or 9; lab. by arrangement

3. 3 units, Spr (Alvarez-Tostado) TTh 8 or 9; lab. by arrangement

#5, 6, 7. Physical Science—Survey of physical sciences as an expanding field of knowledge. Similar to 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

140. Electron Tubes in Research—Elementary study of electron tubes, their characteristics and application to control, measurement. Emphasis on applications, particular attention to photo tube, d.c. amplifier circuits. Prerequisite: Physics 23 or equivalent.

3 units, Aut (Alvarez-Tostado) alternate years, given 1970-71

#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 (chem-
PHYSICS

Emeriti: Paul H. Kirkpatrick, David L. Webster (Professors)
Chairman: Arthur L. Schawlow
Associate Professors: Alexander L. Fetter, David M. Ritson (on leave 1969–70), H. Alan Schwettman, Stanley G. Wojcicki, Mason R. Yearian

OFFERINGS AND FACILITIES

The Russell H. Varian Laboratory of Physics, the adjacent Physics Lecture Hall, and the nearby W. W. Hansen Laboratories of Physics (High Energy Physics Laboratory, Microwave Laboratory, and Biophysics Laboratory) form a closely related complex housing a range of physics activities from general courses through advanced research, and including several accelerators up to 1.2 Bev in size. Separated from this group is the Stanford Linear Accelerator Center (SLAC), a very high energy physics laboratory which 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, 1970, for the following autumn. Graduate students may normally enter the Department only at the beginning of autumn quarter.

PROGRAMS OF STUDY

The study of physics is undertaken by three principal classes of undergraduates: those including physics as part of a general education, those preparing for careers in professional fields that require a knowledge of physics, such as medicine or engineering, and those preparing for teaching or research careers in physics itself. In this Department the courses numbered below 200 are planned to serve all three of these groups. The courses numbered above 200 meet the needs mainly of the third group, but also of some students majoring in other branches of science and in engineering.

BACHELOR OF SCIENCE

Department requirements for the degree of Bachelor of Science are as follows: Physics 51, 53, 54, 61, 100, 101, 110, 111, 120,
121, 122, 130, 131, 132, 170, 171, 200, 201; 9 units of a sequence, to be decided with the concurrence of the Departmental adviser, in a science other than physics or mathematics (in the event that the chemistry background of the student is judged inadequate, the Department will require that this sequence be Chemistry 4 and 5); Language, completion of French 3, German 3, or Russian 3 (or placement in more advanced courses). Another language may be substituted by petition at the discretion of the Department.

The mean grade for all courses taken in physics and chemistry must be C or higher. Students may reach the level of the 200-series courses via a normal sequence or an accelerated sequence. Exceptionally able students with an especially good preparation in physics will find the accelerated sequence advantageous. It requires fewer courses and provides more opportunity for electives in either physics or other fields. Admission to the accelerated sequence requires A grades in 51 and 53 or permission of the Physics Department Undergraduate Study Committee.

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 under the two sequences are shown below. The sequence of courses during the first two years is relatively inflexible, but considerable freedom exists during the upper-class years. The sample programs emphasize mathematics and physics electives only as one possibility. The arrangement of language, chemistry, and general studies courses is also rather arbitrary. Students are urged to work out, in consultation with their advisers, a program which will best fulfill their individual aims. The office of the Physics Department has more detailed information on how to obtain a Bachelor's degree in Physics. This should be carefully studied by prospective majors, especially if they intend to make use of Stanford's programs abroad. Under some circumstances the Department will permit, by petition, flexibility in the requirements so that the student may fit a period abroad into his program.

### NORMAL SEQUENCE

#### First Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 51-53. Mechanics, Electricity</td>
<td></td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Physics 54. Electricity Laboratory</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math. 41, 42, 43. Analytic Geometry and Calculus</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>History 1, 2, 3. History of Western Civilization</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>English 1, 2, 3. Freshman English</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Social Science</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total units</td>
<td>17</td>
<td>16</td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

#### Second Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 55, 57, 61. Light and Heat, Atomic Physics, Optics and Wave Motion</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Physics 56, 58. Light and Heat, and Atomic Physics Laboratory</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics 110, 111. Intermediate Mechanics</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math. 44, 45, 46. Advanced Calculus</td>
<td>3</td>
<td>3</td>
<td>(3)*</td>
<td></td>
</tr>
<tr>
<td>Math. 130, 131, 132. Ordinary Differential Equations, Partial Differential Equations</td>
<td>3</td>
<td>3</td>
<td>(3)*</td>
<td></td>
</tr>
<tr>
<td>Chem. 4, 5. General Chemistry</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total units</td>
<td>15</td>
<td>17</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

#### Third Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 105, 100, 101. Introductory Electronics, Intermediate Physics Laboratory</td>
<td>(3)*</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Physics 120, 121, 122. Intermediate Electricity and Magnetism</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Physics 130, 131, 132. Atomic and Nuclear Structure</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math. 113, 114 or 120. Linear Algebra and Matrix Theory, or Modern Algebra</td>
<td>(3)</td>
<td>3</td>
<td>(3)*</td>
<td></td>
</tr>
<tr>
<td>German 1, 2, 3. First-Year German</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Social Science</td>
<td>—</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total units</td>
<td>16</td>
<td>15</td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

#### Fourth Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 170, 171, 172. Thermodynamics, Kinetic Theory and Introduction to Statistical Mechanics, Physics of Solids</td>
<td>3</td>
<td>3</td>
<td>(3)*</td>
<td></td>
</tr>
<tr>
<td>Physics 200, 201, 202. Advanced Physics Laboratory</td>
<td>2</td>
<td>2</td>
<td>(3)*</td>
<td></td>
</tr>
<tr>
<td>Physics 210, 211, 212. Introductory Theoretical Physics</td>
<td>(3)</td>
<td>3</td>
<td>(3)*</td>
<td></td>
</tr>
<tr>
<td>Math. 106. Complex Variable</td>
<td>(3)*</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Humanities</td>
<td>4</td>
<td>4</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Total units</td>
<td>15</td>
<td>12</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

Grand total of units 177

* Not required for degree in physics.

† Additional elective units must be added to bring this total to 180 as required by the University.
## ACCELERATED SEQUENCE

### First Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 51, 53</td>
<td>Mechanics, Electricity</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Physics 54</td>
<td>Electricity Laboratory</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Math. 43, 44</td>
<td>Analytic Geometry, Calculus, and Advanced Calculus</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>History 1, 2, 3</td>
<td>History of Western Civilization</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>English 1, 2, 3</td>
<td>Freshman English</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Social Science</td>
<td></td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Total units</strong></td>
<td></td>
<td>17</td>
<td>14</td>
<td>12</td>
</tr>
</tbody>
</table>

### Second Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 61</td>
<td>Optics and Wave Motion</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Physics 110, 111</td>
<td>Intermediate Mechanics</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Mathematics 100, 101, 105</td>
<td>Introductory Electronics, Intermediate Physics Laboratory</td>
<td>(3)*</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Physics 120, 121, 122</td>
<td>Intermediate Electricity and Magnetism</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Math. 45, 46</td>
<td>Advanced Calculus</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Math. 130, 131, 132</td>
<td>Ordinary Differential Equations, Partial Differential Equations</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total units</strong></td>
<td></td>
<td>16</td>
<td>18</td>
<td>14</td>
</tr>
</tbody>
</table>

### Third Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 130, 131, 132</td>
<td>Atomic and Nuclear Structure</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Physics 170, 171, 172</td>
<td>Thermodynamics, Kinetic Theory and Introduction to Statistical Mechanics, Physics of Solids</td>
<td>3</td>
<td>3</td>
<td>(3)*</td>
</tr>
<tr>
<td>Physics 210, 211, 212</td>
<td>Introductory Theoretical Physics</td>
<td>(3)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Math. 113, 114, or 120</td>
<td>Linear Algebra and Matrix Theory or Modern Algebra</td>
<td>(3)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>German 1, 2, 3</td>
<td>First-Year German</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Social Science</td>
<td></td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Total units</strong></td>
<td></td>
<td>16</td>
<td>16</td>
<td>18</td>
</tr>
</tbody>
</table>

### Fourth Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>A</th>
<th>W</th>
<th>Sp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 200, 201, 202</td>
<td>Advanced Physics Laboratory</td>
<td>2</td>
<td>2</td>
<td>(3)*</td>
</tr>
<tr>
<td>Physics 220, 221, 222</td>
<td>Classical Electrodynamics</td>
<td>(3)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Physics 230, 231, 232</td>
<td>Quantum Mechanics</td>
<td>(3)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Math. 106</td>
<td>Complex Variable</td>
<td>(3)*</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Humanities</td>
<td></td>
<td></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total units</strong></td>
<td></td>
<td>15</td>
<td>12</td>
<td>9</td>
</tr>
</tbody>
</table>

*Not required for degree in physics.

Additional elective units must be added to bring total to 180 as required by the University.

## MASTER OF SCIENCE

The Physics Department does not offer a separate program for the Master of Science degree, but this degree may be awarded for a portion of the Doctor's degree work. University requirements for the Master's degree are discussed in the "Degrees" section of this bulletin. Among the Departmental requirements are a B average in courses 130, 131, 132, 170, 171, 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 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 and taking 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 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, 253, 254, 256, 273.

All prospective Ph.D. candidates in physics, regardless of their source of financial support, will be expected to gain teaching experience.
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 or research. Applications for fellowships, scholarships, and assistantships are made to the Financial Aids Office; they must be completed by January 15, 1970.

**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.

**#21. Mechanics and Heat** — Equilibrium, uniform and accelerated motion, force, work, momentum and energy; heat, temperature, properties of matter. Prerequisite: working knowledge of elementary algebra, geometry.

4 units, Aut (———) lec. and lab.

**#22. Electricity and Optics** — Electric charges and currents, magnetism, induced
currents; wave motion, interference, diffraction, geometrical optics. Prerequisite: 21.

4 units, Win (J. Schwartz) 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 continuation in Mathematics 42, or consent of instructor.

4 units, Win (Schwettman) lec.; (——) discussions

#53. Electricity — Electric charges and currents, magnetism, induced currents, electric oscillations; atomic origin of electromagnetic phenomena. Prerequisites: 51 and Mathematics 42 or 21, or 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 (Little) 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 (Hofstadter) TTh 11:00-12:15

3 units, Sum (——) MTWF 8

#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 (Schawlow) TTh 11:00-12:15

100, 101. Intermediate Physics Laboratory

—Fundamental experiments in mechanics, heat, electricity and magnetism, optics, and atomic physics. One set of apparatus for each experiment is available so that one or two students will perform a given experiment during a particular laboratory session. Students will work one or two weeks per experiment, completing ten to fifteen during two quarters. Prerequisites: 111 and concurrent or prior registration in 121 and 122.

100. 2 units, Win (Wojcicki, Yearian) by arrangement

101. 2 units, Spr (Wojcicki, Yearian) by arrangement

105. Introductory Electronics — Practical electronics for the research physicist with the emphasis on circuits, covering both vacuum tubes and transistors 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. Recom-
SCHOOL OF HUMANITIES AND SCIENCES

mended: concurrent or prior registration in 120.

3 units, Aut (Pixley) 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 (Hamilton) MWF 11

111. 3 units, Spr (Hamilton) 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. Prerequisites: 55 or admission to Accelerated Sequence and Mathematics 130.

3 units, Aut (Hamilton) TTh 11:00–12:15

171. Kinetic Theory and Introduction to Statistical Mechanics — Elementary kinetic theory, distribution function (including rate of change), Liouville theorem, Maxwell-Boltzmann distribution, Boltzmann equations, quantum statics (Einstein-Bose, Fermi-Dirac distributions). Prerequisites: 130 and 170, or equivalent.

3 units, Win (Bloch) TTh 11:00–12:15

172. Physics of Solids—Introduction to the principal types of solids, with emphasis on their electrical and magnetic properties. Elementary treatment of electrons in metals, energy bands. Applications to semiconductors, rectification, superconductors, para- and ferromagnetism, magnetic resonance. Prerequisites: 171, or 57 and Electrical Engineering 328A.

3 units, Spr (Schwettman) 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, τ-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 (——)
     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


     3 units, Aut (Finkelstein) MWF 10


     3 units, Win (Finkelstein) 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. Prerequisites: 122 or the equivalent, Mathematics 106 and 132, or concurrent registration in Physics 210 and 211.

     220. 3 units, Aut (Henry) MWF 9
     221. 3 units, Win (Henry) MWF 9
     222. 3 units, Spr (Henry) MWF 9


     230. 3 units, Aut (White) TTh 8-10
     231. 3 units, Win (White) TTh 8-10
     232. 3 units, Spr (White) TTh 8-10


     240. 3 units, Aut (Meyerhof) MWF 11
     241. 3 units, Win (Meyerhof) 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 (Finkelstein) 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 (Ritson, M. Schwartz, Wojcicki, Fairbank, Little, Schwettman and others)
MWF 1:15

262. 3 units, Spr (Schawlow, Bloch, Fetter, Schiff, Walecka and others)
MWF 1:15

270. Statistical Mechanics—Microcanonical ensemble, Maxwell-Boltzmann distribution, perfect gas; applications to various systems; canonical ensemble, imperfect gas; virial theorem; grand canonical ensemble; quantum statistics, density matrix approach to statistical mechanics; non-equilibrium statistical mechanics. Prerequisite: 171. Concurrent or prior enrollment in 232 and Mathematics 106 is required.

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

290. Literature of Physics—Intensive study of literature of any special topic. Chiefly preparation, presentation of reports upon topics studied. Prerequisites: 25 units of college physics and consent of instructor.

Any quarter (Staff) by arrangement


330. 3 units, Aut (——) TTh 9-11
331. 3 units, Win (——) TTh 9-11
332. 3 units, Spr (——) TTh 9-11


3 units, Win (Schawlow) TTh 11:00-12:15 alternate years, given 1969-70

336. Advanced Topics in Theoretical Physics—Discussion of selected topics of current interest in theoretical physics. Prerequisite: 330.

3 units, Spr (Walecka) by arrangement


3 units, Aut (Walecka) MWF 9

341, 342. Nuclear and Elementary Particle Theory—Nuclear matter, theory of angular momentum, group theory and nuclear spectroscopy. Weak interactions, nuclear reactions, elementary particle theory, including symmetries, but not including field theory. Prerequisites: 222, 241, 251, 340, concurrent or prior registration in 331, 332 is recommended.

341. 3 units, Win (Walecka) alternate years, given 1969-70
342. 3 units, Spr (Walecka) alternate years, given 1969-70


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)

Professors: Gabriel A. Almond, Charles Drekmeyer, Heinz Eulau, Alexander L. George, Robert A. Horn (on leave spring quarter), Nobutaka Ike, John W. Lewis, Hubert R. Marshall, Robert C. North, Kurt Steiner (on leave autumn quarter), Jan F. Triska (on leave winter, spring quarters), Robert A. Walker, James T. Watkins IV

Associate Professors: Richard A. Brody, Richard R. Fagen, Yosal Rogat (on leave 1969-70, Raymond E. Wolfinger (on leave autumn quarter)

Assistant Professors: David B. Abernethy, Edward S. Greenberg, Robert A. Packenham, Hans N. Weiler (on leave autumn quarter). Acting: Joseph E. Paff, Paul M. Sniderman

Lecturers: Milorad M. Drachkovitch, Robert M. Rosenzweig

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 February 10. 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 ordinarily accepted.

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.

**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 one of the following:

1. a reading knowledge of two Western languages (e.g., French and German); or
2. a reading knowledge of one non-Western language (e.g., Arabic, Chinese, or Japanese) or of Russian; or
3. a reading knowledge of and conversational ability in one language (e.g., French, German, Spanish, Portuguese, Italian); or
4. a reading knowledge of one language and knowledge of statistics and/or related skills.

d. The skill requirement may be fulfilled as follows:

1. by successfully completing a program of at least 15 quarter units of selected courses; or
2. by successfully passing a written examination offered by the Department.

The language or skill alternatives shall be those most likely to be useful in connection with the student's program. (The native language of a foreign student may be accepted in fulfillment of the requirement.) The Department decides on the language or skill program proposed by the candidate.

e. If the candidate has not completed at least one year of previous undergraduate instruction, or 5 quarter units of previous graduate instruction, in political theory, he will take 5 quarter units of graduate instruction in political theory.
f. Not later than the end of the third week of his third quarter in residence, the candidate will submit to the Department a statement of: (a) the three fields of political science 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.

g. After the candidate has completed his preparation in all his fields, and after he has fulfilled the language and/or skill requirements, he takes the written Departmental examinations. These examinations are scheduled in the autumn and spring quarters. Upon successful completion of the written examinations a date for the University oral examination is set by his dissertation committee in consultation with the student.

h. Doctoral candidates who apply for the A.M. degree will be awarded that degree upon completion of the requirements outlined in the description of the Master of Arts program.

i. 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 or 15A.

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. Prerequisites: History 1 and 2.

5 units, Aut (Marshall) MTWThF 10
Win (Marshall) MTWThF 11
Spr ( — — ) MTWThF 1:15

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, Win (Wolfinger) MTWThF 11
Spr (Horn) MTWThF 11

15A. Introduction to Political Science—Basic concepts and problems in political science. Social and psychological factors affecting political beliefs and behavior.

5 units, Aut ( — — , Staff) lec. MW 10
and section
15B. Introduction to Political Science —
Comparative analysis of the formation and
development of political systems.
5 units, Win (Abernethy, Staff)
lec. MW 10 and section

15C. Introduction to Political Science —
The international system.
5 units, Spr (Brody) lec. MW 11 and
section

20. Introduction to Comparative Govern-
ment and Politics —
Governmental institutions and political processes in selected for-
eign 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 neces-
sary 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 adminis-
trative agencies. Emphasis on the analysis
of organizational structure and the interaction
between the organization and its environ-
ment. Prerequisite: 10 or consent of instruc-
tor.
5 units, Aut (——) MTWThF 9

104. Local Government Laboratory — Field
course in municipal affairs offered in coop-
eration with Coro Foundation (San Fran-
cisco).
2 units, Spr (——) T 2:00—4:30

107. Seminar in Government and Natural
Resources —
Political, economic, administra-
tive factors affecting public policy for river
basin development, soil conservation, man-
agement of public domain, related prob-
lems. Pressure groups, legislative bodies,
administrative agencies in the decision-mak-
ning process. Recommended: Economics 1.
5 units, Win (Marshall) M 2:15—4:05

108. Seminar in Administrative Responsi-
bility —
Conflicting loyalties, accountabili-
ties of administrative officials in decision-
making processes; responsibility to public at
large, pressure groups, chief executive, leg-
islature, profession. Case study method
used. Prerequisite: 10.
5 units, Aut (Marshall) M 2:15—4:05

109. Directed Reading in Administration—
Advanced individual study in public admin-
istration. Prerequisite: 100.
Any quarter (Staff) by arrangement

110. Administrative Behavior —
Environment of administrative action; political, so-
cial, psychological factors in management;
problem of incentives.
5 units, Win (Walker) MTWThF 11

For graduate courses in Administration, see
Part III.

COMPARATIVE POLITICS

111A. European Politics: The British Politi-
cal 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 function-
ing of interest groups, political parties, me-
dia of communication, parliament, cabinet,
and bureaucracy. Desirable prerequisite:
15A, or 15B, or 20.
4 to 5 units, Aut (Almond) MWTh 11

111B. European Politics: Government and
Politics in Germany —
Governmental institutions and the political process in the Fed-
eral Republic of Germany as they have
emerged after World War II; determinants
of domestic and foreign policies; processes of
political socialization. Desirable prerequi-
site: 15A, or 15B, or 20, and reading knowl-
edge of German.
4 to 5 units, Spr (Weiler) MTWThF 10

112. Government and Politics in Asia—
Survey of governmental institutions and the
political process in Asian countries. Desir-
able prerequisite: 20, or equivalent, or pre-
vious study of the area.
4 to 5 units, Aut (Ike) MTWThF 1:15

113. Latin American Politics —
Historical, socioeconomic, and cultural context of con-
temporary Latin American politics; compar-
ison of several contemporary Latin Ameri-
can political systems; and analysis of selected problems in Latin American politics.

4 to 5 units, Win (Packenham)
MTWThF 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: 15A, or 15B, or 20, or 112.

4 to 5 units, Spr (Steiner) MTWThF 11

115. Government and Politics in China—Governmental institutions and the political process in the Chinese People’s Republic; analysis of elites, policy formulation, techniques for eliciting mass response, and constraints upon the exercise of central power. Desirable prerequisite: 20 or equivalent or 112; History 190, 191, 192, or 193; or Anthropology 117.

4 to 5 units, Win (Lewis) MTWThF 11

116. Comparative Politics of Communist Parties—Examination of selected communist parties (Soviet, Yugoslav, Czechoslovak, Italian, etc.) in terms of their development, recruitment, membership, style, function, and structure patterns. Emphasis is on the distinctions among these parties, their causes and consequences.

4 to 5 units, Win (Triska) given 1970-71

117. Government and Politics in 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 problems as tribalism and regionalism, administrative weakness, and race relations in plural societies.

4 to 5 units, Aut (Abernethy) MTWThF 10

120. Introductory Seminar in Comparative Politics. Prerequisite: 15A, or 15B, or 20.

5 units, Spr (Steiner) T 4:15-6:05

120A. Seminar in Comparative Politics: Japan—(Graduate students register for 220A.)

5 units, Win (——) Th 4:15-6:05

121. Seminar in Comparative Politics: Party Systems.

5 units, Win (Ike) T 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

123. Seminar in Comparative Politics: Brazil—Consent of instructor required. (Graduate students register for 223.)

5 units, Spr (Packenham) T 7:30-9:30 p.m.

123B. Seminar in Comparative Politics: Cuba—By consent of instructor. Reading knowledge of Spanish strongly recommended.

5 units, Aut (Fagen) W 2:15-4:05

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, Win (Steiner) T 4:15-6:05

125. Seminar in Comparative Politics: Communist China—Focus on domestic problems. (Graduate students register for 225.) Consent of instructor required.

5 units, Aut (Lewis) Th 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 (Weikr) W 2:15-4:05

128. Seminar on the Politics of Development Planning—Examines the political and administrative setting in which planning for economic development takes place; the political implications of economic dependence on the outside world; and the consequences of successful and unsuccessful development projects. Attention will be focused on selected countries of Asia, Africa, and Latin America.

5 units, Spr (Abernethy) M 4:15-6:05

129. Directed Reading in Comparative Politics—Advanced individual study in
comparative politics. Prerequisites: 15A and 15B, or 10 and 20.

Any quarter (Staff) by arrangement

For graduate courses in Comparative Politics, see Part III.

INTERNATIONAL LAW AND RELATIONS

130. Introduction to International Law — A broad overview of theories, development, present state and propensities of international law as a process in various critical arenas of international interaction.

4 to 5 units, Spr (Triska) given 1970–71

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


4 to 5 units, Spr (Weiler) given 1970–71

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

136B. Analysis of the Socialist and Communist Internationals (1864–1956)—Emphasis on the ideological bases, operational devices and historical meaning of the First, Second, and Third Internationals, including the Cominform period.

4 to 5 units, Aut (Drachkovitch) MWF 9

137. The United Nations and Its Antecedents—Development of cooperative arrangements within national state system; nineteenth century public unions, League of Nations, United Nations; specialized agencies: their organization, procedure and work.

4 to 5 units, Spr (Watkins) MTWThF 10

138. Problems of Arms Control and Disarmament—General international politics; international law and relations, stressing problems of arms control, proliferation of nuclear weaponry, inclusion of China in disarmament agreements, on-site inspection and verification of disarmament.

4 to 5 units, Spr (Lewis) T 2:15–4:05

139. 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.

4 to 5 units, Aut (Triska) T 2:15–4:05

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) T 4:15–6:05


5 units, Win (Brody) given 1971–72

142. Seminar in Public Opinion and Foreign Policy.

5 units, Win (Brody) Th 2:15–4:05


5 units, Win (Triska) given 1970–71

146B. Seminar on De-Stalinization—Aspects and problems of the post-1953 political and economic decompression in the Soviet Union and in East-Central Europe. Graduate students register for 246B.

5 units, Win (Drachkovitch) Th 4:15–6:05

147. Seminar on Soviet-Chinese Relations.

5 units, Win (North) T 4:15–6:05

148. Introductory Seminar in International Organization—Prerequisite: 137 or equivalent.

5 units, Win (Watkins) given 1970–71
149. Directed Reading in International Law and Relations—Advanced individual study in international law and relations.

Any quarter (Staff) by arrangement

For graduate courses in International Law and Relations, see Part III.

POLITICAL THEORY

150. Introduction to the History of Political Thought—The first half of the course will be primarily devoted to Greek philosophy. Medieval and modern political and legal theorists will be discussed in terms of four conceptions of the nature and conditions of political freedom. Prerequisite: third-year standing or consent of the instructor.

4 to 5 units, Aut (Drekmeier) MTWThF 11

151. Roman, Medieval, and Early Modern Political Thought—The search for a principle of authority consistent with spiritual ideals, with new forms of social integration, and with the private goals of the individual. Prerequisite: third-year standing or consent of the instructor.

5 units, Win (Drekmeier) MTWThF 11

152. Modern Political Thought — Philosophy and ideology of the Enlightenment, the nineteenth and early twentieth centuries, with particular attention to the critique of liberalism and the development of democratic and socialist theory.

5 units, Win (Drekmeier) given 1970–71

154. Political Theory of China and Japan — Leading thinkers and schools of thought from Confucius to Mao Tse-tung. Prerequisite: third-year standing or consent of the instructor.

4 to 5 units, Spr (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.

4 to 5 units, Aut (North) MTWThF 2:15

158. Theoretical Foundations of Political Sociology—The major contributions of social and political theorists to our understanding of social and psychological phenomena and their impact on political behavior, roles, institutions, and values. Critics and analysts such as Marx, Weber, Freud, Michels and Parsons will be discussed.

5 units, Spr (Drekmeier) MTWThF 11

159. Seminar in Foundations of Social Science.

5 units, Spr (Paff) W 7:30–9:30

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) given 1970–71

160B. 5 units, Spr (Rogat) given 1970–71

162. Origins of Political Speculation.

4 to 5 units, Aut (Paff) MWF 10

169. Directed Reading in Political Theory—Advanced individual study in political theory. Prerequisite: 150.

Any quarter (Staff) by arrangement

For graduate courses in Political Theory, see Part III.

PUBLIC LAW

170. The Supreme Court and the Constitution—Theory and practice of constitutional government in the United States. Formation of the Constitution; federal court system; separation of powers; judicial review; Congressional and Presidential authority; exclusive national and concurrent state powers; emphasis on nature of legal reasoning and judicial process. Prerequisite: third-year standing. (Graduate students register for 270.)

5 units, Aut (Horn) MTWThF 2:15

172. The Constitution and Economic Justice—Changing concepts of private property rights and governmental powers over the economy in American constitutional law; Supreme Court interpretation of the contract and due process clauses versus state police powers; expansion of congressional currency, commerce, taxing and spending, and war powers used to regulate property and the economy. Prerequisite: third-year standing. Recommended: 170. (Graduate students register for 273.)

5 units, Spr (Horn) MTWThF 2:15

173. Civil Liberties in the United States—Civil liberties in contemporary American culture; theory, history underlying them.
Free speech, press in era of mass communications; freedom of association for religious, political, economic groups; rights of ethnic minorities; fair trial, rights of accused persons. Prerequisite: third-year standing. (Graduate students register for 273.)

5 units, Win (Horn) MTWThF 2:15

179. Directed Reading in Public Law —
Advanced individual study in public law.

Any quarter by arrangement with
Public Law faculty

For graduate courses in Public Law, see Part III.

AMERICAN POLITICS

181. Attitude Formation and Voting Behavior—The formation of opinions, perceptions of political events, political participation, voting behavior; the significance for democratic government of findings in these areas. Prerequisites: third-year standing and 10 or equivalent.

5 units, Win (Sniderman) MTWThF 11

184. Legislative Behavior — Congressional elections, constituent relations, policy making and leadership, relations between Congress and administrative and executive agencies; the committee system, seniority and procedure; Congress as an element in the party system. Prerequisites: third-year standing and 10 or equivalent.

5 units, Win (Wolfinger) given 1970-71

185. Political Parties — Conventions, nominations, primary elections and voting; types of party organizations; money in politics; party reform and responsible parties. Prerequisites: third-year standing and 10 or equivalent.

5 units, Win (Greenberg) 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, Spr (Greenberg) MWF12

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

188. Seminar in American Politics: Ideologies of Foreign Policy—Review of the literature on the character and correlates of the major foreign policy orientations, including isolationism, internationalism, neutralism, jingoism; and their implications for the foreign policy process.

5 units, Spr (Sniderman) W 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. Introductory Seminar in Organizational Theory and Research.

5 units, Win (—) Th 4:15-6:05

207. Seminar in Government and Natural Resources—See 107.


209. Directed Reading in Public Administration.

Any quarter (Staff) by arrangement

210. Administrative Behavior—See 110.

211. Seminar in the Theories of Comparative Politics—Introduction to various systematic approaches to the study of comparative politics.

5 units, Spr (Fagen) 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 (Fagen) W 2:15-4:05
218. Seminar in Political Anthropology — 
(Same as Anthropology 245.) An examination 
of political processes in traditional and 
modernizing societies, both simple and com-
plex, and in their various subsystems. Analysis 
will proceed in connection with a re-
thinking of relevant theory from political 
science, anthropology, sociology, and relat-
ed disciplines. 
5 units, given 1970–71

219. Seminar in Political Development 
Theory: Classical, Enlightenment and Marx-
ist Theories of Political Development — Con-
temporary approaches to development pro-
ces in political sociology and political sci-
ence. Toward an empirical theory of politi-
cal development. 
5 units, Win (Almond) M 2:15–4:05

220A. Seminar in Comparative Politics: Ja-
pan — See 120A.

222. Seminar in Comparative Politics: Bra-
zil — See 123.

224. Seminar in Comparative Politics: Lo-
cal Government — See 124.

225 Seminar in Comparative Politics: Com-
munist China — See 125.

226. Seminar in Comparative Politics: East-
ern Europe — Analysis of the major contem-
porary determinants of Soviet and East 
European domestic political decision. 
5 units, Aut (Triska) Th 2:15–4:05

227. Seminar in Comparative Politics: Afri-
ca. 
5 units, Win (Abernethy) M 2:15–4:05

229. Seminar in the Politics of Develop-
ment Planning — See 128.

232. Directed Reading in Comparative Pol-
itics. 
Any quarter (Staff) by arrangement

234. Seminar in International Politics — A 
survey of central concepts. 
5 units, Aut (Brody) Th 2:15–4:05

239. Seminar in Soviet Foreign Policy — See 
139.

241. International Relations — See 141.

242. Public Opinion and Foreign Policy — 
See 142.

246 Seminar in International Law: Inter-
national Treaties — See 146.

246B. Seminar on De-Stalinization — See 
146B.

249. Directed Reading in International 
Law and Relations. 
Any quarter (Staff) by arrangement

251. Seminar in Roman, Medieval, and 
Early Modern Political Thought — See 151.

254. Essentials of Political Theory — Power 
and authority, justice, values and valuation, 
problems of methodology. 
5 units, Aut (Drekmeier) Th 4:15–6:05

258. Seminar in the Theoretical Foundations 
of Political Sociology — See 158.

259. Seminar in Foundations of Social Sci-
ence — See 159.


261. Ideology: Ideology and Contemporary 
Doctrine. 
5 units, Spr (Drekmeier) Th 4:15–6:05

262. Seminar in Early Modern Political 
Theory — Origins of modern conceptions of 
politics and political theory: the problem of 
thought and action in sixteenth century 
thought. 
5 units, Aut (Paff) M 4:15–6:05

263. Seminar in Political Theory: Private 
and Public. 
5 units, Win (Paff) T 7:30–9:30 p.m.

264. Equality and Human Right — A con-
sideration of human needs, political needs, 
the nature of obligation, and the movement 
from natural to human rights. 
5 units, Win (Drekmeier) Th 4:15–6:05

269. Directed Reading in Political Theory. 
Any quarter (Staff) by arrangement

270. The Supreme Court and the Constitu-
tion — See 170.

272. The Constitution and Economic Just-
ice — See 172.

273. Civil Liberties in the United States — 
See 173.

275. Seminar in Jurisprudence — Legal the-
ories, relationships between legal and politi-
cal philosophy. Logical analysis of legal or-
ders. Relation of ethics to law as seen by 
natural lawyers, idealists, utilitarians, posi-
tivists, pragmatists. Sociological jurispru-
dence and American legal realism. Prereq-
quisite: consent of instructor. Open to se-
niors. 
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) T 7:30–9:30 p.m.
281B. 5 units, Win (Eulau) T 7:30–9:30 p.m.

289. Directed Reading in Politics.  
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, Lewis, Skinner, Van Slyke) by arrangement

321A, B. Research Seminar on Social Science and Public Policy.

321A. Discussion of theoretical and empirical readings on relationships between social science and public policy.

5 units, Aut (Packenham) T 7:30–9:30 p.m.

321B. Student research on empirical cases of relationships between social science and public policy.

5 units, Win (Packenham) T 7:30–9:30 p.m.

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) M 2:15–4:05

325. Advanced Seminar in Reform and Revolution in Twentieth Century China and Japan.

5 units, Aut (Ike) Th 2:15–4:05

326. Advanced Seminar on Japanese Politics—Emphasis will be on empirical studies, leadership, voting and public opinion. Reading knowledge of Japanese required.

5 units, Spr (Ike) given 1970–71

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) F 2:15–4:05

336. Research Seminar in the World Communist System—Studies focusing on the volume, intensity and quality of international interaction among and comparison between the various units within the communist system.

5 units, Spr (Triska) given 1970–71

360. Advanced Seminar in Power and Authority.

5 units, Spr (Drekmeier) given 1970–71

380A, B. Research Seminar on Comparative Political Sociology of the Professions.

380A. 5 units, Win (Eulau) T 2:15–4:05
380B. 5 units, Spr (Eulau) T 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. Seminar in American Politics: Public Policy Formation—Analysis of various as
pects of policy-making in American national government.

384A. 5 units, Spr (Wolfinger)
W 2:15–4:05

385A,B. Seminar on Political Behavior: Political Socialization—Readings and discussion of various aspects of political socialization research including outcomes, processes, and agents; student research using data from a variety of sources.

385A. 5 units, Win (Greenberg) given 1970–71
385B. 5 units, Spr (Greenberg) given 1970–71


386A. 5 units, Aut (Greenberg) M 2:15–4:05
386B. 5 units, Win (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 conformity and deviation, ideological coherence, etc. The second quarter will be devoted to experimental research. 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

400A,B,C. Introduction to Political Analysis—Required of all Ph.D. candidates in Political Science. To be taken during first year of residence. Not open to A.M. candidates or students registered in other departments.

15 units, Aut, Win, Spr (Staff) M 2:15–4:05

See also Senior Colloquia.

PSYCHOLOGY

Emeriti: Paul R. Farnsworth, Ernest R. Hilgard, Maud Merrill James, Quinn McNemar, Lois Meek Stolz (Professors)

Chairman: Richard C. Atkinson


Associate Professors: J. Merrill Carlsmit, Edith M. Dowley (Director, The Bing Nursery School), Jonathan L. Freedman, Leo Ganz, Leonard M. Horowitz. Visiting: Gerald C. Davison

Assistant Professors: Charles R. Hamilton, George A. Kaplan

LABORATORIES

Aside from lecture and seminar rooms and offices, the Department has well-equipped laboratories comprising some 50 rooms which are adapted to research and laboratory course work. Special facilities are available, in addition to the general laboratory, for experimentation with animals.

THE BING NURSERY SCHOOL

The Department maintains a nursery school in the Escondido married students’ housing area. This provides a laboratory for child observation, for training in nursery school practice, and for research.

SUMMER SESSION

The courses announced for the Summer Session are those regularly scheduled in the Department curriculum. Additional courses may be announced in the Summer Session Bulletin, to be issued in February, 1970.

PROGRAMS OF STUDY

BACHELOR OF ARTS

For the Bachelor’s degree, 45 units of psychology are required, including courses 1, 60, and one laboratory course from among 103A, 103B, 103C, 103D, and 103E. Related courses in other fields may be counted as fulfilling up to 10 of the nonlaboratory 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, and 210, and one to be selected from 211, 212, and 213. The student is normally expected to spend one-half of his time in research and must present a thesis based on a portion of his research. He will normally take no more than 9 units of coursework 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. A written examination must be completed by the end of the second year of graduate work. Part or all of this examination may, at the student’s option, be taken at the end of the first year. The written examination shall include a special field examination which will normally be one of the following: developmental psychology, learning, perception, personality and psychopathology, physiological psychology, and social psychology. The student will also select three others of the above to be covered in a more general examination.

3. 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. Beyond the first-year graduate courses mentioned above, there are no required courses for any of the areas of concentration. The curriculum has been designed to offer as much help as possible for such learning, of course, and a glance at the list of courses and seminars available will suggest some of the help that may be gained in preparation for the doctoral examinations.

A second aspect of training is one that cannot be gained from reading or seminars. This is the firsthand knowledge of, and practical experience with, the methods of psychological investigation and study. These methods do not exist in the abstract; they are ways of behaving with the people or animals who are being studied. They are skills, and they require guided practice for their perfection. Again, however, as with formal courses, there are no specific requirements; students are provided with whatever opportunities they need to reach those levels of competence representative of doctoral standing. Continuing research programs, sponsored by members of the faculty, offer direct opportunities for experience in the fields represented by the faculty’s several research interests.

Each student will achieve competence in somewhat unique ways and at a somewhat unique rate. Each student and his adviser share in planning a program which will lead to the objectives discussed.

FELLOWSHIPS AND ASSISTANTSHIPS

The Dr. C. Annette Buckel Foundation, supplemented by additional support from the Board of Trustees of the University, has provided a teaching assistantship in child psychology and the University provides several fellowships and scholarships. The Thomas Welton Stanford Fellowship in Psychic Research is a postdoctoral fellowship for research in psychic phenomena, established by the Trustees, in 1913, from the "Psychic Fund" created by Thomas Welton Stanford. There are teaching assistantships in general and experimental psychology, statistics, social psychology, personality and psychopathology, developmental psychology, and the nursery school. A number of research assistantships are available in connection with faculty research. United States Public Health Service, National Science Foundation, and National Defense Education Act stipends, and Veterans Administration assistantships are available.

COURSES OPEN TO ALL STUDENTS

#1. General Psychology — Introduction, survey.

5 units, Aut (——) MWThF 11
and sections
Win (Zimbardo) MWThF 10
and sections
Spr (Horowitz) MWThF 10 and sections
4 to 5 units, Sum (——) MTWThF 9
and sections
103B. Experimental Psychology: Perception—Prerequisites: 1 and 60.
4 units, Spr (Kaplan) TTh 2:15-4:05 and three hours by arrangement

103C. Experimental Psychology: Learning—Prerequisites: 1 and 60.
4 units, Aut (Lawrence) MWF 3:15 and three hours by arrangement

103D. Experimental Psychology: Personality and Interpersonal Processes—Prerequisites: 1 and 60.
4 units, Aut (Lawrence) MWF 3:15 and three hours by arrangement

103E. Experimental Psychology: Social—Prerequisites: 1 and 60, and prior or concurrent enrollment in 121.
2 to 3 units, Spr (——) TTh 2:15-4:05

104. Special Laboratory Projects—Prerequisites: 103A, B, C, D, or E, and consent of instructor.
3 to 6 units, any quarter (Staff) by arrangement

111. Developmental Psychology—Prerequisite: 1 or equivalent.
4 units, Aut (Sears) MWF 9

113. Adolescent Development—Prerequisite: 1 or equivalent.
3 units, Spr (——) M 9-10 and W 9-11

114. Exceptional Children—The study of children with deviant patterns of development; includes gifted, retarded, sensory defects, emotional problems. Prerequisite: 111.
3 units, Sum (——) MTWTh 1:15

117. Observation of Children—Enrollment limited to 16. Prerequisites: 111 or equivalent, and consent of instructor.
3 to 5 units, Aut, Win (Dowley) Th 2:15-4:05 and by arrangement

118. Nursery School Practice—Supervised experience with the nursery school child. Prerequisites: 111, 117, and consent of instructor.
3 to 5 units, Win, Spr (Dowley) T 2:15-4:05 and by arrangement

121. Social Psychology—Prerequisite: 1 or equivalent.
4 units, Spr (Zimbardo) MWF 11

131. Abnormal Psychology—Psychopathology and behavior deviations. Concepts and theories regarding these conditions. Prerequisites: 1 and at least second-year standing.
4 units, Win (Davison) MWF 11
Spr (Mischel) MWF 1:15

132. Personality—Prerequisite: 1 or equivalent.
4 units, Win (Sanford) MWF 10 and by arrangement

141. History of Psychology—Prerequisites: three courses in psychology and junior standing.
3 units, Spr (Hastorf) TTh 11:00-12:20

145. Psychological Foundations of Education—(Same as Education 215.) Introductory course in application of psychological principles to educational practices. Prerequisite: 1 or equivalent.
4 units, Aut (Gage) MW 3:15-5:05
Sum (Staff) MTWTh 9 and by arrangement

147. Comparative Psychology—Prerequisite: 1 or equivalent.
3 units, Aut (Hamilton) MWF 10

148. Physiological Psychology—Prerequisites: 1 and a course in zoology or physiology.
3 units, Win (Pribram) MWF 9

151. Statistical Methodology—Prerequisite: 60 or equivalent.
3 units, Win (Horowitz) MWF 10

152. Analysis of Data—Prerequisite: 151 or permission of instructor.
3 units, Spr (Carlsmithe) MWF 10

155. Human Abilities—(Same as Education 255.) The nature, development, and measurement of intellectual abilities. Prerequisites: 1 and 60.
3 units, Spr (Cronbach, Snow) by arrangement

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.
3 units, Aut (Shepard) by arrangement
165. Mathematical Theories of Learning and Memory I — Reviews the stimulus-sampling approach to classical phenomena of learning, memory, and decision making. Probability models of psychological processes are introduced, mathematically analyzed, and their applications to learning data are illustrated. Psychological topics include: learning, reinforcement contingencies and parameters, 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.

3 units, Win (Bower) MWF 11

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. Prior familiarity with 165 is desirable but not essential. Prerequisites: 1 and 60 or 165.

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

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.

3 units, Spr (Shepard) MW 2:15-3:30

181. Honors Seminar (Junior) — Limited to students in the Psychology Honors Program.

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

182. Honors Seminar (Senior) — Limited to students in the Psychology Honors Program.

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

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, Aut (Kaplan) by arrangement

190A. Undergraduate Seminar in Early Experience—Primarily intended for majors in psychology. Prerequisite: consent of instructor.

3 units, Spr (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, Spr (Bandura) by arrangement, given 1970-71

193. Undergraduate Seminar in Social Psychology—Primarily intended for majors in psychology. Prerequisite: consent of instructor.

3 units, Spr (——) by arrangement

194. Undergraduate Seminar in Developmental Psychology—Primarily intended for majors in psychology. Prerequisite: consent of instructor.

3 units, Spr (——) 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 268A.

197. Undergraduate Seminar: The Structure of Memory—Primarily intended for majors in psychology. Prerequisite: consent of instructor.

3 units, Aut (Ganz) by arrangement

See also Senior Colloquia.

COURSES PRIMARILY FOR GRADUATE STUDENTS

Undergraduate students may be admitted only by special permission.

207. Contemporary Viewpoints in Psychology—A survey of major issues in contemporary psychology with their historical backgrounds. Required of and limited to first-year graduate students in psychology.

2 to 3 units, Aut (Zimbardo)

TTh 11:00-12:20
208. Advanced Physiological Psychology—Lectures in psychobiology with optional laboratory work. Prerequisites: graduate standing in psychology, or undergraduates having completed 148 or Biology 153.

2 to 4 units, Spr (Hamilton)
by arrangement

209. Advanced Perception—Prerequisite: graduate standing in psychology or consent of instructor.

2 to 3 units, Win (Ganz) by arrangement

210. Advanced Learning—Prerequisite: graduate standing in psychology or consent of instructor.

2 to 3 units, Aut (Atkinson, Bower)
by arrangement

211. Advanced Developmental Psychology—Prerequisite: graduate standing in psychology or consent of instructor.

2 to 3 units, Win (Sears) by arrangement

212. Advanced Social Psychology—Prerequisite: graduate standing in psychology or consent of instructor.

2 to 3 units, Spr (Freedman)
by arrangement

213. Advanced Personality—Prerequisite: graduate standing in psychology or consent of instructor.

2 to 3 units, Aut (Mischel) M 9-12

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

221A. Small Groups I: Group Theory—(Enroll in Business 475.) Prerequisite: consent of instructor.

4 units, Aut (Leavitt) by arrangement

221B. Small Groups II: Experimental Small Group Research—(Enroll in Business 476.) Prerequisite: consent of instructor.

4 units, Spr (Bavelas) by arrangement

222. Mathematical Theories of Perception—Prerequisite: consent of instructor.

3 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. Prerequisites: Computer Science 50A, 126, or 136.

3 units, Aut (——) TTh 1:15-2:30

243. Seminar on the Development of Early Social Communication—Prerequisite: consent of instructor.

2 to 3 units, Win (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—(Enroll in Education 311.)

3 units, Spr (Hess) by arrangement

246. Methods in Developmental Research—Prerequisite: consent of instructors.

4 units, Spr (Sears, Maccoby, Dowley)
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 (Kretchmer) 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. Prerequisites: 60, Statistics 7, or equivalent.

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

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: Education 250B and 252, or equivalent.

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

250. Seminar in Psychological Scaling—Selected topics in psychological scaling, psychophysical measurement, and data analysis. Prerequisite: consent of instructor. Recommended: 164.

2 to 3 units, Win (Shepard) by arrangement

254. Principles of Personality Change I—Prerequisite: graduate standing in psychology or consent of instructor.
3 units, Aut (Davison) by arrangement

255. Principles of Personality Change II—Prerequisites: graduate standing and consent of instructor.
3 units, Win (Bandura) W 2:15-4:05, given 1970-71

256. Personality Development—Prerequisites: graduate standing and consent of instructor.
2 to 3 units, Spr (Sears) by arrangement

257. Individually Supervised Practicum—Prerequisites: graduate standing and consent of instructor.
3 to 5 units, Aut, Win, Spr (——) by arrangement

258. Child Research Practicum—Prerequisites: 117 and consent of instructor.
3 to 4 units, Win (Dowley) TTh 1:15, given 1969-70

260. Seminar in the Perception of Motion and Change—Prerequisite: consent of instructor.
2 to 3 units, Spr (Kaplan) by arrangement

261. Seminar in Social Psychology—Prerequisite: consent of instructor.
2 to 3 units, Aut (——) by arrangement

262. Seminar in Verbal Behavior—Prerequisite: consent of instructor.
2 to 3 units, Win (Horowitz) TTh 10

263. Seminar in Perception—Prerequisite: consent of instructor.
2 to 3 units, Spr (Ganz) by arrangement

264. Seminar in Learning Theory—Prerequisite: consent of instructor.
2 to 3 units, Win (Bower) by arrangement

265A. Seminar in Mathematical Theories of Learning and Memory—Prerequisite: consent of instructor.
2 to 3 units, Aut (Atkinson, Bowers) by arrangement

266. Seminar in Developmental Psychology—Prerequisite: consent of instructor.
2 to 3 units, Spr (——) by arrangement

267. Seminar in Person Perception—Prerequisite: consent of instructor.
2 to 3 units, Win (Hastorf) by arrangement, given 1970-71

268. Seminar in Physiological Psychology—Special topics. Graduate or undergraduate standing. Prerequisites: 148 or 208, and consent of instructor.
2 to 3 units, Win (Hamilton) by arrangement

269. Seminar in Personality—Prerequisite: consent of instructor.
2 to 3 units, Win (Mischel) TTh 9-12

271. Seminar in Information Processing—Prerequisite: consent of instructor.
2 units, Spr (Lawrence) by arrangement

275. Research—Research of intermediate nature, whether or not to be used toward Master’s thesis, may be undertaken with members of Department faculty.
(Staff) by arrangement

276. Internship in Psychology—As part of training for advanced degrees in personality and experimental psychopathology, developmental psychology, arrangements are made for residence service in hospitals, penal institutions, and schools.
5 to 15 units, any quarter (Staff) by arrangement

(Staff) by arrangement

303. Research Seminar in Hypnosis—Primarily for graduate students doing research within hypnosis and related areas. Prerequisite: consent of instructor.
1 to 3 units, Aut, Win, Spr (E. Hilgard, J. Hilgard) F 4:15-5:30

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

Seminar in Educational Psychology — See Education 415.

The Biochemistry of Behavior—See Psychiatry 9.

SLAVIC LANGUAGES and LITERATURES

Emeriti: Jack A. Posin (Professor); Sarra Kliachko, Elisabeth Stenbock-Fermor (Assistant Professors)

Chairman: Joseph A. Van Campen

Visiting Professor: Andrzej Wirth

Associate Professors: Lawrence L. Stahlberger, Joseph A. Van Campen

Acting Assistant Professor: Robert T. Whitaker, Jr.

Senior Lecturer: Nicholas S. Pashin

Acting Instructor: I. Szwede

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.

GRADUATE PROGRAM IN HUMANITIES

The Department participates in the Graduate Program in Humanities leading to a joint Ph.D. degree. For a description of that program, and fellowships offered in connection with it, see the section "Humanities Special Programs" in this bulletin.

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 case courses numbered 111, 112, 113, 145, 146, 147, 148, 187, 188, 189, and 191.

In addition to the 35 units mentioned above, students not enrolled in the Honors program in Humanities (for a description see "Humanities Special Programs" in this bulletin) are to select with the help of their adviser a minimum of three general courses (9 units) in support of their major program.

MASTER OF ARTS: RUSSIAN

No student is accepted for candidacy for the degree of Master of Arts unless he has completed the equivalent of the training represented by the requirements for the A.B. degree. Students intending to work toward the Ph.D. degree are required to pass the reading examination in either French or German during their first year of graduate studies. There are no examinations for the Master of Arts degree; a thesis, however, is required.

Requirements:

1. The following courses (or their equivalents) are part of the basic Master of Arts program: Phonology, Syntax and Lexicology (196, 197); Old Church Slavonic (211, 212); History of Russian Language (213); Russian Literature to the Nineteenth Century (189); Studies in Russian Fiction (193A, 193B); Graduate Seminar (300); Thesis (299).

2. Each student shall, in addition, choose with the approval of his adviser a number of electives sufficient to bring the total to 44 units.

DOCTOR OF PHILOSOPHY: SLAVIC

Candidates are not obliged to present a minor but they are urged to offer one. A minor in a second language is strongly recommended. If it is in French, German, or Spanish, it should be equivalent to the course requirements for the degree of Master of Arts.

Candidacy—Candidates should read carefully the general regulations governing the
conferring of this degree, as described in the section "Degrees" in this bulletin. For specific Departmental requirements and recommendations, the student should consult with his adviser. No student is accepted as a candidate until he has completed the equivalent of the training represented by the requirements for the Master of Arts degree as described above.

General Requirements — All candidates, regardless of their field of specialization, are expected to fulfill these requirements:
1. Have a reading knowledge of French and German, to be demonstrated by passing an examination.
2. Write a dissertation that embodies such results of research as would merit publication.
3. Pass written and oral examinations along the following lines:
   a) The principles of general and descriptive linguistics and the outlines of the history of the Russian language in its relationship to the development of the other Slavic languages.
   b) The history of Russian literature including its relationship to the development of other Slavic literatures, or of European literature; or to Russian intellectual history.
   c) The essentials of the political and cultural history of the Slavic world.
4. Prove, by examination, that they can write and speak Russian correctly.

Specialization — Candidates in Slavic Languages and Literatures specialize either in linguistics or literature. Once the basic requirements for the Master of Arts degree have been satisfied, candidates may draw up individual programs of study and research in consultation with the graduate adviser. Minimal language requirements (along with others) will thus vary according to the nature of the specialized program requested.

Course Work — Candidates for the Ph.D. degree should arrange their course work in such a way as to fulfill all requirements for their major and minor within nine quarters after receiving the A.B. degree. This can be done by enrolling for a minimum of 12 units per quarter. Candidates who enroll for less must expect a corresponding delay.

GENERAL COURSES (A)
When registering, students are advised to prefix the identifying letter A to the course number.

   4 units, Aut (Shane) MWF 10

#146. Russian Literature of the Twentieth Century—Major emphasis on the novel. Readings in English.
   4 units, Spr (Whittaker) MWF 10

#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 1969-70

#151. Dostoevsky—A reading of the major works in English translation. Open to all students except freshmen.
   4 units, Aut (Shane) MWF 11, alternate years, given 1969-70

#153. Leo Tolstoy—Chief works of fiction in English translation. Open to all students except freshmen.
   4 units, Win (Stahlberger) MWF 11, alternate years, given 1969-70

SLAVIC AND RUSSIAN COURSES
FIRST- AND SECOND-YEAR
(Under the direction of Joseph A. Van Campen)

POLISH
§15. Elementary Polish — An intensive grammar course, with emphasis on rapid acquisition of the essentials for a reading knowledge of the language.
   4 units, Aut (Szwede) MTWTh 8

§16. Intermediate Polish — Introduction to the reading of prose texts. Prerequisite: 15 or equivalent.
   4 units, Win (Szwede) MTWTh 8

§17. Advanced Polish — Reading of prose texts. Prerequisite: 16 or equivalent.
   4 units, Spr (Szwede) MTWTh 8

RUSSIAN
#1. First-Year Russian.
   5 units, Aut (Staff)
#2. First-Year Russian—Continuation of 1.
5 units, Win (Staff)

#3. First-Year Russian—Continuation of 2.
5 units, Spr (Staff)

5. Intensive First-Year Russian — Equivalent to 1, 2, and 3 combined. Enrollment limited. Consent of instructor necessary.
12 units, Sum (Staff) MTWThF 8:00–9:30, 10:30–12:00, and W 2:15–4:05

10. Elementary Russian — Accelerated course for beginners, particularly for those seeking to fulfill the University requirement of a reading knowledge for the Ph.D. degree. Open to senior, graduate students only. No auditors permitted.
4 units, Win (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) TWTh 8

#52. Second-Year Russian.
5 units, Aut (Staff) MTWTh 8 or 1:15

#53. Second-Year Russian — Continuation of 52. Satisfies General Studies requirement under C. Prerequisite: 52.
5 units, Win (Staff) MTWThF 12 or 1:15

#54. Second-Year Russian — Continuation of 53. Prerequisite: 53.
5 units, Spr (Staff) MTWThF 12 or 1:15

THIRD YEAR

111. Third-Year Russian — Prerequisite: 54 or equivalent.
5 units, Aut (Whittaker) MWF 9

112. Third-Year Russian — Continuation of 111.
5 units, Win (Whittaker) MWF 9

113. Third-Year Russian — Continuation of 112.
5 units, Spr (Whittaker) MWF 9

#147. Russian Nineteenth-Century Prose—Discussion of selected problems, based on readings in Russian. This course must be taken concurrently with General Course 145.
1 unit, Aut (Shane) 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, Spr (Whittaker) by arrangement

ADVANCED AND GRADUATE

R182. Solzhenitsyn—Conducted in Russian.
4 units, Aut (Pashin) TTh 1:15–3:05

R183. Chekhov—Conducted in Russian.
4 units, Spr (Pashin) TTh 3:15–5:05

#184. The Russian Short Story—Conducted in Russian. Prerequisite: 113 or equivalent.
4 units, Aut (Pashin) alternate years, given 1970–71

#185. The Russian Novella — Conducted in Russian. Prerequisite: 113 or equivalent.
4 units, Win (Pashin) alternate years, given 1970–71

#186. The Russian Drama—Conducted in Russian. Prerequisite: 113 or equivalent.
4 units, Spr (———) alternate years, given 1970–71

#187. Russian Poetry of the Nineteenth Century—A survey of the major figures and movements.
4 units, Win (Stahlberger) MWF 1:15

#188. Russian Poetry of the Twentieth Century — A survey of the major figures and movements.
4 units, Spr (Stahlberger) MWF 1:15

#189. Russian Literature from the Eleventh to the Eighteenth Century.
4 units, Spr (Stahlberger) MWF 10

#191. Russian Literary Criticism — Emphasis will be on major nineteenth-century texts. Lectures in Russian; written work may be in English.
3 units, Aut (Pashin) alternate years, given 1970–71

192. Russian Literary Criticism—Continuation of 191.
3 units, Win (Pashin) TTh 1:15–3:15, alternate years, given 1969–70

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.

4 units, Aut (Whittaker) MWF 11

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.

4 units, Win (Whittaker) MWF 11, given 1969–70

196. Russian Pronunciation — Problems of theoretical and applied phonology. Prerequisite: 54 or equivalent.

3 units, Aut (Pashin) TTh 3:45–5:05

197. Russian Syntax and Lexicology — Introduction to problems of advanced grammar and usage.

3 units, Spr (Pashin) TTh 1–3:15

198. Introduction to Russian Folklore — Conducted in Russian.

3 units, Win (Pashin) TTh 3:45–5:05

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

GRADUATE COURSES IN SLAVIC LINGUISTICS AND LITERATURES

201. Synchronic Morphology of Russian Conjugation and Declension.

3 units, Aut (Van Campen) MWF 3:15


2 units, Win (Van Campen) MWF 3:15

206. Graduate Seminar — Polish romanticism. Drama and poetry conducted in English.

4 units, Aut (Wirth) TTh 10


4 units, Spr (Wirth) TTh 10

211. Introduction to Old Church Slavonic.

3 units, Aut (Van Campen) MWF 2:15

212. Advanced Old Church Slavonic — Prerequisite: 211.

3 units, Win (Van Campen) MWF 2:15

213. History of the Russian Language — Prerequisite: 212.

3 units, Spr (Van Campen) MWF 3:15

228. Divergence of Slavic Languages.

2 units, Spr (Van Campen) alternate years, given 1970–71

251. Examination of the Structure of Non-Russian Slavic Languages.

3 units, Aut (Van Campen) alternate years, given 1970–71

271. Russian Literature of the Seventeenth and Eighteenth Centuries.

3 units, Win (Stahlberger) alternate years, given 1970–71

277. Gogol.

3 units, Win (Shane) TTh 10

278. Tolstoy.

3 units, Spr (Whittaker) every three years, given 1971–72

279. Dostoevsky.

3 units (—) by arrangement

280. Comparative Slavic Literature of the Medieval Period.

3 units, Aut (Stahlberger) every three years, given 1970–71


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 (Van Campen, Stahlberger, Whittaker, Pashin, Wirth) by arrangement

300. Graduate Seminar — Subjects to be announced in Time Schedule.

3 units, Aut (Stahlberger) by arrangement

Win (Shane) by arrangement

Spr (Van Campen) by arrangement

SOCIAL SCIENCES (SPECIAL PROGRAM)

HONORS PROGRAM IN SOCIAL THOUGHT AND INSTITUTIONS

Charles Drekmeier (Chairman), Margot Drekmeier, Oliver Holmes, 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

SOCILOGY

Emeriti: Richard T. LaPiere, Charles N. Reynolds (Professors)
Chairman: Bernard P. Cohen
Vice Chairman: W. Richard Scott
Associate Professor: W. Richard Scott. (By Courtesy:) Elizabeth G. Cohen
Assistant Professors: C. Norman Alexander, J. Victor Baldridge, John W. Meyer
PROGRAMS OF STUDY

BACHELOR OF ARTS

The Bachelor of Arts degree, with a major in Sociology, may be obtained in one of two ways:

1. The Standard Major — Typically, the student electing this program must take 45 units of sociology, in addition to basic University requirements.

   In special cases, students are allowed to take up to a total of 15 units outside the Department and are permitted to count such units toward the fulfillment of the 45-unit requirement. These students should work out an appropriate study program with their Departmental adviser and then petition the Undergraduate Studies Committee of the Department for approval of their program.

   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, and, in addition, two courses must be selected from the remaining five courses in the Fundamental Program. The two courses from the Fundamental Program used to satisfy this requirement must be taken for 5 units of credit each. These requirements are designed to provide each major with a sound basis for further work in more specialized fields in sociology.

   To be recommended for the degree the student must maintain an average grade of C or higher in the major field. Normally, students who expect to graduate as Sociology majors must be registered with the Department two full quarters prior to graduation.

2. The Honors Program — The Honors Program provides specialized training and research experience for those qualified students who wish to pursue independent study 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, a course in sociological theory, and two courses from the Fundamental Program. 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 (c) 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.

All sociology graduate students must develop a thorough grounding in both sociological theory and research methods to provide a solid foundation for later specialization. To accomplish this, six graduate courses are required: Theory Construction, Advanced Social Statistics, Research Design, Logic of Social Research, Basic Problems in Sociological Theory, and Problems in Sociological Measurement. In addition, for students entering with a deficiency in statistics, Statistics 107, Psychology 60, Statistics 50 or some equivalent must be taken in the first quarter after entering.

Each candidate must select three fields within sociology as his areas of special competence, in consultation with the Director of Graduate Studies. He must pass written examinations in these fields in order to be certified for the University oral examination. Examples of such fields are Small Groups, 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. The written examinations will ordinarily be given only within the first seven weeks of autumn and spring quarters.

After passing the University oral examination, the candidate must satisfactorily complete a doctoral dissertation. Members of the faculty are available to assist the candidate at each stage of his research in fulfilling the dissertation requirement.

THE MASTER OF ARTS IN TEACHING DEGREE

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and wish further to strengthen their academic preparations. The program consists of a minimum of 25 units in the teaching field and 12 units in the School of Education.
TEACHING ASSISTANTSHIPS AND FELLOWSHIPS

The University has a number of fellowships and scholarships available. Information about these, as well as application blanks, may be secured by writing the Office of Admissions.

In addition, the Department has annual teaching assistantships, 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 (——) MWF 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) MWF 11 and sections by arrangement

#1B. Introduction to Sociology: Bureaucracy in Modern Society—A description and analysis of some of the fundamental changes which have occurred and are occurring in the structure of industrialized societies. Topics covered include: bureaucratization, rationality, the structure of formal organizations, oligarchical tendencies in organizations, the distribution of power in society, impersonality, and alienation.
5 units, Aut (Scott) MWF 11 and sections by arrangement

#1C. Introduction to Sociology: the Individual and Social Structure—This course emphasizes the social construction and definition of actors and actions in modern societies. Analysis focuses on families, peer groups, schools and organizations as mediating structures between the individual and the institutional order. Readings in Weber, Simmel, Freud, Mead, Durkheim and modern empirical studies.
5 units, Win (Meyer) MWF 1:15 and sections by arrangement

7. Introduction to Statistics—(Enroll in Statistics 7.)
5 units, Aut (Anderson) MTWThF 3:15

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

FUNDAMENTAL PROGRAM

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 (——) MWF 1:15

#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, Win (Dornbusch) MWF 11

104. Interpersonal Behavior—An examination of research in such areas as power and prestige structures in small groups; commu-
nunication networks and processes; deviance, conformity, and social control.

5 units, Aut (Berger) MWF 10

#105. Organizations: Structures and Processes — An analysis of the structural characteristics of economic, political, educational and other organizations and their impact on individual participants. Prerequisite: 1 or consent of instructor.

3 to 5 units, Win (Scott) MTWThF 10

106. Introduction to Sociological Theory — Critical analysis of some basic notions and theories used in sociological analysis, like Heider's balance theory, Homans' theory of social behavior as an exchange process and structural-functional analysis. Required of all sociology majors.

5 units, Spr (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 1:15

OTHER COURSES OPEN TO UNDERGRADUATES AND GRADUATES

107. Introduction to Statistics—For graduate students. (Enroll in Statistics 107.)

4 units, Aut (Anderson) MTWThF 3:15

110. Religious Institutions and Behavior—A sociological approach to organized religion, emphasizing the interaction between the church and its social setting.

5 units, Spr (Dornbusch) MWF 10

#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, Aut (Meyer) MWF 9

129. Family Institutions and Behavior — Social structure of the family in Western and non-Western societies; family pathologies.

5 units, Win (Zelditch) MWF 9

130. Population Problems—(Same as Food Research 135.) Analysis of U.S. and world population growth. Economic and social causes and consequences of trends in births, deaths, and migration. Population in relation to food and development; population theories and policies; national family planning programs.

5 units, Win (Kirk) MTWTh 9

131. Advanced Social Psychology: Situational Identity and Social Behavior—A perspective on major problems in social psychology; reviewing and analyzing perspectives on personal behaviors in such areas as social perception, self-conceptions, social definitions of selves and situations, and the normative context of interaction.

5 units, given 1970–71

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, Spr (——) MWF 1:15

135. Social Psychology of Family Relationships — Analysis of the family as a social-psychological unit; emphasis on family roles and relations, pathology.

5 units, given 1970–71

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.

5 units, Spr (——) T 2:15–5:05

160. Advanced Interpersonal Behavior — A more intensive examination of topics covered in 104. Prerequisite: 104 or consent of instructor.

3 to 5 units, Win (——) W 2:15–5:05


3 units, Win (Switzer) MWF 11

162. Theory and Application of Statistics (Non-Mathematical) — (Enroll in Statistics 162.)

3 units, Spr (Switzer) MWF 11

163. Comparative Institutional Analysis — Cross-cultural approach to the study of institutions and social systems. Prerequisite: 102 or consent of instructor.

5 units, Spr (——) W 2:15–5:05

165. Advanced Social Stratification—Analysis of stratification structures in complex social systems. Emphasis is placed on the formulation of theory relevant to problems of stability of stratification structures.

5 units, Win (Simpson) W 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

204. Field Methods in the Study of Organizations — Field research on a selected organizational problem will be carried out with the student gaining experience in data collection and analysis.
   5 units, Spr (Baldridge) Th 2:15–5:05

209. Exploration of Research Problems in the Study of Stratification.
   5 units, Spr (Baldridge) Th 2:15–5:05

211C. Foundations of Education: Social—(See Education 211C).
   3 units, Win, Spr (Cohen, Haukinesshore)

215. Exploration of Problems in the Relation of Status to Political Behavior.
   5 units, Spr (Meyer) M 2:15–5:05

216. Theories of Interpersonal Processes—A consideration and comparison of some of the current theories concerned with explaining interpersonal behavior.
   5 units, Spr (——–) M 2:15–5:05

217. Problems in Theoretical Analysis — Prerequisite: 253 and consent of instructor.
   5 units, given 1970–71

   5 units, Win (Wallin) M 2:15–5:05

220A. Research Problems in the Sociology of Education—(See Education 310A.) Prerequisite: consent of instructor.
   4 units, Aut (Cohen, Baldridge) MW 9–11

220B. Research Problems in the Sociology of Education—See Education 310A.) Prerequisite: consent of instructor.
   4 units, Win (Cohen, Baldridge) TTh 8–10

221. Evaluation Processes and Expectation Structures.
   5 units, Spr (Berger) T 2:15–5:05

230. Population Problems—(Same as Food Research 235.) See 130.
   5 units, Win (Kirk) MWF 10

231. Seminar: Demography of the Developing Countries—(Same as Food Research 235.) The demographic position of the major regions in relation to their problems of economic and social development. Problems of population policy.
   3 units, Spr (Kirk) by arrangement

233. Survey Methods — Problems and techniques of survey analysis.
   5 units, Aut (Wallin) Th 2:15–5:05

   5 units, Spr (——–) F 2:15–5:05

235. Fields Methods — Problems and techniques of conducting field research.
   5 units, given 1970–71

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

250. Basic Problems in Sociological Theory — Prerequisite: consent of instructor.
   5 units, Aut (Zelditch) W 2:15–5:05

253. Theory Construction — Prerequisite: consent of instructor.
   5 units, Win (——–) T 2:15–5:05
255. Logic of Social Research—Practicum in the formulation and critical evaluation of research designs for the study of sociological problems. Prerequisites: 149 and 260.

5 units, Spr (Wallin) T 2:15-5:05

260. Research Design — Prerequisite: 161 and 162.

5 units, Aut (——) M 2:15-5:05


5 units, Spr (——) F 2:15-5:05


5 units, Win (Cohen) M 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

Assistant Professors: Gustavo Alfaro, Joaquim F. Coelho, Rubén A. Gamboa, Luis Ponce de León. Acting: Janice T. Geasler

Senior Lecturer: Phillip Petersen

The Department of Spanish and Portuguese accepts candidates for the degree of Bachelor of Arts, Master of Arts in Spanish, and Doctor of Philosophy in Spanish, and for certification as high school and junior college teachers. Special consideration is given to the needs of those who intend to make teaching their profession.

PROGRAMS OF STUDY

BACHELOR OF ARTS

Candidates are expected to complete a minimum of 42 units from courses in this Department numbered 100 or higher. Courses are to be selected with the guidance of the student's adviser. Language competence equivalent to Spanish 113 is required.

For students in the Honors Program in Humanities, up to six units of that program may be applied toward completion of the Spanish major.

STANFORD SPANISH PROGRAM IN 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 Credential Secretary, School of Education.

MASTER OF ARTS IN TEACHING

The degree of Master of Arts in Teaching is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and who wish further to strengthen their academic preparation. The program consists of a minimum of 45 quarter units of graduate study, 36 of which must be completed at Stanford. A minimum of 25 units of courses
taken must be in the teaching field and at least 12 units must consist of graduate courses in the School of Education at Stanford.

For general requirements, see School of Education, page 47.

Specific requirements:

Language Study: Spanish 164, 165, 166, 185, 201, 202 19 units
Literature: Chosen from courses in Hispanic Literature or Civilization numbered from 180 up 10 units
Methods: Spanish 210 2 units
Language Lab 215 2 units
Courses in Education 12 units

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 and fellowships offered in connection with it, see the section “Humanities Special Programs” 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 (4 units).
4. 7 units to be chosen from the following courses: 190, 204, 205, 260, 261, 263, 264, 266.
5. 26 units of courses in Spanish or Portuguese above 180 chosen with the approval of the student's adviser, of which 6 units may be in related fields dealing with the area.
6. 299. Thesis (4 units) or a three-hour written examination in Hispanic Literature, Linguistics, and Civilization.

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 Latin, Portuguese, and one other foreign language. This knowledge must be demonstrated by examination.
2. Pass the final written examinations in the following fields:
   a) Philology and Linguistics, Medieval Literature and Civilization.
   b) Spanish Literature and Civilization from 1500 to the present.
   c) Spanish American Literature and Civilization.
   Portuguese and Brazilian Literature and Civilization may be substituted for either b) or c) above.
3. Write a dissertation that embodies such results of research as would merit publication.
4. Pass a final University oral examination in defense of the dissertation.
5. Satisfactory teaching experience. Teaching assistantships are available to enable candidates to fulfill this requirement, which will be waived only in the case of students who have teaching experience in other institutions.
6. Ph.D. candidates, except those in the Graduate Humanities Program, are required to present no less than 18 units of graduate work in a related field chosen with the consent of the adviser.
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.
3 units, Win (Alfaro) alternate years, given 1970-71

150. Unamuno and Ortega — Present-day conflicts in literary works of Unamuno, Ortega y Gasset. Not open to Spanish majors.
2 to 3 units, given 1970-71

3 units, Spr (Ponce de Leon) MWF 11

152. Lorca and Other Contemporary Spanish Dramatists in Translation — Modern trends, tensions as reflected in significant Spanish dramatists of present day. Not open to Spanish majors.
3 units, Aut (Schevill) given 1970-71

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.
4 units, Aut, Win (Staff)

#2. First-Year Spanish—Continuation of 1.
4 units, Aut, Win, Spr (Staff)

#3. First-Year Spanish—Continuation of 2.
4 units, Aut, Win, Spr (Staff)

#5. Intensive First-Year Spanish — Offers preparation in comprehension, speaking, reading and writing the language. Since classes are limited to 15, applicants should consult the Department as soon as possible.
12 units, Sum (Staff) MTWThF 8:00-9:30 and 10:30-12:00 and one hour daily in the Language Laboratory by arrangement

10. Elementary Spanish — Accelerated course for beginners, particularly for those seeking to fulfill the University requirement of a reading knowledge for the Ph.D. degree. Open to seniors and graduate students only.
4 units, Spr (Staff) MTWThF 1:15
Sum (Staff) MTWThF 10

#22. Second-Year Spanish—Prerequisite: 3.
3 units, Aut, Win, Spr (Staff)

#23. Second-Year Spanish — Continuation of 22.
3 units, Aut, Win, Spr (Staff)

3 units, Aut, Win, Spr (Staff)

#29. Intensive Second-Year Spanish—Reading, grammar, composition, and conversation. Enrollment is limited.
9 units, Sum (Staff) MTWThF 8 and 11

#54. Second-Year Spanish — Enrollment limited to 15. Satisfies General Studies Requirement under C. Prerequisite: 23.
5 units, Spr (Staff) MTWThF 9

99. Individual Reading — Enrollment only by special consent. Prerequisite: 23.
1 to 4 units, any quarter (Staff) by arrangement

THIRD- AND FOURTH-YEAR

100. Advanced Spanish Conversation — May be repeated for credit. Prerequisite: 24 or equivalent.
3 units, Win (Ponce de León) MWF 1:15

111. Third-Year Spanish—Prerequisite: 24.
3 units, Aut (Staff) MWF 8 or 10

112. Third-Year Spanish — Continuation of 111.
3 units, Win (Staff) MWF 8 or 10
113. Third-Year Spanish — Continuation of 112.

3 units, Spr (Staff) MWF 8 or 10

Note — Courses 121 through 189 marked with the symbol # satisfy General Studies Requirement under C, when taken for 4 units.

#121. Hispanic American Cultural Readings — Prerequisite: 23 or equivalent.

4 units, Spr (Geasler) MWF 1:15

and one hour by arrangement

#125. Spanish Cultural Readings — Training in careful reading of books with significant cultural content. Prerequisite: 23 or equivalent.

3 to 4 units, Aut (Geasler) MWF 9

#126. Cervantes — Reading and interpretation of selected passages from Don Quixote. Prerequisite: 23 or equivalent.

3 to 4 units, Win (Alfaro) given 1970–71

#131. Masterworks of Spanish Literature I — From its origins to end of Fifteenth Century. Prerequisite: 23 or equivalent.

3 to 4 units, given 1970–71

#132. Masterworks of Spanish Literature II — Sixteenth and Seventeenth centuries. Prerequisite: 23 or equivalent.

3 to 4 units, Aut (Alfaro) given 1970–71

#133. Masterworks of Spanish Literature III — From 1700 to 1898. Prerequisite: 23 or equivalent.

3 to 4 units, Win (Ponce de León) MWF 2:15

#134. Modern and Contemporary Spanish Literature — Prerequisite: 23 or equivalent.

3 to 4 units, given 1970–71

#142. The Spanish Novel of the Nineteenth Century.

3 to 4 units, Spr (Ponce de León) MWF 2:15

#151. Masterworks of Spanish American Literature I — Prerequisite: 23 or equivalent.

3 to 4 units, Win (Geasler) MWF 11

#152. Masterworks of Spanish American Literature II — Prerequisite: 23 or equivalent.

3 to 4 units, Spr (Geasler) MWF 11

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. Enrollment limited to 15. Students in the short-term program should enroll for 165A for 2 units.

4 units, Sum (Staff) MTWThF 9

166. Spanish Conversation. Enrollment limited to 15. Students in the short-term program should enroll for 166A for 2 units.

4 units, Sum (Staff) MTWThF 9

ADVANCED AND GRADUATE

#180. Lope de Vega, Tirso and Calderón — Study and interpretation of four or five representative comedies.

3 to 4 units, Spr (Geasler) MWF 9

181. History of Linguistic Thought.

3 units, Spr (Petersen) given 1970–71

#182. Contemporary Spanish Theater.

3 to 4 units, alternate years, given 1970–71

#184. Spanish Speech and Drama — Reading and rehearsing of Spanish plays. May be repeated for credit. Prerequisites: 100 and 112 or permission of instructor.

3 units, alternate years, given 1970–71

185. Spanish Phonetics.

2 to 3 units, Win (Petersen) TTh 11

Sum (Petersen) MWF 10

#186. Spanish American Literature I — Colonial epoch. Open only to graduate and advanced undergraduate students.

3 to 4 units, Aut, alternate years, given 1970–71

#187. Spanish American Literature II — Romanticism. Open only to graduate and advanced undergraduate students.

3 to 4 units, Win, alternate years, given 1970–71

#188. Spanish American Literature III — Modernismo. Open only to graduate and advanced undergraduate students.

3 to 4 units, Aut (Geasler) MWF 2:15

#189. Spanish American Literature IV — Twentieth Century. Open only to graduate and advanced undergraduate students.

3 to 4 units, Win (Geasler) MWF 2:15
190. Spanish Linguistics—(Same as Education 283.)
3 units, Spr (Petersen) TTh 9 and one hour by arrangement

193. The Problems of Spain in the Literature of the Nineteenth and Twentieth Centuries.
3 to 4 units, Aut (Ponce de León) MWF 11

195. Chilean Literature of the Twentieth Century.
3 to 4 units, Aut, every third year, given 1970–71

195A. Argentine Literature of the Twentieth Century.
3 to 4 units, Aut, every third year, given 1971–72

195B. Mexican Literature of the Twentieth Century.
3 to 4 units, Aut (Alegria) MW 3:15

3 to 4 units, Spr (Alfaro) alternate years, given 1970–71

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 (Ponce de León) MWF 11
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) MWF 3:15
3 units, Sum (Staff) MTWF 2:15

203. Advanced Grammar and Stylistics — Prerequisite: 202 with grade of B or equivalent.
3 units, Spr (Schevill) MWF 3:15

204. Modern Spanish I — The phonology of modern Spanish.
3 units, Aut (Espinosa) MWF 10

205. Modern Spanish II — The syntax of modern Spanish.
3 units, Win (Espinosa) MWF 10

206. Advanced Intensive Spanish — Intensive work on oral expression, correction of pronunciation and grammar.
12 units, Sum (Staff) MTWThF 11 and 1:15 and one lab.

207. Conversations on Contemporary Spanish America — This course will present the cultural life of twentieth century Spanish America.
5 units, Sum (Staff) MTWThF 11

210. Methods of Teaching Spanish—(Same as Education 292.) See also Language Laboratory 215.
2 units, Aut (Petersen) TTh 1:15

211. Spanish Literature from its Origins to 1500.
4 units, Aut (Espinosa) MWF 10

212. Spanish Literature of the Sixteenth and Seventeenth Centuries.
4 units, alternate years, given 1970–71

213. Spanish Literature from 1700 to 1850.
4 units, Aut (Ponce de León) W 7:15 p.m.

214. Spanish Literature from 1850 to 1905.
4 units, Aut (Schevill) TTh 4:15 p.m.

215. Spanish Literature from 1905 to the Present.
4 units, Win (Schevill) T 7:15–10:00 p.m.

217. Spanish Theater of the Golden Age.
3 to 4 units, given 1970–71

218. Spanish Renaissance Prose.
3 units, alternate years, given 1970–71

220. Cervantes.
4 units, alternate years, given 1970–71

223. The Modern Spanish Novel.
3 to 4 units, alternate years, given 1970–71

3 units, Aut, alternate years, given 1970–71

3 units, alternate years, given 1970–71

228. Contemporary Spanish Poetry.
3 to 4 units, Spr (Gicovate) MW 3:15

230. Hispanic Folklore.
2 units, every third year, given 1970–71

232. The Spanish Epic Tradition.
3 units, every third year, given 1970–71
240. Spanish Versification.
   3 units, Win (Espinosa) given 1970-71

248. Proseminar: Problems and Methods of Research in Hispanic Literatures I.
   2 units, Win (Gicovate) MW 2:15

249. Proseminar: Problems and Methods of Research in Hispanic Literatures II.
   2 units, Spr (Gicovate) MW 2:15

250. Graduate Seminar in Spanish Literature — Subject to be announced in Time Schedule.
   3 units, Sum (Staff) T 4:15–6:05

251. Graduate Seminar in Spanish American Literature — Subject to be announced in Time Schedule.
   3 units, Spr (Gicovate) T 2:15

255. Contemporary Novelists of Spanish America.
   3 units, Aut (Alegria) M 5–7

260. History of the Spanish Language — Readings in Old Spanish. Prerequisite: elementary knowledge of Latin and consent of instructor.
   3 units, Win (Espinosa) MWF 11

261. Old Spanish—Elements of phonology, morphology; reading of Old Spanish texts. Prerequisite: elementary knowledge of Latin and consent of instructor.
   4 units, Aut (Espinosa) given 1970–71

263. Historical Spanish Linguistics I—Prerequisite: 260.
   3 units, Win (Espinosa) given 1970–71

264. Historical Spanish Linguistics II.
   3 units, Spr (Espinosa) MWF 11

266. Hispanic Dialectology.
   3 units, Spr (Espinosa) given 1970–71

299. Individual Work — Exclusively for graduate students in Spanish working on thesis or engaged in special work.
   1 to 12 units, any quarter (Staff) by arrangement

PORTUGUESE COURSES
FIRST- AND SECOND-YEAR

#1. First-Year Portuguese.
   4 units, Aut (Staff) MWTThF 12

#2. First-Year Portuguese — Continuation of 1.
   4 units, Win (Staff) MWTThF 12

#3. First-Year Portuguese — Continuation of 2.
   4 units, Spr (Staff) MWTThF 12

#15. Intensive First-Year Portuguese — Equivalent to 1, 2, and 3 combined. Enrollment limited. Consent of instructor necessary.
   12 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

#23. Second-Year Portuguese — Continuation of 22.
   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.

#54. Second-Year Portuguese—Enrollment limited to 15. Satisfies General Studies Requirement under C. Prerequisite: 23.
   4 units, Spr (Staff) MWF 12

99. Individual Reading — Enrollment only by special permission. Prerequisite: 23.
   1 to 2 units, any quarter (Staff) by arrangement

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, Spr (Staff) given 1970–71

ADVANCED UNDERGRADUATE AND GRADUATE

181. Advanced Portuguese.
   3 units, Aut (Coelho) MW 11

182. Advanced Portuguese — Continuation of 181.
   3 units, Win (Coelho) MW 11

183. Advanced Portuguese — Continuation of 182.
   3 units, Spr (Coelho) MW 11
185. Portuguese Linguistics.
   4 units, alternate years, given 1970–71
186. Portuguese Phonetics.
   4 units, alternate years, given 1970–71
191. Portuguese Literature I.
   3 to 4 units, Aut (Coelho) MWF 10
192. Portuguese Literature II.
   3 to 4 units, Win (Coelho) MWF 10
195. Brazilian Literature I.
   3 to 4 units, Aut (Coelho) MWF 2:15
196. Brazilian Literature II.
   3 to 4 units, Win (Coelho) MWF 2:15
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) MTWThF 11

250. Graduate Seminar—Subject to be announced in Time Schedule.
   3 units, Spr (Coelho) M 7:15 p.m.

299. Individual Work.
   1 to 12 units, any quarter (Staff) by arrangement

SPEECH and DRAMA

Emeriti: James G. Emerson (Professor); Helene Blattner, Elisabeth Buckingham (Associate Professors)
Chairman: Michael Barry
Professors: Michael Barry, Wendell Cole, Eleanor Prosser, H. Donald Winbigler.
Visiting: Andrzej Wirth
Lecturers: Evelyn Draper, Jean Hartman, Michel Langinieux

PROGRAMS OF STUDY

BACHELOR OF ARTS

The requirements for the degree of Bachelor of Arts with a major in Speech and Drama are planned to allow the student wide latitude in developing his special aptitudes. Students are encouraged to declare their major in Drama in their sophomore year. A minimum program is required of all students. Every major in Speech and Drama must take:

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>90, 91, 92. Dramatic Literature</td>
</tr>
<tr>
<td>160A, 160B. Theater Practice</td>
</tr>
<tr>
<td>164A, 164B, 164C. Acting; Directing</td>
</tr>
<tr>
<td>164L. Movement (concurrent) with 164A, 164B, 164C</td>
</tr>
<tr>
<td>173A. Theatrical Makeup</td>
</tr>
<tr>
<td>174A, 174B, 174C. Introduction to Design and Technical Production</td>
</tr>
<tr>
<td>195. Theater Criticism</td>
</tr>
</tbody>
</table>

Electives in Speech and Drama (Undergraduate and Graduate with consent of instructor) | 9 |

Total ......................................................... 52

An additional six units must be taken, to be chosen from:
170A, 170B, 170C. Visual Arts for Theater or Art History

As a major in Speech and Drama, each student is required to take one unit of Speech and Drama 160A or 160B each quarter; at least two units of 160B are required each year. Thirty hours of work per unit each quarter will be required to pass the course. A minimum of 6 units of Speech and Drama and 160A and 160B is required. No more than 10 units of 160A and 160B, however, may be counted toward graduation requirements of 180 units.

All students must complete a program of interrelated study in an area other than Drama totaling 12 units. This program is to be chosen with the approval of the student's faculty adviser. A grade average of C must be maintained in all course work.

Special Major Program for the Honors Candidate in Humanities — Students who are planning to take the special Honors Program in Humanities may fulfill the requirements for the major in Speech and Drama by satisfactory completion of the following program:

164A, 164B, 164C. Acting and Directing
164L. Movement (concurrent with 164A, 164B, 164C)
90, 91, 92. Dramatic Literature

Six units to be chosen from Speech and Drama 170A, 170B, 170C or Art History

 Electives in theater and drama totaling at least nine units at the undergraduate course level, or at the
graduate course level with consent of the instructor.

**Graduate Program in Humanities**

The Department of Speech and Drama also participates in the Graduate Program in Humanities leading to a joint Ph.D. degree in Speech and Drama and Humanities. For a description of that program and fellowships offered in connection with it, see the section “Humanities Special Programs.”

**Teaching Credentials**

*The degree of Master of Arts in Teaching of Speech and Drama* is offered jointly by this Department and the School of Education. The degree is intended for candidates who have a teaching credential and who wish further to strengthen their academic preparation. The program consists of a minimum of 30 units in the teaching field and 12 units in the School of Education. Detailed requirements for the course are outlined in the School of Education section.

*Standard Teaching Credential (Secondary)*—Students wishing to obtain the Stanford General Secondary Credential should consult the Credential Secretary of the School of Education for the general requirements, and the teacher training adviser, Professor Helen Schrader, in the Department of Speech and Drama for Departmental requirements.

**Advanced Degrees**

Any student wishing to enter upon graduate work in the Department of Speech and Drama at Stanford University should apply to the Office of the Director of Admissions. Graduate students, when applying for admission, must furnish their scores on the Aptitude Test of the Graduate Records Examination. Applicants for the doctoral degree must also submit a sample of their best written scholarly work. All graduate students must be degree candidates.

For University regulations governing advanced degrees, see the section “Degrees” in this bulletin.

**Master of Fine Arts**

An intensive program in theater arts has been inaugurated for the exceptionally gifted student who wishes to train for a professional career in the fields of acting, directing, costume, lighting, stage design, and technical production. Artists-in-residence will serve as teachers in the training program in addition to the regular departmental faculty. The acting program is designed for two years; the curriculum for directors and designers is planned for three years. For students with a strong background in drama, the three-year curriculum could well be reduced to two years. Advanced standing would be based upon special examination.

In addition to regular University requirements for admission, all applicants for the acting and directing programs will be interviewed; design applicants must submit a portfolio of their work. While overall scholastic ability will be a factor in admission, primary emphasis will be placed on evidence of superior potential in theater arts.

The M.F.A. is designed as a terminal degree, but if a candidate successfully completes his work for the M.F.A. in Directing and demonstrates strong interest and ability in teaching and research, he will be urged to continue to the Ph.D. degree. 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.

**Costume Design Major**

Candidates for the M.F.A degree in Costume Design are required to complete 92 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>271A, 271B, 271C. Costume I</td>
<td>9</td>
</tr>
<tr>
<td>297, 298, 299. Theater History</td>
<td>9</td>
</tr>
<tr>
<td>170A, 170B, 170C. Visual Arts for the Theater</td>
<td>9</td>
</tr>
<tr>
<td>281A, 281B, 281C. Stage Design I</td>
<td>9</td>
</tr>
<tr>
<td>260. Crew</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>39</strong></td>
</tr>
</tbody>
</table>

**Second Year**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>272A, 272B, 272C. Costume II</td>
<td>9</td>
</tr>
<tr>
<td>291A. Directing I (one quarter)</td>
<td>3</td>
</tr>
<tr>
<td>251A, 251B, 251C. Lighting I</td>
<td>9</td>
</tr>
<tr>
<td>260. Crew</td>
<td>3</td>
</tr>
<tr>
<td>173A, 173B. Theatrical Makeup</td>
<td>2</td>
</tr>
<tr>
<td>Electives</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>
### Third Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>260. Crew</td>
<td>3</td>
</tr>
<tr>
<td>Electives (to include courses in Art and Architecture)</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21</td>
</tr>
</tbody>
</table>

### SCENE DESIGN MAJOR

Candidates for the M.F.A. degree in Scene Design are required to complete 93 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>281A, 281B, 281C. Scene Design I</td>
<td>9</td>
</tr>
<tr>
<td>297, 298, 299. Theater History</td>
<td>9</td>
</tr>
<tr>
<td>241A, 241B, 241C. Technical Production I</td>
<td>9</td>
</tr>
<tr>
<td>170A, 170B, 170C. Visual Art for the Theater</td>
<td>9</td>
</tr>
<tr>
<td>260. Crew</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>39</td>
</tr>
</tbody>
</table>

#### Second Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>282A, 282B, 282C. Scene Design II</td>
<td>9</td>
</tr>
<tr>
<td>271A, 271B, 271C. Costume I</td>
<td>9</td>
</tr>
<tr>
<td>291A. Directing I (one quarter)</td>
<td>3</td>
</tr>
<tr>
<td>251A, 251B, 251C. Lighting I</td>
<td>9</td>
</tr>
<tr>
<td>260. Crew</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>33</td>
</tr>
</tbody>
</table>

#### Third Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>283A, 283B, 283C. Scene Design III Thesis</td>
<td>6</td>
</tr>
<tr>
<td>260. Crew</td>
<td>3</td>
</tr>
<tr>
<td>Electives (to include courses in Art and Architecture)</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21</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>9</td>
</tr>
<tr>
<td>297, 298, 299. Theater History</td>
<td>9</td>
</tr>
<tr>
<td>170A, 170B, 170C. Visual Art for the Theater</td>
<td>9</td>
</tr>
<tr>
<td>241A, 241B, 241C. Technical Production I</td>
<td>9</td>
</tr>
<tr>
<td>260. Crew</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>39</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>9</td>
</tr>
<tr>
<td>242A, 242B, 242C. Technical Production II</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>33</td>
</tr>
</tbody>
</table>

### DIRECTING MAJOR

Candidates for the M.F.A. degree in Directing are required to complete 88 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>291A, 291B, 291C. Directing I</td>
<td>15</td>
</tr>
<tr>
<td>297, 298, 299. Theater History</td>
<td>9</td>
</tr>
<tr>
<td>261A. Acting I (one quarter)</td>
<td>3</td>
</tr>
<tr>
<td>173A, 173B. Theatrical Makeup</td>
<td>2</td>
</tr>
<tr>
<td>260. Crew</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>31</td>
</tr>
</tbody>
</table>

#### Second Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>271A, 271B. Costume I (two quarters)</td>
<td>6</td>
</tr>
<tr>
<td>244A, 244B. Survey of Lighting and Technical Production (winter and spring quarters)</td>
<td>6</td>
</tr>
<tr>
<td>281A, 281B. Scene Design I (two quarters)</td>
<td>6</td>
</tr>
<tr>
<td>292. Directing II (autumn quarter)</td>
<td>6</td>
</tr>
<tr>
<td>300-series. Dramatic Literature (two quarters autumn and winter)</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>38</td>
</tr>
</tbody>
</table>

#### Third Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>293A, 293B, 293C. Directing III Thesis</td>
<td>9</td>
</tr>
<tr>
<td>Production</td>
<td>9</td>
</tr>
<tr>
<td>Electives (3 courses of 3 or 4 units each)</td>
<td>1-6</td>
</tr>
<tr>
<td>308. Comprehensive Research</td>
<td>1-6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>19-27</td>
</tr>
</tbody>
</table>

(Note—If the "Directing" candidate is interested in going on to the Ph.D. degree, his electives should specifically be 360A,B,C, and 200, 201, and 306. If these courses are taken, he will need only 12 additional courses (or, normally, 3 quarters' work) to complete the remaining residence requirements for the Ph.D.)

### ACTING MAJOR

The candidate for the M.F.A. in Acting is required to complete 72 units of course work.
First Year

261A, 261B, 261C. Acting I 9
174A. Costume Design and Construction 3
260. Crew 1
263A, 263B, 263C. Voice 3
265A, 265B, 265C. Movement 3
291A. Directing I 6
264. Rehearsal and Performance 6
294A, 294B. Projects with M.F.A. Directors (winter and spring quarters) 2
173A, 173B. Theatrical Makeup (winter and spring quarters) 2
Electives (winter and spring quarters) may be chosen from courses outside of Speech and Drama 6

Total ......................................................... 42

Second Year

262A, 262B, 262C. Acting II 9
297, 298, 299. Theater History or Dramatic Literature 9
263A, 263B, 263C. Voice 3
265A, 265B, 265C. Movement 3
264. Rehearsal and Performance 6

Total ......................................................... 30

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. Examinations. Before scheduling his comprehensive examination, and normally before the second year of residence, the candidate must pass a written examination on theater arts. The examination is given annually in the fall. When course work is completed, the candidate takes written comprehensive examinations in his four fields of concentration (see below). Upon successful completion of all qualifying examinations, the candidate is admitted to a University oral examination based on his four fields.

4. Dissertation. Immediately preceding completion of his comprehensive examinations, the candidate will file formal application for candidacy as prescribed by the University. The dissertation must be completed and approved within 5 years from the quarter in which candidacy is granted. A candidate taking more than 5 years will be required to reinstate his candidacy by repassing comprehensive examinations on dramatic literature.

Specialization—During the first year of residence, the candidate, in consultation with his adviser, will select four fields of concentration. One of the four fields is designated as the candidate's major field of specialization so that much preparatory research and study for the dissertation will have been completed before completion of course work.

One field of concentration is to be chosen from each of the following groups:

1. Comparative drama in one literary period. (Examples: Medieval Drama, Renaissance Drama, European Drama in the Eighteenth Century, Modern Drama from 1870 to 1914, etc.)
2. One major playwright.
3. One national drama. (To be chosen from English, American, French, Italian, Spanish, German, Greek.)
4. One dramatic genre, or dramatic criticism. (Examples: Tragicomedy, Farce, Comedy of Manners, Melodrama, etc.)
Only two areas of study in a candidate’s program are permitted to overlap significantly. (Examples: French Drama and Molière; or Aeschylus and Tragedy.) At least one area of study must be before 1700.

**Fellowships**

The Department of Speech and Drama awards a number of fellowships to graduate students in both the M.F.A. and Ph.D. programs. These grants range in amounts from about $1,500 to $3,500. Completed application forms for 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.

Limited opportunities are also available for teaching assistantships, but they are usually awarded to the student who has completed a portion of his work in the program.

**Speech Correction, Hearing, and Speech Sciences**

For programs and courses in Speech Correction, Hearing, and the Speech Sciences, please refer to the Program in Speech and Hearing Sciences listed in the section “School of Medicine” in this bulletin.

**Summer Session**

A special brochure is available, with full details of courses given in the summer by the Department of Speech and Drama.

**Courses**

**General**

#30. Oral Interpretation—Basic course in understanding the organization of the logical and emotional content of literature with emphasis on its communication to the listener.

3 units, Aut, Win, Spr (Staff) MWF 10 and 11

**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.

**Public Speaking**—Includes preparation and presentation of original speeches, and analysis and written criticism of significant public addresses.

3 units, Aut, Win, Spr (Hastings, Mosier, Wragge) MWF 9, 10; MTW 10, 11, 2:15; TWTh 9, 10, 11, 1:15

80A, 80B, 80C. Debate, Forensics, and Symposium—The theory and practice of debate and forensic speaking. Students will have opportunities to participate in campus speaking events, intercollegiate debate and public presentations. May be repeated for credit.

80A. Debate.

2 units, Aut (Mosier) M 8-10 p.m.

80B. Debate and Forensics.

2 units, Win (Mosier) M 8-10 p.m.

80C. Symposium.

2 units, Spr (Mosier) M 8-10 p.m.

100. Independent Study.

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

120A. Exposition—Focuses on the individual as he experiences the process of communication in an interacting group.

3 units, Aut, Win (Schrader, Staff) MWF 11 or 1:15

120B. Argumentation — Reasoning processes and their use in analysis and persuasion.

3 units, Aut, Win, Spr (Hastings) MWF 10

120C. Discussion — Focuses on group phenomena which facilitate or inhibit free communication in the solving of problems in an interacting group.

3 units, Win, Spr (Schrader) MWF 10

121. Advanced Public Speaking—Preparation and delivery of platform speeches designed to modify audience behavior. Prerequisite: 20 or equivalent.

3 units, Spr (Mosier) MTW 2:15

130. Persuasion Theory — Philosophical, psychological, and rhetorical principles of persuasion.

4 units, Aut, Win (Hastings) MW 2:15–4:05

132. Group Communication — Decisions, conflict, and communication in small groups. Prerequisite: 120A or 120C.

4 units, Spr (Schrader) TTh 2:15–4:05
134. Language and Communication—Analysis of symbolic processes.
   4 units, Spr (Hastings) MW 2:15-4:05

140. Contemporary Issues—The role of American spokesmen in contemporary social controversies.
   4 units, Win (Wrage) TTh 2:15-4:05

Business and Professional Speaking—See Business 386, Graduate School of Business Bulletin.
   Aut, Spr (——)

THEATER AND DRAMA

Undergraduate

#60. Introduction to the Contemporary Theater—Survey of the arts of the theater; lectures and discussion of readings in contemporary drama. May not be offered in support of the major.
   3 units, Win (Prosser) MWF 9

#90. Development of Drama (Classical and Medieval)—Survey of masterpieces of Western drama from origins in Greece to the Renaissance.
   4 units, Aut (Prosser) MW 1:15-3:05

#91. Development of Drama (Renaissance and Baroque)—Survey of the art of drama from the Renaissance to Ibsen.
   4 units, Win (Reynolds) MW 1:15-3:05

160. Theater Practice—Credit for participation by undergraduates in productions in acting or stagecraft. May be repeated. Prerequisite: consent of instructor.
   160A. Acting.
      1 to 3 units, any quarter (Staff) by arrangement

   160B. Crew.
      1 to 3 units, any quarter (Staff) by arrangement

164. Fundamentals of Acting and Directing—Not open to freshmen. Sophomores with consent of instructor.
   164A. Principles of Acting—Actor's resources and methods, basic body movement. To be taken concurrently with 164L.
      3 units, Aut (——) WF 10–12

      3 units, Win (——) WF 10–12

164C. Directing—Techniques of analysis, blocking and composition. Acting projects.
      3 units, Spr (Reynolds) WF 10–12; lab. M 10–12

164L. Movement—To be taken concurrently with 164A,B,C.
      1 unit, Aut, Win, Spr (Langinieux) M 10–12

165A,B,C. Undergraduate Acting II—Prerequisites: 164A,B,C.
   165A. 3 units, Aut (——) TTh 2:15–4:05

   165B. 3 units, Win (——) TTh 2:15–4:05

   165C. 3 units, Spr (——) TTh 2:15–4:05

170A,B,C. Visual Art for the Theater—Survey of painting, sculpture, as it affects theater style.
   170A. 3 units, Aut (Russell) T 10–12 and Th 11

   170B. 3 units, Win (Russell) T 10–12 and Th 11

   170C. 3 units, Spr (Russell) T 10–12 and Th 11

173A,B. Theatrical Makeup—Laboratory course in the art of stage makeup. 173A required of all undergraduate drama majors; complete sequence required of all M.F.A. acting, directing and costume majors.
   173A. 1 unit, Win (Russell) M 11–1

   173B. 1 unit, Spr (Russell) M 11–1

174. Introduction to Design and Technical Production—Open to undergraduates and graduates with insufficient background in theater arts.
   174A. Costume Design and Construction.
      3 units, Aut (Hartman) TTh 9; lab. by arrangement

   174B. Stage Lighting Design and Practice.
      3 units, Win (Landry) TTh 9; lab. by arrangement

   174C. Scene Design and Construction.
      3 units, Spr (Hay) TTh 9; lab. by arrangement

190. Classical Modes of Acting—Open to seniors and graduates.
   3 units, Aut (Reynolds) TTh 10–12
191. Renaissance and Baroque Modes of Acting—Open to seniors and graduates. 3 units, Win (———) TTh 10-12
192. Romantic and Modern Modes of Acting—Open to seniors and graduates. 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 theater arts. 1 to 4 units, any quarter (Staff) by arrangement
195. Theater Criticism—Readings in contemporary techniques. Papers based on performances attended in the area. 3 units, Win (Prosser) TTh 1:15–2:30

GRADUATE COURSES FOR M.F.A.
Open by permission to unusually qualified undergraduate students
(Note—All courses are year-long and conducted as a combination of class and studio work. These courses are offered as a sequence autumn, winter, and spring.)

241A,B,C. Technical Production I—Introduction to technical production and scenicographic techniques.
241A. 3 units, Aut (Hunt) T 9, Th 9–11 and F 10–12
241B. 3 units, Win (Hunt) T 9, Th 9–11 and F 10–12
241C. 3 units, Spr (Hunt) T 9, Th 9–11 and F 10–12
242A. 3 units, Aut (Hunt) by arrangement
242B. 3 units, Win (Hunt) by arrangement
242C. 3 units, Spr (Hunt) by arrangement
243A,B,C. Theater Engineering—A study of the use of electrical and mechanical devices for theater equipment, theater planning, and facilitated theatrical production.
243A. 2 units, Aut (Landry) by arrangement
243B. 2 units, Win (Landry) by arrangement
243C. 2 units, Spr (Landry) by arrangement
244A,B. Survey of Lighting and Technical Production—Required of M.F.A. directing majors.
244A. 3 units, Win (Hunt) MW 9
244B. 3 units, Spr (Hunt) MW 9
245. Theater Management—Theater organization, production organization, box office procedures, publicity, and business procedures.
3 units, Aut (Burgess) by arrangement
246A. 2 units, Aut (Staff) by arrangement
246B. 2 units, Win (Staff) by arrangement
246C. 2 units, Spr (Staff) by arrangement
251A,B,C. Lighting I—Introduction to stage lighting.
251A. 3 units, Aut (Landry) MTh 12
251B. 3 units, Win (Landry) MTh 12
251C. 3 units, Spr (Landry) MTh 12
252A,B,C. Lighting II—Advanced stage lighting.
252A. 3 units, Aut (Landry) M 11 and Th 1
252B. 3 units, Win (Landry) M 11 and Th 1
252C. 3 units, Spr (Landry) M 11 and Th 1
253A. 2 units, Aut (Landry) by arrangement
253B. 2 units, Win (Landry) by arrangement
253C. 2 units, Spr (Landry) by arrangement
260. Crew—Credit for participation by graduate students in productions in acting or stagecraft. May be repeated.
1 unit, any quarter (Staff) by arrangement
261A,B,C. Acting I—Basic, special problems, and projects (contemporary). Open to seniors with consent of instructor.
261A. 3 units, Aut (———) T 10–12 and Th 11
261B. 3 units, Win (———) TTh 10–12
261C. 3 units, Spr (———) TTh 10–12
262A,B,C. Acting II—Projects in Classical, Shakespearean, Restoration, Nineteenth Century, modern acting.
262A. 3 units, Aut (Staff) TTh 10–12
262B. 3 units, Win (Staff) TTh 10–12
262C. 3 units, Spr (Staff) TTh 10–12
### Speech and Drama

<table>
<thead>
<tr>
<th>Course</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>263A,B,C. Voice.</td>
<td>1 unit, Aut (Draper) by arrangement</td>
</tr>
<tr>
<td>263A.</td>
<td>1 unit, Win (Draper) by arrangement</td>
</tr>
<tr>
<td>263C.</td>
<td>1 unit, Spr (Draper) by arrangement</td>
</tr>
<tr>
<td>264. Rehearsal and Performance—Participation in Stanford Repertory Theater company productions, Speech and Drama productions and projects.</td>
<td>2 units, any quarter (Staff) by arrangement</td>
</tr>
<tr>
<td>265A,B,C. Movement.</td>
<td>1 unit, Aut (Staff) MWTh 12</td>
</tr>
<tr>
<td>265B.</td>
<td>1 unit, Win (Staff) MWTh 12</td>
</tr>
<tr>
<td>265C.</td>
<td>1 unit, Spr (Staff) MWTh 12</td>
</tr>
<tr>
<td>271A,B,C. Costume I—Introduction to costume history, design and construction.</td>
<td>3 units, Aut (Russell) T 9 and Th 9-11</td>
</tr>
<tr>
<td>271B.</td>
<td>3 units, Win (Russell) T 9 and Th 9-11</td>
</tr>
<tr>
<td>271C.</td>
<td>3 units, Spr (Russell) T 9 and Th 9-11</td>
</tr>
<tr>
<td>272A,B,C. Costume II—Projects in costume design.</td>
<td>3 units, Aut (Russell) T 1:15</td>
</tr>
<tr>
<td>272B.</td>
<td>3 units, Win (Russell) T 1:15</td>
</tr>
<tr>
<td>272C.</td>
<td>3 units, Spr (Russell) T 1:15</td>
</tr>
<tr>
<td>273A,B,C. Costume III — Design research and thesis.</td>
<td>3 units, Aut (Russell) by arrangement</td>
</tr>
<tr>
<td>273B.</td>
<td>3 units, Win (Russell) by arrangement</td>
</tr>
<tr>
<td>273C.</td>
<td>3 units, Spr (Russell) by arrangement</td>
</tr>
<tr>
<td>281A,B,C. Scene Design I — Principles of design and practice.</td>
<td>3 units, Aut (Hay) M 10-12 and W 10</td>
</tr>
<tr>
<td>281B.</td>
<td>3 units, Win (Hay) M 10-12 and W 10</td>
</tr>
<tr>
<td>281C.</td>
<td>3 units, Spr (Hay) M 10-12 and W 10</td>
</tr>
<tr>
<td>282A,B,C. Scene Design II — Projects in design.</td>
<td>3 units, Aut (Hay) W 11-1</td>
</tr>
<tr>
<td>283A,B,C. Scene Design III — Design research and thesis.</td>
<td>3 units, Aut (Hay) M 10-12 and W 10</td>
</tr>
<tr>
<td>283B.</td>
<td>3 units, Win (Hay) M 10-12 and W 10</td>
</tr>
<tr>
<td>283C.</td>
<td>3 units, Spr (Hay) M 10-12 and W 10</td>
</tr>
<tr>
<td>291A,B,C. Directing I—Principles of directing.</td>
<td>3 units, Aut (Hay) by arrangement</td>
</tr>
<tr>
<td>291A.</td>
<td>3 units, Win (Hay) by arrangement</td>
</tr>
<tr>
<td>291B.</td>
<td>3 units, Spr (Hay) by arrangement</td>
</tr>
<tr>
<td>291C.</td>
<td>3 units, any quarter (Staff) by arrangement</td>
</tr>
<tr>
<td>292. Directing II—Preparation for production.</td>
<td>6 units, Aut (Staff) by arrangement</td>
</tr>
<tr>
<td>293A,B,C. Directing III — Thesis production.</td>
<td>3 units, Aut (Staff) by arrangement</td>
</tr>
<tr>
<td>293B.</td>
<td>3 units, Win (Staff) by arrangement</td>
</tr>
<tr>
<td>293C.</td>
<td>3 units, Spr (Staff) by arrangement</td>
</tr>
<tr>
<td>294A,B. Acting Projects with M.F.A. Directors.</td>
<td>3 units, Win (Staff) by arrangement (Directing I)</td>
</tr>
<tr>
<td>294B.</td>
<td>3 units, Spr (Staff) by arrangement (Directing II)</td>
</tr>
<tr>
<td>297. Theaters and Staging (Classical) — Theater buildings, theories of production, and staging methods.</td>
<td>3 units, Aut (Cole) MWF 9</td>
</tr>
<tr>
<td>298. Theaters and Staging (Baroque) — Theater buildings, theories of production, and staging methods.</td>
<td>3 units, Win (Cole) MWF 9</td>
</tr>
<tr>
<td>299. Theaters and Staging (Modern) — Theater buildings, theories of production, and staging methods.</td>
<td>3 units, Spr (Cole) MWF 9</td>
</tr>
</tbody>
</table>

### PH.D. Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>301. Seminar in Classical Drama (Greek and Roman).</td>
<td>3 to 4 units, Aut (——) MW 1:15-3:05 or 10-12, given 1970-71</td>
</tr>
<tr>
<td>302. Seminar in Medieval Drama.</td>
<td>3 to 4 units, Spr (Prosser) MW 1:15-3:05 or 10-12</td>
</tr>
</tbody>
</table>
303. Seminar in Renaissance Drama (1550–1640).
3 to 4 units, Aut (Reynolds) MW 1:15–3:05
or 10–12

304. Seminar in Baroque Drama (1660–1775).
3 to 4 units, Aut (——) MW 1:15–3:05
or 10–12

305. Seminar in Romantic Drama (1780–1880).
3 to 4 units, Win (——) MW 1:15–3:05
or 10–12, given 1970–71

306. Seminar in Modern Drama (1880 to present).
3 to 4 units, Spr (——) MW 1:15–3:05
or 10–12

3 to 4 units, Spr (Prosser) MW 1:15–3:05
or 10–12

308. Seminar in Comedy.
3 to 4 units, Win (——) MW 1:15–3:05
or 10–12, given 1970–71

309. Seminar in Early American Drama.
3 to 4 units, Win (Cole) MW 1:15–3:05
or 10–12

310. Seminar in Contemporary American Drama.
3 to 4 units, Spr (Cole) MW 1:15–3:05
or 10–12

311. Existentialism in Modern Drama.
3 to 4 units, Aut (Wirth) MW 1:15–3:05
or 10–12

312. European Documentary Drama.
3 to 4 units, Win (Wirth) MW 1:15–3:05
or 10–12

313. Theater of Absurd in West and East.
3 to 4 units, Spr (Wirth) MW 1:15–3:05
or 10–12

360A. Research Methods.
4 units, Aut (Prosser) TTh 2:15–4:05

360B. History of Dramatic Criticism.
4 units, Win (Reynolds) TTh 2:15–4:05

360C. Contemporary Critical Techniques.
4 units, Spr (——) TTh 2:15–4:05

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. Comprehensive Research (M.F.A.)
1 to 6 units, any quarter (Staff)
by arrangement

399. Core Seminar.
1 unit, any quarter (Staff) F 12–2

400. Dissertation Research.
Any quarter (Staff) by arrangement

STATISTICS
Emeritus: Quinn McNemar (Professor)
Chairman: Rupert G. Miller, Jr.


Professor of Biostatistics: Byron W. Brown, Jr.

Associate Professor: Bradley Efron

Assistant Professors: Richard Olshen, Paul Switzer, George G. Woodworth

OFFERINGS AND FACILITIES
The Department's purposes are to acquaint students with the role played in science and technology by probabilistic and statistical ideas and methods, to provide instruction in the theory and application of techniques that have been found to be commonly useful, and to train research workers in probability and statistics. There are courses for general students as well as for those who plan careers in statistics in government, business, industry, and teaching. General students with an interest in the principles of statistical inference and the theory of making decisions in the face of uncertainty should take Statistics 50. Statistics 110 covers the most important techniques used in the analysis of experimental data in engineering and science. Statistics 116 provides a general introduction to the theory of probability. The sequence 116, 119, 120 is a basic one-year course in mathematical statistics; the sequence 116, 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 50A.
3. Statistics 116, 119, 120 (or the Honors sections of these courses), and 4 additional courses chosen from offerings in the Statistics Department (24 units). Students can receive credit toward fulfilling this requirement for, at most, 1 of the following 3 courses: Statistics 7, 50, 110.
4. Four additional courses chosen from offerings in the Statistics Department or from authorized courses in other departments.

**MASTER OF SCIENCE**

In addition to the University's basic requirements for the Master's degree, the Department requires that the student take 45 units of work from offerings in the Statistics Department or from authorized courses in other departments. If advanced statistics courses are included in the program, the total number of units may be reduced.

Programs are ordinarily arranged to provide specialization in mathematical statistics, mathematics in behavioral science, industrial statistics, or data processing and operations research. Each student will normally fulfill the following requirements for the Master of Science degree:

1. Statistics 116, 217, 218, 219, 220 (or the Honors sections of these courses).
2. Mathematics 113; and Computer Science 136 or an additional course in Mathematics at the 100 level or above.
3. Three additional courses from offerings in the Statistics Department.
4. Additional units to complete the requirements chosen from offerings in the Statistics Department or from authorized courses in other departments.

Requirements "3" and "4" enable the student to specialize in mathematical statistics, mathematical models in behavioral science, industrial statistics, or data processing and operations research.

Students who are interested in mathematical statistics should concentrate on more advanced courses in the Department.

Students interested in mathematical models in behavioral sciences can take 206, 207, 208, and 209 offered within the Department, as well as authorized courses from other departments.

The program in industrial statistics is directed toward students with graduate training in engineering or science. Such students will usually take 110, 161, 218, 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 sta-
tistical theory. In addition, a Ph.D. candi-
date must offer six quarter courses from the
advanced courses offered in specialized
fields such as Decision Theory, Large Sam-
ple Theory, Multivariate Analysis, Non-para-
metric 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 mathe-
matical ingenuity; questions are in mathe-
matics, 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, ad-
ditional compensation is given.

Doctor of Philosophy Minor — The gen-
eral requirements for the minor in statistics
are a reasonable knowledge of the principal
branches of the theory of statistics and pro-
fessional competence in those branches of
statistical theory commonly applied in the
major. Ordinarily a student will be required
to take Statistics 116, 217, 218, 219, and 220.
In addition, five other courses will be chosen
from offerings in the Statistics Department
or from authorized courses in other depart-
ments. A written examination to establish
proficiency will be required and must be
taken before the University oral examina-
tion. This examination for the minor will be
given once in the spring quarter.

FELLOWSHIPS AND
ASSISTANTSHIPS

A variety of fellowships and assistant-
ships 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 com-
putation assistance to investigators. A small-
er 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 Informa-
tion Bulletin. Overseas applicants, who may
not receive the Information Bulletin promp-
tly, should write directly to the Educational
Testing Service, 20 Nassau Street, Prince-
ton, New Jersey 08540.

COURSES

7. Introduction to Statistics—(Same as Eco-
nomics 7 and Sociology 7.) Especially de-
signed for students in economics, sociology,
and other social sciences.
5 units, Aut (Anderson) MTWThF 3:15

27. Introduction to Probability Theory—
Basic probability theory (combinatorial
problems). Independence and dependence.
Random variables and probability laws. The
binomial, normal, Poisson laws. Expectation.
Law of large numbers and Central Limit
Theorem. Conditional probability and ex-
pectation. Prerequisite: Mathematics 23 or
43.
3 units, Aut (—) MWF 2:15
Spr (—) MWF 2:15

#50. Elementary Statistics — An introduc-
tion to statistics for the general student, with
emphasis on concepts of decision making in
the face of uncertainty.
5 units, Aut (—) MTWThF 9
Spr (Moses) MTWThF 2:15
4 units, Sum (—) MTWThF 10

50H. Elementary Statistics — Honors ver-
sion of 50. No prerequisite, but the subject
matter will be covered in greater depth and
strong preparation in high school mathe-
matics is desirable. Limited enrollment.
5 units, Win (—) MTWThF 9

104. Sampling from Human Populations
(Elementary) — Theory of sampling from
finite populations; efficiency of various sur-
vey designs; application. Prerequisite: ele-
mentary course in statistics.
3 units, given 1970–71

107. Introduction to Statistics—For gradu-
ate students. Lectures same as Statistics 7.
4 units, Aut (Anderson) MTWThF 3:15

110. Statistical Methods in Engineering and
the Physical Sciences — Use of statistical
methods in research, production. Measure-
ment errors, comparison of two or more
means, curve fitting, correlation, design of engineering experiments. Prerequisite: calculus.

4 units, Aut (——) TTh 10 and MW 4:15
Win (——) MTWF 9
Spr (——) MTWF 10
Sum (——) MTWTThF 9

116. Theory of Probability — This course covers the material of 27 in more detail and with more emphasis on mathematical technique. Students are expected to have a good working knowledge of calculus, including infinite series and double integrals. The course is designed to provide an adequate background for all courses whose prerequisite is probability theory. Prerequisite: Mathematics 44 or equivalent.

4 units, Aut (——) MTWF 11
Win (——) MTWF 11
Spr (Miller) MTWF 9
Sum (——) MTWTThF 11

116E. Theory of Probability—A course similar to 116 for engineering students. Prerequisite: Mathematics 45.

3 units, Aut (Olshen) MWF 2:15


4 units, Aut (Johns) MTWF 10

119. Elementary Statistical Inference—Review of probability; distribution theory; sampling, sampling distributions; univariate, bivariate normal distribution; correlation, regression. Prerequisite: 27 or 116.

4 units, Win (Olkin) MWF 9

119H. Elementary Statistical Inference—Honors version of 119. Prerequisites: grade of A in 116 or B in 116H; Mathematics 45.

4 units, Win (——) MWF 11

120. Statistical Inference — Point estimation; interval estimation; tests of hypothesis; linear hypothesis; distribution free methods; sequential analysis. Prerequisite: 119.

4 units, Spr (Olkin) MWF 9

120H. Statistical Inference — Honors version of 120.

4 units, Spr (——) MWF 11

136. Introduction to the Theory of Games — Two person-zero sum games; strategy; minimax solutions; infinite games. Prerequisite: 27 or equivalent.

3 units, Aut (Johns) MWF 2:15

150. Elementary Statistics — For graduate students. Lectures same as 50.

4 units, Aut (——) MTWTThF 9
Spr (Moses) MTWTThF 2:15
3 units, Sum (——) MTWTThF

150H. Elementary Statistics—For graduate students. Lectures same as 50H.

4 units, Win (——)


3 units, Win (Veinott) MW 4:15–5:30


3 units, Spr (Iglehart) TTh 4:15–5:30

161, 162. Theory and Application of Statistics (Non-Mathematical) — This course is intended for the student who has had a single elementary statistics course. Tests of significance and estimation, with emphasis on the application and rationale of the most common methods. Chi-square, least squares, regression, correlation, non-parametric methods, analysis of variance, elementary design of experiments. Prerequisites: 7, 50, or 110, or Psychology 60 within the past 12 months, or consent of the instructor.

161. 3 units, Win (Switzer) MWF 11
162. 3 units, Spr (Switzer) MWF 11

199. Independent Study—For undergraduates.

(Staff)
204. Sampling from Human Populations—
Theory of simple and complex sample survey designs. Limiting distributions. Estimate theory for finite populations. The sampling of experiments. Prerequisites: completion of or concurrent registration in 120.

3 units, Spr (Madow) MWF 11

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 1970–71

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 1970–71

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, Aut (Solomon) MWF 11


3 units, Spr (Solomon) MWF 1:15

216. Statistical Techniques for Industrial Problems—Review of principles of lot-by-lot acceptance inspection; variables inspection; recent results in use of economic costs and Bayesian statistical methods; general principles of sequential sampling plans; sampling plans for continuous production; life testing. Prerequisite: 120 or equivalent.

3 units, Aut (Woodworth) MWF 1:15

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

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 (Johns) MWF 3:15
218H. 3 units, Spr (Johns) MWF 3:15

219. Elementary Statistical Inference—For graduate students. Lectures same as 119.

3 units, Win (Olkin) MWF 9


3 units, Win (——) MWF 11

220. Statistical Inference — For graduate students. Lectures same as 120.

3 units, Spr (Olkin) MWF 9

220H. Statistical Inference — Honors version of 220.

3 units, Spr (——) MWF 11

221. Analysis of Variance—Theory of general linear hypotheses; important special cases of analysis of variance; case of unequal class frequencies. Prerequisite: 120 and some knowledge of matrix algebra, or consent of the instructor.

3 units, Win (Woodworth) 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 (Woodworth) MWF 11

230A,B,C. Advanced Probability — Mathematical foundations, beginning with development of Lebesgue measure and integration. Fundamental concepts of probability, limit laws, laws of large numbers, convergence theorems, infinitely divisible distributions, conditional expectations, martingales. Prerequisite: Mathematics 116 or equivalent.

230A. 3 units, Aut (Olshen) MWF 1:15
230B. 3 units, Win (Olshen) MWF 1:15
230C. 3 units, Spr (Olshen) 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 hypothesis, confidence inter-
vals, 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.

236A. 3 units, Aut (Stein) MWF 2:15
236B. 3 units, Win (Stein) MWF 2:15
236C. 3 units, Spr (Stein) MWF 2:15

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.

242A. 3 units, given 1970-71
242B. 3 units, given 1970-71

249. Dynamic Optimization (Stochastic)—(Enroll in Operations Research 349.) Optimal prediction and filtering theory of linear systems; realization of theory of random processes, nonlinear prediction, plus some recent research results. Prerequisites: Operations Research 347A,B or equivalent, or consent of instructor.

3 units, Aut (Kalman)


3 units, Win (——) TTh 4:15-5:30


3 units, Spr (——) MW 4:15-5:30

252. Operations Research—(Enroll in Operations Research 252.) For graduate students who have not had the equivalent of Operations Research 152 and 153. Prerequisites: Calculus and Statistics 27, or 110, or 116.

4 units, Aut (——) MW 3:15-5:05
Win (——) MW 4:15-6:05

255. Linear Programming—(Enroll in Operations Research 240.) This course will survey linear programming, emphasizing standard model formulation, fundamental theorems, variations of the simplex method and parametric programming. Students will solve a linear programming problem on computer. Corequisite: Mathematics 113.

3 units, Aut (Manne) TTh 1:15-2:45


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 second-year graduate students in Statistics.

260A. 2 to 5 units, Aut (Brown, Efron) Th 1:15-3:05 and by arrangement
260B. 2 to 5 units, Win (Brown, Efron) Th 1:15-3:05 and by arrangement
260C. 2 to 5 units, Spr (Brown, Efron) Th 1:15-3:05 and 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).

310. Bayesian Statistics—Subjective probability and its application to statistics, Bayes estimates and their asymptotic properties, Lindley's paradox, credible and incredible interval estimation. Prerequisite: 290B.

3 units, given 1970-71
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, Win (Anderson) MWF 3:15
324B. 3 units, Spr (Anderson) MWF 3:15

326A. Sequential Analysis — The Wald sequential probability ratio test, operating characteristics and applications; Bayes sequential decision problems; asymptotic shapes; sequential design of experiments; special topics. Prerequisites: 217 and 220.

3 units, Win (——) MWF 11

326B. Sequential Analysis—General theory of optimal stopping with applications to sequential statistical decision problems.

3 units, Spr (——) MWF 11

328A,B,C. 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, Aut (Efron) MWF 2:15
328B. 3 units, Win (Efron) MWF 2:15
328C. 3 units, Spr (Woodworth) MWF 2:15


332A. 3 units, given 1970-71
332B. 3 units, given 1970-71

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, Aut (Stein) MWF 9
336B. 3 units, Win (Stein) MWF 9

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 1970–71
343B. 3 units, given 1970–71

345. Special Topics in Time Series Analysis —Discussion of current theoretical and empirical research on time series analysis.

3 units, given 1970–71

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, Aut (Solomon) TTh 10
351B. 3 units, Win (Solomon) TTh 10

361. Classification and Pattern Recognition —An examination and comparison of procedures which use random data to define classes, to discriminate between classes, to assign individuals to classes, and to estimate error rates in assignment. Source material will be drawn from the current literature in mathematical statistics, and will include parametric and non-parametric approaches. Prerequisite: 236. Recommended: 324 and 328.

3 units, Spr (Switzer) MWF 3:15

384. Special Topics in Multivariate Analysis: Matrix Analysis and Inequalities—Consideration will be given to those topics in matrix theory and inequalities which are generally omitted from courses in matrix theory. Applications in statistics will be stressed. Prerequisites: Mathematics 113 and 114. Recommended: 220.

3 units, Aut (Olkin) MWF 3:15–4:30

399. Research —Research work as distinguished from independent study of nonresearch character listed in 199 and 299.

Any quarter (Staff) by arrangement
Dean: Bayless Manning

Professors: Marc A. Franklin, John Henry Merryman, Carl Bernhardt Spaeth

Associate Professor: Richard A. Posner

Lecturer: George Torzsay-Biber

The Work of the Law School

The School of Law was established as a department of the University in 1893. Its purpose is to provide a thorough legal education for students who are fitted by their maturity and their previous academic training to pursue professional study under university methods of instruction. The curriculum leading to the first degree in law (LL.B.) constitutes an adequate preparation for the practice of law in any English-speaking jurisdiction. Graduate work leading to the degrees of Master of Laws and Doctor of the Science of Law is also offered. (For full Law School Curriculum and Faculty see the School of Law Bulletin.) The Law School is on a two-term academic calendar. Registration for the Autumn Term will be held on September 3, 1969, and classes for Spring Term will terminate on June 10, 1970.

Courses

Graduate

The following courses are open to qualified graduate students of other departments of the University upon permission of the instructor:

233. 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)

283. Roman Law—Study of Roman law as it has developed from the time of Augustus to that of Justinian. Although the private law will be studied in its entirety, emphasis will be on those parts which are still operative in modern civil law systems and in international law. Legal institutions will be studied through actual problems drawn mainly from Justinian’s Digest and their solutions will be discussed in historical context. The main purpose of the course is to identify and study the fundamental principles of Roman law and, in addition, to provide a background for further study in jurisprudence, legal history, and comparative law. Roman text will be provided in English translation. Some knowledge of Latin is desirable but not required. A paper will be required.

3 term units, Spr (Torzsay-Biber)

333. Selected Problems in International Law and Organizations—Case studies will be selected from among the following: problems faced by the Organization of American States and the United Nations in Guatemala, the Dominican Republic, and Cuba; the United Nations and the Congo; the cluster of related questions presented by South Africa, South West Africa, and Rhodesia; the United Nations, SEATO, and Vietnam. Attention will be focused on the international aspects of civil strife.

3 term units, Aut (Spaeth)

360. Telecommunications, Emerging Public Policy, Issues—This course will attempt an interdisciplinary approach to problem areas in the rapidly changing telecommunications industry. Areas will include the structure of the U.S. international communications industry; introducing satellites into domestic U.S. communications; the future of Comsat and of Intelsat (the international telecommunications satellite consortium); the conservation of the electromagnetic spectrum; competition, regulation and vertical integration in domestic common-carrier markets; computers and communications; and the quest for greater diversity in broadcasting through public, pay and cable television. Enrollment is open to law students and to graduate students in business, economics, and engineering-economic systems.

3 term units, Spr (Posner)

Nonprofessional

The following nonprofessional course, open to juniors and seniors, as well as to graduate students in other departments,
may be counted toward the A.B. degree but not toward professional degrees in law.

104. 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) MTWThF 9
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 biology. 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.

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


Acting Instructor: Katharine Robertson. Clinical: Donna J. Jensen

OFFERINGS AND FACILITIES

A two-year Master's degree program is offered for students entering the field of physical therapy. Candidates are prepared for practice and for the examination for registration in California and other states. The program is designed for students who are interested in a future career in administration or in academic or clinical teaching in the field.

Classes are held at the Stanford Medical Center, which houses physical therapy, lecture, laboratory, seminar and research rooms, and a library.

Following initial directed clinical experience in the Medical Center during the first year of the program, students are assigned 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; 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 Stanford Information Bulletin lists the long-term loan policies of the University and the details of the National Defense Student Loan Program.

Further information about traineeships and scholarships may be obtained from the Division of Physical Therapy on request.

PREREQUISITES AND OTHER COURSES

Basic prerequisites are courses in biology, chemistry, mathematics, human anatomy, human physiology and psychology. Physics and statistics are recommended. Each student's academic background will be reviewed on an individual basis for admission.

As a part of the physical therapy program, students will be enrolled in courses in anatomy, physiology, and neurological sciences that are offered by the respective departments in the Medical School. Electives related to the field of health may be selected.

COURSES

100. Introduction to Physical Therapy — General survey of history of field, common physical disabilities, and current therapeutic procedures; observation of treatment. For undergraduate students interested in a future career in the field.

2 units, Aut (Daniels) T 3:15-5:05

220. Human Motion and Therapeutic Procedures I — Functional anatomy; biome-
chanics and neuroanatomy related to body motion; organization and development of movement; analysis and practice of related therapeutic exercise procedures; tests and measurements.

5 units, Aut (Staff) MWF 10-12 and open labs. by arrangement

221. Human Motion and Therapeutic Procedures II—Continuation of 220.
5 units, Win (Staff) MWF 10-12 and open labs. by arrangement

222. Human Motion and Therapeutic Procedures III—Continuation of 221.
5 units, Spr (Staff) MWF 10-12 and open labs. by arrangement

230. Physical Agents I — Analysis of the principles underlying the use of electromyography, electrotherapy, massage, and hydrotherapy; practice of essential techniques.
3 units, Aut (Staff) TTh 10-12 and open labs. by arrangement

231. Physical Agents II — Continuation of 230.
3 units, Win (Staff) lec. TTh 10-12 and open labs. by arrangement

240. Clinical Medicine I — Basic medical lectures in pathology, medicine, surgery, and specialty areas; discussion of problems in patient care.
3 units, Aut (Special Lecturers) W 9 and Th 1:15-3:05

241. Clinical Medicine II—Continuation of 240.
3 units, Win (Broune, Special Lecturers) M 9 and Th 1:15-3:05

2 or 3 units, Spr (Special Lecturers) Th 1:15-3:05

250. Social and Psychological Aspects of Illness and Disability — Special problems of handicapped individuals related to reactions to illness and disability, patient-therapist relationships; emphasis on total rehabilitation of the patient.
2 to 3 units, Spr (Special Lecturers) by arrangement

255. Directed Clinical Experience in Physical Therapy — Students are assigned part-time to health care facilities.
1 to 5 units, any quarter (Blood, Kent) by arrangement

256. Internship in Physical Therapy—Students are assigned to treatment facilities for full-time supervised clinical experience.
4 to 12 units, any quarter (Blood, Kent, Staff) by arrangement

257. Case Studies and Directed Reading.
2 to 4 units, any quarter, by arrangement

260. Introduction to Administration — Administration of physical therapy facilities in hospitals, special centers, and in home care.
3 units, Win (Daniels, Staff) MWF 10

261. Seminar in Administration — Program planning; supervising and consulting techniques; interprofessional and interdepartmental relationships; field work and projects.
3 units, Spr (Daniels, Staff) MWF 2:15-3:05

270. Seminar in Therapeutic Procedures and Community Health—Individual patient evaluation and program planning; use of community resources.
3 units, Win (Staff) MTTh 9

275. Analysis of Clinical Testing — Presentation, discussion of principles and techniques of testing procedures; newer developments in the field and in related clinical areas.
2 to 4 units, Spr (Staff) MWF 1:15-3:05

280. Curriculum Development and Instruction — Objectives, organization, content, techniques in teaching courses in physical therapy; projects in selected areas of the field.
5 units, Win (Daniels) MTWThF 11

1 to 5 units, any quarter (Staff)

1 to 8 units, any quarter (Staff) by arrangement

290. Seminar in Research and Thesis Problems—Basic principles of research with emphasis on material applied to physical therapy.
3 to 5 units, Win, Spr (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, Henry J. Ralston III, Doris B. Wilson

Instructor: Maureen B. Sass

Clinical Lecturers: Dean T. Clark, Burt L. Davis, Jr., Mitchell S. Madison, Robert W. Meyer, Reuben Stutch, Bernerd O. A. Thomas

PROGRAMS OF STUDY

Instruction in the Department of Anatomy is planned primarily to meet the needs of students in medicine, but, insofar as facilities permit, all of the courses are open to other properly qualified third- and fourth-year undergraduate and graduate students. Those who are not registered in medicine but wish to take work in the Department should make arrangements in advance with the instructors concerned.

Facilities are available for a limited number of doctors of medicine, or others with equivalent training, who may wish to do special dissections or pursue work on problems within the scope of the Department. Graduate study may be undertaken in such aspects of anatomy as are indicated by the courses listed. Programs combining work in anatomy and other fields of biology or medicine may be arranged.

ADVANCED DEGREES

Students desiring to become candidates for advanced degrees in anatomy should consult the general University regulations regarding such degrees, which are summarized in the section "Degrees" in this bulletin. Candidates for the degree of Doctor of Philosophy will be expected to have done the equivalent of at least the basic work offered in the Department. All programs leading to an advanced degree in anatomy must be worked out individually and approved by the Department faculty. It is expected that an average grade of B will be maintained. Approval must also be obtained by graduate students in other departments who wish to elect anatomy as a minor.

COURSES

200. Embryology—Lectures on normal and abnormal human development. For medical, graduate, and senior undergraduate students. Prerequisite: consent of instructor.

   2 units, Aut (Wilson) M 2:15-3:05 and Th 1:15-2:05

201. Dissection of the Human Body—Demonstrations and lectures. A few nonmedical students may be admitted by special arrangement.

   5 units, Aut (Gray, Sass) TW 2:15-5:05 and F 1:15-5:05


   4 units, Win (Gray, Sass, Turner) M 1:15-5:05 and Th 8:00-11:50

203. Histology—Structural and functional organization of cells, tissues, and organs, as seen with the light and electron microscopes.

   3 units, Aut (Christensen, Kirkman) M 3:15-4:05 and Th 2:15-5:05

204. Histology—Continuation of 203.

   3 units, Win (Christensen, Kirkman, Campbell) T 2:15-3:05 and F 2:15-5:05

205. Cell Biology—Lectures on the cell as an integrated biochemical system in which organelles serve as the basic units of organization. The main emphasis is on the structure and function of these organelles, and how their activities are integrated in the cell. Faculty members from other departments, as well as guest lecturers from outside the University, will participate.

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

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 and 202.

   2-5 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

209. Neuroanatomy—Study of the functional anatomy of the central nervous system of man through prepared slides and the dissection of central systems of man and other mammals. Enrollment of nonmedical students by consent of instructor. Prerequisite: histology.

4 units, Aut (Turner, Ralston, Stilwell) MTTh 1:15-3:05

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

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 (Campbell) TWThF 1:15-4:05

270. Experimental Neuroanatomy—A seminar and laboratory course designed to introduce to advanced students selected research areas in neuroanatomy, emphasizing Golgi and Nauta methods and electron microscopy used for the study and interpretation of histological materials. Two lecture and four laboratory hours weekly. Limited to ten students. Enrollment by consent of instructor.

4 units, Spr (Chow, Ralston, Staff) by arrangement, alternate years, given 1969–70

299. Research—By individual arrangement, approved by Department faculty.

Any quarter (Staff) by arrangement


3 units, Aut (Stilwell, Staff) WF 9:00-11:50

3 units, Win (Stilwell, Staff) TTh 1:15-4:05

3 units, Spr (Stilwell, Staff) TTh 1:15-4:05

BIOCHEMISTRY

Acting Chairman: Paul Berg


Associate Professor: George R. Stark

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. G. R. Stark. A strong undergraduate background in chemistry (both physical and organic) is recom-
mended. 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. Biochemistry Lectures — These deal with basic biochemistry, and with special biochemical aspects of the various life processes. Open to medical, graduate, and advanced undergraduate students.

200. 4 units, Aut (Staff) MTWTh 11
201. 4 units, Win (Staff) MTWF 11

202. Biochemistry Laboratory — Open to medical, graduate, and advanced undergraduate students.

4 units, Win (Staff) MW 1:00-4:50 and T 1:00-3:50

203. Mechanisms of Biochemical Reactions — Detailed examination of a few selected topics; examples will be taken from processes such as enzyme-catalyzed hydrolyses and group transfer reactions, participation of coenzymes in enzymatic reactions, modification of enzyme structure and activity. Prerequisite: three quarters of organic chemistry; 101, 102 also recommended. Consent of the instructor required both for auditors and students enrolling for credit.

2 units, Spr (Stark) WTh 10


2 units, Aut (Kaiser) given 1969–70

212. Special Topics in Biochemistry.

2 units (Lehman) given 1971–72

213. The Arrangement of Information in Chromosomes.

2 units (Hogness) given 1970–71


3 units (Baldwin) given 1971–72


2 units, Spr (Berg) given 1969–70, by arrangement

216. Special Topics in Neurobiology — (Same as Genetics 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 1970–71

220. Membrane Biochemistry.

2 units (Kornberg) given 1970–71

270. Seminar.

By arrangement

299. Research and Special Advanced Work.

By arrangement

**GENETICS**

Chairman: Joshua Lederberg*


Assistant 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; pro-
gress of study and research training leading
to a Ph.D. in Genetics; research training for
medical students in the Medical Scientist
Training Program; and research training to
holders of the Ph.D. or M.D. The Depart-
ment also participates in an interdepartmen-
tal program leading to a Ph.D. in Neuro-
logical Sciences.

The Department of Genetics is interested
in applicants for the Ph.D. degree who have
an interest in fundamental aspects of biolo-
gy. It welcomes applicants with a back-
ground in biology, biochemistry and also
chemistry, physics and mathematics or com-
cutation. The Department administers a
Ph.D. program of unusual flexibility which
makes special provision to support training
in biology for students whose main back-
ground 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 pa-
thology of intellectual development. These
facilities offer unusual opportunities for re-
search and study in the fields of molecular
biology, heredity, neurobiology, and devel-
opmental medicine. The program of the
Laboratories together with courses in the
various neurological sciences divisions of the
Medical School and in the Biology Depart-
ment cover the requirements of the Ph.D.
degree in Neurological Sciences.

An Instrumentation Research Laboratory,
founded with NASA support for basic re-
search in exobiology, also offers special re-
search opportunities in collaboration with
other faculty involving advanced instrumen-
tation, 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, genetic-
s of antibody formation, immunogenetics
and somatic cell genetics, the genetic con-
trol of human leukocyte antigens, biochemical
neurogenesis, the investigation of extra-
terrestrial life, application of new physical
methods to biochemical analysis, genetic
demography, and population genetics.

Financial support for predoctoral and
postdoctoral trainees is available including
full tuition and personal stipend at current
national levels. Support opportunities exist
through appointments as part-time research
assistants. However, applicants are also
strongly encouraged to apply independently
for National Institutes of Health, National
Science Foundation, or other fellowships.
Predoctoral applicants are encouraged to
take the Graduate Record Examination in
Biology, Chemistry, or Physics. Further in-
quiries should be directed to the Graduate
Student adviser (predoctoral applicants) or
the appropriate faculty member (postdoc-
toral applicants).

For further information on the availability
of the following courses, consult the quar-
terly Time Schedule, or inquire at the De-
partment Office. Additional courses in ge-
genetics are included in the listing of the De-
partment 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 dis-
cussed include eugenics, euphenics (control
of development), mechanistic foundations of
behavior, transplanted and artificial organs,
duration of life, symbiosis of men and ma-
chines. The course emphasizes the confron-
tation of new science with social policy.

2 units, Aut (Lederberg, Staff) TTh 11-12

201. Medical Genetics—Genetics of human
populations, genetic analysis of human vari-
ability, pedigree analysis, applications to
genetic diseases and some of the more im-
portant genetic polymorphisms. Nonmedical
students who wish to enroll in this course
must obtain special consent from the Depart-
ment of Genetics.

2 units, Win (Bodmer, Staff) TF 1:15-2:05

210. Human Population Genetics — Prin-
ciples and methods of population genetics
as applied to human populations. Topics
covered will include estimation of mutation
rates, loads, maintenance of balanced poly-
morphisms, population structure and the
effects of genetic drift, genetic demography,
transplantation genetics, etc. Emphasis will
be on the comparison of theory with obser-
vation, rather than on the mathematical aspects of population genetics. However, a background of mathematics at least up to elementary calculus will be assumed. The course will be basically an extension of Genetics 201. Prerequisite: 201, elementary population genetics, basic genetics, elementary calculus.

2 units, Aut (Bodmer) W 4:15–6:05 alternate years, given 1970–71

211. Mathematical Genetics — (Same as Mathematics 279A.) Mathematical models in population genetics, ecology, population growth, and epidemiology. The first part of the course deals mainly with deterministic models in population genetics. Prerequisite: at least one year of calculus, and consent of instructors.

3 units, Spr (Bodmer, Karlin) by arrangement, alternate years, given 1969–70

213. Antibodies and Molecular Immunology—An advanced seminar and lecture course concerned with the structure and genetics of immunoglobulins, cellular and molecular events in antibody synthesis, theories of antibody formation, and genetics of the immune response. Students will be expected to participate in the seminars and to do extensive reading. Prerequisites: a knowledge of biochemistry, elementary immunology and genetics. Limited to 15 students.

3 units, Spr (Herzenberg, McDevitt)

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 1970–71

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)

249. Cytogenetics—(Same as Biological Science 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, Aut, Win (Herzenberg, Weissman)

299. Individual Research.

Any quarter (Staff) by arrangement

371. Human Biochemical Genetics—(Same as Medicine 371.) Examples of gene-environment interactions underlying the clinical manifestations of inherited diseases will be explored. Starting with those model systems, e.g., hemoglobin, wherein specific alterations of protein structure are well characterized and can be correlated with the final disease pattern of the patient, the course will consider a variety of genetic diseases, those which are rare and well characterized as well as those which are common though less well understood. Students will be expected to participate actively in seminar presentations. Limited to 14 students. Prerequisites: a knowledge of the principles of biochemistry and genetics.

2 units, Spr (Shooter, Rowley, Schneiderman) W 1:15–3:05
**Associate Professors:** Robert J. Roantree, Leon T. Rosenberg. **Clinical:** Orland A. Soave

**Assistant Professors:** Alfred A. Amkraut, Bernard W. Nelson

**Instructor:** Rodolfo W. Ferraresi

**PROGRAMS OF STUDY**

The Department of Medical Microbiology offers, in addition to the courses required of students of medicine, a group of courses for students who wish to specialize in various aspects of medical microbiology. An undergraduate program leading to the degree of Bachelor of Arts in Medical Microbiology is offered to seniors who have completed all of the essential premedical sciences (Biological Sciences, 15 quarter units; Chemistry, 24 quarter units; Physics, 12 quarter units), as well as Quantitative Analysis (Chemistry 110, 111). The following courses in the Department are normally covered during the senior year: Medical Microbiology 101, 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. Candidates for the degree of Master of Arts will be expected to have completed the premedical requirements (see above) and Quantitative Analysis (Chemistry 111, 112), and to complete the following courses: Medical Microbiology 101, 202, 204, 205, 206, 207, 270; in addition, Biochemistry 200 and 201 are required. At least 15 units of research bearing on the thesis subject must be completed. A grade average of B in Departmental courses completed will become ineligible for more advanced courses.

**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); and general pathology (Pathology 200). The choice among these (or other) formal courses should be discussed with an adviser.

A grade average of B in Departmental and related subjects is required for admission to research work. The student is expected to pass an oral examination covering the general fields of the Department’s offerings toward the end of his first year of graduate work. Students entering the Department with advanced standing in microbiology from other institutions are expected to take the final examination in Medical Microbiology 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. 5 units, Aut (Hayflick, Staff) MWF 1:15; lab. MWF 2:15–4:05

200. Basic Medical Microbiology—An introduction to the principles of immunology, primarily for first-year medical students. 2 units, Aut (Staff) WTh 10
201. Diseases and Care of Laboratory Animals — Lectures and demonstrations on the methods of restraint, anesthesia, and venipuncture used on the common species of laboratory animals. Emphasis will be placed upon the spontaneous diseases of laboratory animals and their influence upon research projects. Open to students of the School of Medicine and to graduate students in the biological sciences.

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

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 and serology, of practical laboratory diagnosis, and of preventive measures. Prerequisites: required premedical sciences and 200 or 205.

4 units, Win (Staff) TTh 9-11 and F 11-12

204. Topics in Bacterial Genetics—Lectures and demonstrations on inheritance in bacteria and their viruses, with emphasis on aspects relevant to infectious disease. Prerequisite: 101 (or equivalent). Consent of the instructor required for both auditors and students enrolling for credit.

3 units, Win (Stocker) MWF 1:15 alternate years, given 1969-70

205. Immunology and Serology—Lectures and demonstrations covering infection, immunity, antigen-antibody reactions. Prerequisites: 101 or 202, Biology 103 or Anatomy 203, and Biochemistry 200.

3 units, Win (Amkraut, Ferraresi, 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

207. Virology Laboratory.

2 units, Spr (Schwerdt) by arrangement

208. Advanced and Special Work—Graduate students and selected undergraduate students who have completed necessary basic courses with satisfactory grade average may be admitted by instructor to advanced work on an informal basis in: general bacteriology, including genetics; medical microbiology; immunology and serology; or virology. 10 units maximum, any quarter (Staff) 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—An intensive review of the current literature in one or a few selected areas of interest chosen from among the following: specificity, immunogenicity, genetic variants of serum proteins, tissue specific antigens. Prerequisite: 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.

10 units maximum, any quarter (Staff) by arrangement

PATHOLOGY

Emeritus: Bruno Gerstl (Professor)
Chairman: David Korn

Professors: Klaus G. Bensch, David Clict, David Korn, Lellass J. Rather (on leave autumn, winter quarters), Lucien J. Rubinstein

Associate Professors: Ronald F. Dorfman, Richard L. Kempson, Paul L. Wolf

Assistant Professors: George W. H. Bailey (on leave), Luis J. Fajardo, Lysia F. Forn, Mary M. Herman, Jon C. Kosek, Howard Sussman, Irving Weissman. Visiting: Klaus Lewin, Malcolm Mitchinson, Simon Tomassini

Instructor: Errol C. Friedberg (on leave).

Acting: John E. Lund. Director of Electron Microscopy: Glen B. Haydon
Program of Study

The teaching of the Department is limited largely to the instruction of medical students, and is outlined in the School of Medicine Bulletin. The course listed below is open to nonmedical students.

Course

210. Histo- and Cytochemical Techniques — Diverse experimental techniques employed in histo- and cytochemical investigation will be considered with particular emphasis on quantitative aspects. Principles, methods, areas of application, and limitations will be included.

1 unit, Win (Click) M 12:15

Pharmacology

Emeritus: Leon Kolb (Clinical Associate Professor)
Chairman: Avram Goldstein
Associate Professor: Lewis Aronow
Assistant Professors: Tatiana A. Assaykeen, William B. Pratt

Programs of Study

The Department of Pharmacology presents a series of basic courses in contemporary pharmacology (Pharmacology 201, 202, 203) which are offered to medical students and are also open to qualified graduate students. In addition, advanced courses are available to qualified graduate and medical students. A program of study and research training is offered which leads to a Ph.D. in Pharmacology. 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 (summer only). 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 this Department are:

Molecular Pharmacology. Research in this area is intended 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; biochemical mechanisms associated with drug tolerance and addiction; cell regulatory mechanisms in carbohydrate metabolism; regulation of nucleic acid synthesis in mammalian cells; regulation of protein synthesis and developmental pharmacology.

Clinical Pharmacology and Toxicology. Research in this area is intended to promote the rational use of drugs in man and to develop an understanding of the environmental hazards of modern societies. Topics of interest to members of the Department include drug metabolism, dosage scheduling, and environmental pharmacology.

Prospective candidates for an advanced degree should consult the University’s general requirements described in the section “Degrees” in this bulletin, and obtain further information from the Department. Consult Time Schedule for additional elective courses.

Courses

Pharmacology 201 (Principles of Pharmacology) and Pharmacology 202 (Systematic Pharmacology) are considered basic to the proper training of the medical practitioner, and will generally be taken by second-year medical students within the framework of the elective curriculum offered by the School of Medicine. These courses are open to nonmedical school students for credit, by arrangement with the Chairman of the Department. A laboratory course, Pharmacology 203, will be particularly useful to the graduate student in Pharmacology, but will be open to other graduate and medical students insofar as laboratory facilities permit.
Advanced elective courses are open to students in all parts of the University, but the instructor’s permission is required prior to registration. In general, courses in pharmacology require as prerequisites a good knowledge of physiology and biochemistry and sometimes of microbiology or principles of pharmacology. Students should therefore always consult with the instructor about the adequacy of their preparation.

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 a prerequisite for further study in pharmacology and therapeutics. Prerequisites: mammalian physiology and biochemistry, or consent of the instructor.

4 units, Aut (Staff) MTWTh 8

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. Prerequisites: 201 or consent of instructor.

5 units, Win (Staff) MThF 8 and W 8–10

203. Pharmacology Laboratory — Training in laboratory techniques applicable to pharmacological research. Enrollment is limited. Prerequisites: 201 and consent of instructor.

2 units, Spr (Staff) M 1–5 and F 1–2

210. Cellular Regulatory Mechanisms in Carbohydrate Metabolism—A course of lectures and discussions on the different regulatory processes which keep carbohydrate catabolic reactions in the cell in pace with its energy requirement; the effect of different hormones on the carbohydrate metabolism at the cellular and subcellular level. Prerequisite: biochemistry.

1 unit, Win (Mansour) T 4:15, given 1970–71

211. Hormonal Control of Cellular Metabolism and Development—A lecture, discussion, and reading course concerned with mechanisms of hormone effects on regulation of metabolism and development at the cellular and subcellular levels, dealing primarily with various vertebrate systems. Students should have knowledge of biochemistry and genetics.

1 unit, Win (Schimke) T 4:15, given 1971–72

212. Drug Metabolism — Lectures and discussions on the metabolic conversions of foreign compounds in the mammalian organism, including factors such as species, age, and genetic variability. Prerequisite: 201.

1 unit, Win (Aronow) T 4:15

213. Drug Addiction, Tolerance, and Physical Dependence — Lectures and discussion with emphasis on recent research into the biochemical basis of these phenomena. Students should be conversant with modern biochemistry and genetics and should have taken (or be taking) courses in physiology and 201.

1 unit, Spr (Goldstein) T 4:15

214. The Anti-Cancer Drugs—A joint course offered by the Departments of Pharmacology, Radiology, and Medicine. The biochemical basis of action of the anti-cancer drugs will be developed in detail, and current research trends (including clinical aspects) will be discussed by invited lecturers. Open to medical staff, and advanced medical and graduate students. Prerequisite: 201.

2 units, Spr (Staff) W 7:30–9:30 p.m., given 1970–71


2 units, Aut (Kalman) T 4:15–6:05

218. Environmental Toxicology.

2 units, Spr (Dreisbach) T 4:15–6:05, given 1970–71

270. Research Seminar—A weekly conference for discussion of current research in pharmacology.

1 unit, any quarter (Staff) Th 4:15

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 — With the approval of the Department qualified students may elect re-
search work in any area of pharmacology. Any quarter (Staff) by arrangement

PHYSIOLOGY
Emeritus: James P. Baumberger (Professor)
Acting Chairman: Maurice E. Krahl
Professors: Jefferson M. Crisman, Ronald Grant, Maurice E. Krahl, F. Eugene Yates
Associate Professors: Julian M. Davidson, George A. Feigen
Acting Assistant Professor: Noel Thompson

PROGRAMS OF STUDY
The Department of Physiology offers required and elective courses for students in the School of Medicine, open also to other qualified graduate students. In addition, the Department offers advanced laboratory courses restricted to Ph.D. candidates in physiology.

The Department offers the Ph.D. degree, but not the Master's or Bachelor's degrees.

GRADUATE STUDY
Students with undergraduate or Master's degrees who have completed a year each of college chemistry (including lectures in organic chemistry), physics, calculus (differential and integral), and biology will be considered for admission to graduate study. An applicant must file a report of his scores (aptitude and advanced biology) on the Graduate Record Examination as part of his application. In the case of certain students, especially those with degrees in engineering or physics, the Department will consider admission even if the above requirements have not been met. In those cases the students will be expected to complete the requirements during their graduate studies.

Emphasis is placed on providing all graduate students with a strong background in the laboratory study of major physiological phenomena, from which they may undertake highly individual courses of advanced research and study. The total course of study is expected to occupy four years, including three summers. Required courses for all students are: 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, and to a few first-year students.

Support for qualified students in years two through four may be applied for from the National Science Foundation and the U.S. Public Health Service.

In addition to graduate studies, this Department operates a postdoctoral program in Immunophysiology under a training grant from the U.S. Public Health Service. Two traineeships are available annually. The candidates must be U.S. citizens and holders of doctoral degrees in the Medical, Veterinary, Biological, or Physical Sciences. The stipendiary levels are set by the USPHS according to the level of experience and the number of dependents, but in any case they
do not exceed $7,500 per annum. Applications should be made by letter directly to Dr. George A. Feigen before May 1.

**Courses**


4 units, Spr (Yates, Krahl, Harrison, Maffly) MWF 1:15–3:05

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, Fletcher, Maffly) MT 9–11 and F 8–12


5 units, Win (Davidson, Krahl, Greenberg, Reaven) MF 9–11, T 8–9, and W 10–11

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, Win (Grant) MWTh 11–12

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 (Crimson) W 4:15–6:05 and F 4:15–5:05, alternate years, given 1969–70

205. Comparative Systems — (Formerly 302.) A lecture course for biologists on the mathematical approach to comparative mechanical, electrical and biological systems. Includes treatment of first- and second-order linear systems, forcing functions, Laplace transform and stability analysis. Prerequisite: one year of calculus.

3 units, Aut (Thompson) W 4:15–6:05 and F 4:15–5:05

206. Physiological Control Systems—(Formerly 303.) A lecture course for biologists on the systems analysis approach to selected physiological systems under negative feedback control. Examples for detailed analysis include regulation of arterial pressure, alveolar ventilation, adrenocortical function and pupillary area. The course includes a discussion of time bases (“biological clocks”). Use of the analog computer in the study of physiological processes is demonstrated. Prerequisites: 200, 201 and 205, and one year of calculus.

3 units, Win (Yates) W 4:15–6:05 and F 4:15–5:05

207. Immunophysiology Laboratory—(Formerly 304.) A laboratory course in quantitative immunophysiology emphasizing basic immunochrometrical 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 (Feigen) T 7:30–9:30 p.m., alternate years, given 1969–70

210. Neuroendocrinology—(Formerly 308.) A lecture and discussion course on selected topics of current interest in the general area of nervous and endocrine system interrelationships. Special emphasis will be placed on mechanisms for control of pituitary function and behavioral aspects of neuroendocrinol-
ogy. 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 1970–71

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

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. Ordinarlly, 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: neuroendocrinology, central nervous system function, adrenal cortical functions, regional blood flow in skin and nerve, immune reactions and anaphylaxis, reproductive physiology, blood flow in brain, cybernetics (systems analysis and instrumental techniques).

Any quarter (Staff) by arrangement

PROGRAM IN SPEECH AND HEARING SCIENCES

Emeritus: Virgil A. Anderson (Professor)
Acting Director: Earl D. Schubert
Professors: Jon Eisenson (on leave autumn, winter quarters), Earl D. Schubert
Associate Professors: Clara N. Bush, Dorothy A. Huntington. Clinical: Richard F. Dixon
Assistant Professors: James H. Dewson III. Clinical: Lyman S. Barrett, Donald R. Calvert
Instructors: Donald M. Morehead, Max H. Powers. Clinical: Robert H. Gottsleben

OFFERINGS AND FACILITIES

Activities in the Program are designed to prepare students for research, teaching at the university level, and for professional careers in the fields of language disorders, audiology, and the speech and hearing sciences. The programs are so organized as to facilitate selection of electives outside the major, thus encouraging the student to make an interdisciplinary approach to the mastery of his specialty.

The Program is fortunate in having its own library which contains a highly-selected core of books and journals, primarily in the fields of speech and hearing but sampling closely related areas as well. Speech and hearing clinics provide opportunities for the student to supplement his academic experience, and to conduct research with a wide range of speech and hearing disorders. The Scottish Rite Institute for Childhood Aphasia is closely affiliated with the Program and provides additional facilities for training and research with a selected group of children with language disabilities. The speech and hearing laboratories are well instrumented for a wide variety of research projects, and for furnishing training in modern measurement techniques.

SCHOLARSHIPS AND ASSISTANTSHIPS

The Phi Chapter of Kappa Alpha Theta Fund and the J. D. Zellerbach Fund provide scholarships specifically for students in the Program. Applications for these special
scholarships should be made directly to the Director of the Program.

Assistantships are available to students who have sufficient background of training and experience. In addition, traineeships from the Rehabilitation Services Administration and from the Children's Bureau are available for graduate students with the proper qualifications. A limited number of postdoctoral traineeships in audiology are available from the National Institute of Neurological Diseases and Blindness. Applications for assistantships or traineeships should be made directly to the Director of the Program.

PROGRAMS OF STUDY

DOCTOR OF PHILOSOPHY

The University's basic requirements for the doctorate (residence, dissertation, examination, etc.) are discussed in the section "Degrees" in this bulletin. The student may specialize in any one of the three fields—language disorders, audiology, or speech and hearing sciences.

Each student's doctoral program is planned individually with the needs and interests of the candidate in mind. The general University requirements for the doctorate are followed as they apply to residence, application for candidacy, etc. The student must have a reading knowledge of one foreign language.

Ordinarily doctoral candidates will complete a minimum of fifteen units of 400 (Doctoral Research) which is the formal course registration for the dissertation. The candidate is expected to attend a special doctoral dissertation seminar during each quarter of his residence or until his dissertation has been completed. (See course 400 for days and hours.)

Candidates for the doctorate may include a formal minor as a part of their total program. The minor is chosen in consultation with the candidate's major adviser, but the content and details of the minor program are specified and administered by the department in which the minor is taken.

The student will take a qualifying examination prior to admission to the University oral examination. The University oral examination will be focused on the dissertation.

POSTDOCTORAL

A limited number of postdoctoral trainees and fellows will be accepted each year. For information write to the Director of the Program.

NON-MAJORS

A number of the courses should prove to be useful as electives to graduate students from other departments. In any specific instance this possibility should be explored with the instructor involved.

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)

212. Phonetic Theory—Study of the basic types of sound elements characteristic of spoken language. Special emphasis will be placed on phonetic and phonemic sound change, with applications to English. Prerequisite: knowledge of phonetic or phonemic transcription.

3 units, Aut (Bush) MWF 2:15

220. Psychology of Speech—Origin, development of speech, semantics; relation of speech to thought, emotion, personality.

3 units, Aut (Eisenson) MWF 9

221. Instrumental Phonetics—Techniques of instrumental research in speech perception and production. Theory and instrumentation for analysis and manipulation of speech signals. Laboratory. Prerequisite: consent of instructor.

2 units, Aut (Huntington) Th 3–5

223. Speech and Language Development—Study of phonology, syntax, and semantics in the developing language of the child. Contributions of learning and linguistics theory to the study of language development.

3 units, Spr (Morehead) MWF 8

230. Speech Science I—Study of the structure of the speech mechanism and its function. Special attention will be given to recent research in respiratory control, the nature of phonation, and the articulatory adjustments characteristic of spoken language.

4 units, Win (Bush) MTWF 2:15

231. Speech Science II—Study of the acoustic characteristics of speech with reference to their physiological and perceptual correlates.

3 units, Spr (Huntington) MWF 2:15
250. Stuttering — Theories of etiology and therapeutic approaches to stuttering.
   3 units, Win (Eisenson) MWF 9
   Sum (—- ) MTWF 1:15

252. Aphasia — Historical survey, pathology; methods of testing, diagnosis, therapy.
   3 units, Spr (Eisenson) MWF 9

253. Aphasia in Children — Language disorders and related problems in children with perceptual dysfunctions. Prerequisite: consent of instructor.
   3 units, Win (Morehead) TWF 1:15

270. Clinical Practice in Speech and Hearing — Prerequisite: consent of instructor.
   1 to 4 units, any quarter (Staff)
   by arrangement

271. Clinical Practice in Audiology — Prerequisite: consent of instructor.
   1 to 4 units, any quarter (Dixon, Staff)
   by arrangement

281. Hearing Measurements and Interpretation — Theory, practice in measurement of audition. Interpretation of hearing tests.
   4 units, Win (Dixon) MWF 8 and one hour by arrangement

284. Advanced Clinical Audiology — Differential diagnostic procedures. Prerequisite: 281 or equivalent.
   4 units, Spr (Dixon) MTWF 8

286. Industrial Audiology — Determining industrial hazards to hearing; medico-legal problems of noise-induced hearing loss; control measures. Prerequisite: consent of instructor.
   2 units, Spr (Dixon) TTh 9

291. Hearing Aids and Residual Hearing — Description and acoustic measurement of wearable amplification systems. Hearing aids as rehabilitative devices. Prerequisite: consent of instructor.
   3 units, Aut (Dixon) MTWF 8

292. The Auditory Process — A systematic survey of our current knowledge of the operation of the auditory system. Emphasis is placed on acquiring a knowledge of the acoustic signal, and on an understanding of the methods of measuring a sensory process.
   4 units, 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. Research Methods — Prerequisite: some training in statistics.
   3 units, Aut (Huntington) MWF 1:15

   4 units, Aut (Huntington) Th 9-11 and two hours by arrangement

311. Experimental Phonetics II — Study of experimental work in acoustic characteristics of speech. Lectures, demonstrations, laboratory.
   4 units, Win (Huntington) Th 9-11 and two hours by arrangement

312. Experimental Phonetics III — Study of experimental work in physiological characteristics of speech. Lectures, demonstrations, laboratory.
   4 units, Spr (Huntington) Th 9-11 and two hours by arrangement

330. Seminar in Phonetics and Speech Science — Material will vary from year to year; hence, may be repeated for credit.
   4 units, Spr (Bush) MW 3:15-5:05

340. Seminar in Speech Pathology — Material will vary from year to year; hence, may be repeated for credit.
   4 units, Aut (Morehead) MW 3:15-5:05
   3 units, Sum (Morehead) MW 3:15-5:05

366. Acoustic Instrumentation I — Basic principles of electronic circuits. Description and application of instrumentation commonly used in speech and hearing sciences. Prerequisite: consent of instructor.
   3 units, Aut (— ) M 7-10 p.m.

370. Clinical Internship — In-service clinical practice and observation in selected speech and hearing centers. Prerequisite: consent of instructor.
   1 to 12 units, any quarter (Staff)
   by arrangement

380. Seminar in Audiology — Material will
vary from year to year; hence, may be repeated for credit.

4 units, Win (Dixon) MW 3:15-5:05
3 units, Sum (Dixon) MW 3:15-5:05

381. Seminar in Experimental Audiology—Material will vary from year to year; hence, may be repeated for credit.

1 to 4 units, Win (Dewson) by arrangement


4 units, Win (Schubert) MTWF 11

393. Experimental Audiology II: The Peripheral Mechanism—Study of the mechanics and electrophysiology of the middle and inner ear. Analysis of the ear as a transducer, and of the neural encoding process. Prerequisite: consent of instructor.

3 to 4 units, Spr (Schubert) MWF 10

394. Experimental Audiology III: Central Auditory Mechanisms—Anatomy and physiology of the central auditory system. Demonstration of electrophysiological research procedures. Prerequisite: consent of instructor.

4 units, Spr (Dewson) MTWF 11

400. Doctoral Research.

1 to 15 units, any quarter, (Staff) T 4:15
AFRICAN STUDIES

NDEA LANGUAGE AND AREA CENTER

**Director:** Joseph Greenberg

The African Studies Language and Area Center offers courses in beginning and advanced Hausa, 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, Stanford University, Stanford, California 94305.

**UNDERGRADUATE PROGRAM IN AFRICAN AND AFRO-AMERICAN STUDIES**

**Committee in Charge:** James L. Gibbs, Jr. (Chairman), Frederick Bowser, William Chace, Elizabeth Cohen, Carl Degler, Sanford Dornbusch, Peter Duignan, 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 for students who wish to do significant work in African and Afro-American Studies combined with training in a traditional academic discipline.

**ADMISSION TO THE PROGRAM**

The Program is open to sophomores, juniors and seniors with a satisfactory academic record. 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 if these are needed. A transcript should also be included. Students may submit a term paper or other sample of their written work if they wish.

Freshmen and sophomores interested in the Program should consult with the Chairman of the Committee in Charge. Students planning to enroll in the Program should take History 47 and 48 in their freshman year. Ordinarily students should apply for admission by the last quarter of the sophomore year.

**REQUIREMENTS**

Students in the Program have an affiliation with one department and take fifty units of credit in African and Afro-American Studies. Twenty-five of these units will be in “core” courses in this area and twenty-five units in “collateral” courses. Normally, the bulk of a student’s core courses will be taken in the department with which he is affiliated. Majors in the Program may offer an African language, Hausa, Swahili, or Yoruba, to satisfy the “collateral” course requirement as well as General Studies requirements.

The exact content of each student’s program will be individually devised in consultation with his adviser. This adviser will be a member of the Committee in Charge who is also a member of the faculty in the department with which the student is affiliated.
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)*

**ANTHROPOLOGY**
109. Peoples of Africa.

**FOOD RESEARCH INSTITUTE**

**HISTORY**
47. African Civilizations.
102H. The Cultural Dilemma of Modern Africa.
147A. The Emergence of Tropical Africa to 1850.
147B. Modern Africa since 1850.
148A. History of West Africa.
182. History of Negro in Latin America.

**HOOVER INSTITUTION**
131. History of Southern Africa.

**POLITICAL SCIENCE**
134. Inter-State Relations in Africa.
186. The Politics of Race.

**SOCIOLOGY**
175. The Evolution of Underdeveloped Societies.

**ENGLISH**
175. Literature of Black America.

**COLLATERAL COURSES**

*(See course descriptions under Departmental listings)*

**ANTHROPOLOGY**
1. General Anthropology.

**COMMUNICATION**

**FOOD RESEARCH INSTITUTE**
170. Trade Problems of Developing Countries.

**HISTORY**
103. Expansion of Europe Overseas: The Case of Africa.
160. History of the South (1815–1900).
172. Era of the Civil War.
173. Reconstruction and Race Relations in America.

**HOOVER INSTITUTION**
111. Europe in Africa.

**LINGUISTICS**
332A,B,C. Beginning Hausa.
334A,B,C. Beginning Swahili.
335A,B,C. Intermediate Swahili.
342A,B,C. Beginning Yoruba.

**POLITICAL SCIENCE**
157. American Political Thought.
173. Civil Liberties in the United States.
127A. Education and Politics in Developing Countries.

**PSYCHOLOGY, SOCIOLOGY, AND EDUCATION**
103. Introduction to Social Psychology.
145. Psychological Foundations of Education.

**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:** Ronald D. Jamtgaard

**Affiliated Faculty:**

**Professors:** Edward A. Feigenbaum, George E. Forsythe, John G. Herriot (on leave 1969–70), William F. Miller

**Associate Professors:** Jerome A. Feldman, Gene H. Golub

**Assistant Professors:** David J. Gries, D. Rajagopal Reddy

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 a Programming Language—FORTRAN, Job Control Language, PL/1, etc.** Courses are offered continuously for those persons desirous of developing solutions to their problems through the use of the facilities available at the Campus Facility.

   **No credit, any quarter (Staff) by arrangement; usually meets 2 hours per day for six days over a period of three weeks as announced.** The classes include an informal supervised programming laboratory. Contact the User Services Group at the campus Facility for registration or information about these courses. Do not register officially with the Registrar.

Other introductory courses:

- **Introduction to Programming** — See Computer Science 5, 50A,B, 126, 136, 238.

### FOOD RESEARCH INSTITUTE

**Emeriti:** Karl Brandt, Joseph S. Davis, Helen C. Farnsworth, S. Daniel Neumark, E. Louise Peffer, Vernon D. Wickizer, Holbrook Working (Professors)

**Director:** William O. Jones

**Professors:** Roger W. Gray, Bruce F. Johnston, William O. Jones, Dudley Kirk

**Associate Professors:** John A. Jamison, Ben-
Other Departments, Institutes, and Programs

Table of Contents

Offerings and Facilities

The Food Research Institute was founded as a Department of Stanford University in 1921 to pursue research on problems of food supply, consumption and distribution. While the emphasis upon commodity problems continues, research has also expanded into other areas of modern applied economics, e.g., instability in international trade, development of the agricultural sector within 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 economics 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.

Master 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 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

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, Aut (Mandell) MTWThF 11

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

103. World Food Economy—(May be taken as 203 by graduate students.) Food supplies and requirements in a developing economy; the major food groups, international contrasts and trends in food-consumption patterns; interrelations of food, population, and economic progress.

5 units, Aut (Johnston) MTWThF 11

105. Commodity Futures Markets and Prices—(May be taken as 205 by graduate students.) Description of the uses and functioning of commodity futures markets, with emphasis upon business uses of the markets. The meaning of hedging and the evolution of hedging practice. Determinants of the level of market use, and the relationship between level of use and market usefulness. Consideration from the evidence of price behavior, trading composition, and external influences, of the performance of futures markets in price determination and other functions. The extent, influence, and importance of speculation in commodity futures.

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

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 will include African-non-African international trade and economic relations (theoretical background, historical perspective, case studies of export-led growth, international capital flows) and intra-African trade and economic integration (customs union theory, historical perspective, case studies of African economic integration). Prerequisite: basic economic theory.

3 to 5 units, Win (Pearson) W 4:15-6:05
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.

203. World Food Economy—See 103.

205. Commodity Futures Markets and Prices—See 105.

COURSES IN THE GROUP BELOW ARE CONTINUOUS. REGISTRATION WILL BE ACCEPTED AND GRADES GIVEN ONLY FOR THE ENTIRE SEQUENCE.


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.


220. Economics of Agriculture (Production)—The nature and scope of agricultural economics; the theory of the farm firm; aggregate agricultural production and product supply functions; technical change in agriculture. Emphasis will be on analysis and on analytic techniques which are helpful in solving contemporary problems in both developed and underdeveloped agricultures.

221. Economics of Agriculture (Consumption)—Application of the analytic tools and techniques developed in 220 to problems of demand for agricultural products. Price, income, and quality elasticities of demand. Applications of the theory of price determination.

224. Empirical Investigation 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.

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.
270. Foreign Trade Problems of Developing Countries—Topics include problems and prospects of commodity trade, trade in primary products, export instability and stabilization measures, import substitution and commercial policy, economic integration. Emphasis will be on theory and related empirical evidence. Prerequisite: previous work in international trade theory or economic development.
3 to 5 units, (Massell) by arrangement
285. Seminar: Demography of the Developing Countries — The demographic position of the major regions in relation to their problems of economic and social development. Problems of population policy. Prerequisite: 235 or consent of instructor.
3 units, Spr (Kirk) by arrangement
304. Seminar: Foreign Trade Problems of Developing Countries — Reports and discussion of current research on specific aspects of the international aspects of economic development. Prerequisite: consent of instructor.
3 units, Spr (Massell) by arrangement
305. Seminar: International Commodity Problems—For Graduate students only. Research papers and reports on selected topics pertaining to commodity agreements, buffer stock schemes, futures or forward markets, etc. Prerequisite: consent of instructor.
3 units, Spr (Gray, Massell) by arrangement
3 units, Spr (Reynolds) 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 to 5 units, Win (Jones) MTW 11
366. Seminar: Economics of Tropical Agriculture—Continuation of 365.
3 to 5 units, Spr (Jones) T4:15–6:05
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

GENERAL STUDIES PROGRAM


The courses listed below are offered under the auspices of the Committee on General Studies.

110. Elementary Human Physiology I—Particular attention will be given to the physiology and anatomy of the circulatory system, kidneys, respiratory system, and digestive system. These topics will be illustrated by describing disorders of these systems. Prerequisites: a knowledge of chemistry, physics, and human anatomy at the high school level will be assumed.
4 units, Win (Sapirstein)

111. Elementary Human Physiology II—Particular attention will be given to the physiology and anatomy of nerve, muscle, central nervous system, endocrines, and reproductive processes. These topics will be illustrated by describing disorders of these systems. This course may be taken independently of General Studies 110, but the latter is recommended. Prerequisites: a knowledge of chemistry, physics, and human anatomy at the high school level will be assumed.
4 units, Spr (Sapirstein)
GRADUATE DIVISION SPECIAL PROGRAMS

Dean of the Graduate Division: Lincoln E. Moses
Associate Dean: Robert M. Rosenzweig

SPECIAL PH.D. PROGRAM

The Graduate Division Special Programs make provision for students whose plans for study toward the Ph.D. degree do not fall within the province of any one department. Such a program may be individually planned for an unusually well-qualified graduate student who has already been admitted to a department or school of the University and enrolled therein.

A student with a well-considered program not now provided for in the existing departments or special programs of the University may then approach a professor qualified to give him guidance. The professor, if he believes the program desirable, will gather a special committee consisting of at least three other members of the Academic Council who represent the student’s various fields of interest. Included in the advisory committee must be professors from at least two departments of the University. Before the student embarks on the program, this committee will address a Declaration of Intention (Form G54) to the University Committee on the Graduate Division:

1. Defining the area of the special program, showing that the University is qualified to offer it, and proposing a title for the degree.

2. Outlining the program of study and research contemplated.

3. Indicating, if possible, the nature of the dissertation contemplated.

If this Declaration is approved by the University Committee on the Graduate Division, the special committee will supervise the candidate’s work and sign the forms ordinarily transmitted by major departments. The chairman of the special committee will normally direct the dissertation. Students registering for special research under the guidance of their committee or for the Ph.D. dissertation should use the following course numbers:

400. Research.
   By arrangement

   By arrangement

COURSES FOR GRADUATE STUDENTS

337A, 337B, 337C. Seminar in Public Affairs — The core seminar in the University’s Public Affairs Fellowship Program, focusing on the contemporary role of democratic government and the responsibilities of its leaders: the nature of democratic government and politics; the dynamics of social, economic, and political change; and critical emerging issues of public policy. Enrollment required of and limited to Public Affairs Fellows. Credit will be given only for completion of the entire sequence.

337A. 5 units, Aut (Hutchinson) by arrangement

337B. 5 units, Win (Hutchinson) by arrangement

337C. 5 units, Spr (Hutchinson) by arrangement

340. The Human Potentiality — An inquiry directed to the question what is the nature of man’s highest potentiality and how does he move in the direction of its realization. Points of view taken from the fields of the behavioral sciences, humanistic psychology, parapsychology, literature and philosophy, and various religious teachings will be compared and evaluated in group discussion. Enrollment limited to 15.

2 units, Aut, Win, Spr (Harman) MW 4:15–6:05

The following courses, though given within the departments listed, may be taken by any interested graduate students:

ANTHROPOLOGY

256. Cultural Transmission.

COMPUTER SCIENCE

126. Computing in the Social Sciences and Humanities.
136. Introduction to Algorithmic Processes.

EDUCATION

200. History of Education.
206A. Comparative Education.
220. Introduction to Public School Administration.
299. Children’s Literature.
308. Introduction to American Higher Education.
315. Cultural Transmission.
325A,B,C. School Facility Planning.

ENGLISH
204. Advanced Exposition.
208. Introduction to Modern Linguistics.
270. Contemporary American Fiction.

FOOD RESEARCH INSTITUTE

GEOLOGY
287. Minerals, Politics, and Economics.

GRADUATE SCHOOL OF BUSINESS
For course offerings in the Graduate School of Business, please refer to their current Degree Programs Bulletin.

HOOVER INSTITUTION
Note—The following courses taught by staff members of the Hoover Institution are offered for academic credit as indicated.

211. Seminar: An Interdisciplinary Approach to the History of Africa from 1800—The partition of Africa. Contrasting theories of imperialism. European penetration and administration. Development of exploitation. Decolonization in Africa. The imperial impact appraised. Experts from other disciplines will be brought in to show how their field sheds light on African history and how use of methods of linguistics, for example, can be of help to African historians.
5 units, Spr (Duignan, Gann)

221. Seminar: An Interdisciplinary Approach to the History of Africa up to 1800—Survey of location and nature of sources available; special problems of methodology. A brief survey of the early history of man in Africa. The peopling of Africa. The emergence of early African states. The special features of the African civilizations. Role of the slave trade. European colonization up to 1800. The abolitionist movement and its impact on Africa. Experts from other disciplines will be brought in to show how their field sheds light on African history and how use of methods of linguistics, for example, can be of help to African historians.
5 units, any quarter (Gann or Duignan)

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)

INDUSTRIAL ENGINEERING
229. Engineering Economy.

INTERNATIONAL STUDIES
The Committee on International Studies coordinates resources for regional and comparative studies at Stanford, and inquiries about opportunities in the international field may be addressed to the CIS, Room 2R, Building I, Stanford University, Stanford, California 94305. Virtually all area-related courses are offered by individual schools and departments and are listed thereunder in this bulletin. Special programs leading to the A.M. in Latin American Studies and the A.M. in East Asian Studies are described under those headings.

Interdisciplinary faculty committees on African Studies, East Asian Studies, Latin American Studies, Russian, East European and Communist Studies, and Western European Studies coordinate and enrich University resources for the study of their respective regions. Members of these committees stand ready to counsel students who wish to emphasize one of these regions in their graduate or undergraduate programs to complement a departmental specialization. In some instances, special fellowship support is available. Inquiries about area-related opportunities may be addressed to the relevant committee c/o CIS.

No Ph.D. is offered in area studies, but a qualified doctoral candidate will be assisted
in designing a cross-disciplinary program focused on the region of his interest. The Graduate Division Special Ph.D. Program outlined at the beginning of this section enables a student to pursue a doctoral program in the area of his special interest, if that interest cannot be accommodated within a regular departmental Ph.D. program.

HOOVER INSTITUTION on WAR, REVOLUTION and PEACE

Emeriti: Harold H. Fisher (Chairman), Joseph S. Davis, Edgar E. Robinson, Graham H. Stuart (Councilors), Witold S. Sworakowski (Professor)

Director: W. Glenn Campbell
Associate Director: Richard F. Staar
Executive Assistant to the Director: Alan H. Belmont
Information Officer: James R. Hobson
International Political Studies Program Director: Stefan T. Possony
African Studies Program Director: Peter Duignan

Senior Staff Members: Richard V. Allen, Rita R. Campbell, Milorad M. Drachkovitch, Roger A. Freeman, Lewis H. Gann, E. Berkeley Tompkins

Senior Research Fellows: William C. Bark, Karl Brandt, Dan T. Smith, Eric Voegelin

Research Fellows: Kia-ngau Chang, Theodore Draper, Howard P. Jones, Dimitri von Mohrenschildt, Bertram D. Wolfe, Yuan-li Wu


Head, Publications Department: Brien G. Benson

Editor: Carole Norton

Curators: Joseph W. Bingaman (Latin America Collection), Anna M. Bourguina (Nicolaevsky Collection), Peter Duignan (Africa Collection), R. W. Lyman (Honorary Curator, British Labor Collection), John T. Ma (East Asia Collection), Karol Maichel (East European Collection), Philip T. McLean (Special Collections), 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 major area collections (Western Europe, Eastern Europe, East Asia, Africa, and the Middle East) is in itself outstanding, the distinguishing feature of this Institution lies in the fact that it houses under one roof for convenient study the records of the major upheavals of the contemporary world.

The Institution's holdings include government documents, files of newspapers and serials, manuscript memoirs, diaries and personal papers of men and women important in world affairs, publications of ephemeral societies and of resistance and underground movements, and the publications and records of national and international bodies, both official and unofficial, as well as books and pamphlets, many of them rare and irreplacerable.

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
OTHER DEPARTMENTS, INSTITUTES, AND PROGRAMS

policy. Since 1919 some 200 volumes have been published by the Institution. To mark its 50th anniversary, the Institution is planning for the fall of 1969 an international scholarly conference on peaceful change and, aided by a substantial grant, has begun a major program of peace research. Other notable long-term research efforts include as topics African colonialism, Communist Chinese economic development, the Communist International, and the growth of American government.

In addition to its own research staff, the Institution has been used continually by American and foreign scholars. Considering the value of the collections, every effort will be made to increase the use of Institution resources by providing more funds for predoctoral and postdoctoral fellowships.

In these ways, by acquisitions, by research, by publications, and by fellowships, the Institution carries out its functions of collecting the living documents of international affairs, organizing and making them available for use, fostering their utilization, and encouraging and aiding the spread of knowledge.

Several of the Senior Scholars on the Institution's staff teach courses at Stanford University. See listings under Undergraduate Special Programs and Graduate Division Special Programs; also see History, Political Science, and Senior Colloquia for other courses offered by staff members.

COMMITTEE on HYDROLOGY

Committee in Charge: Ray K. Linsley (Chairman), 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:

### Course No. Subject Units

C.E. 207. Advanced Hydraulics 3
C.E. 209. Hydraulics of Open Channels 3
C.E. 233. Statistical Models in Civil Engineering 3
C.E. 234. Decision Making in Civil Engineering 2
C.E. 235. Stochastic Process Models in Civil Engineering 2
C.E. 260A. Advanced Hydrology 4
C.E. 260B. Advanced Hydrology 4
C.E. 261. Nuclear Hydrology 4
C.E. 263. Sedimentation Problems 3
C.E. 264. Ocean and Coastline Engineering 3
C.E. 265A. Flow in Permeable Media 3
C.E. 265B. Applied Hydrodynamics 3
C.E. 266. Engineering Hydrology 4
C.E. 268. Mechanics of Flow through Soils 3
C.E. 269. Water Resources Engineering Seminar 1
C.E. 273. Water Resources Chemistry 3
C.E. 276. Water Quality in Water Resources Development 2
C.E. 277. Nuclear Explosives Engineering 3
C.E. 278. Environmental Radioactivity 3
Geol. 110. Introduction to Marine Geology 4
Geol. 115. Introduction to Biological Oceanography 3
Geol. 116. Introduction to Marine Geology 4
Geol. 115. Introduction to Biological Oceanography 3
Geol. 171. Introduction to Geochemistry 3
Geol. 204A,B. Computer Applications in the Earth Sciences 6
Geol. 233. Principles of Geomorphology 5
Geol. 284. Engineering Geology 3
Geol. 285. Hydrogeology 5
Geol. 286. Development of Groundwater Resources 3
Engr. 171. Nuclear Energy 3
Engr. 172. Nuclear Science 3
Engr. 175. Radiation Measurements Laboratory 3
Engr. 176. Radiisotope Methods 3
Engr. 177. Radioactivation Analysis 3
Pet.E. 151A,B. Reservoir Fluids 6
C.S. 136. Introduction to Algorithmic Processes 3
I.E. 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**

**ADMINISTERED BY STANFORD UNIVERSITY**

The Inter-University Center for Japanese Language Studies in Tokyo, Japan, is a cooperative enterprise of twelve major academic institutions in the United States and Canada with Stanford University as the administrative agency. The purpose of the Center is to provide qualified graduate and undergraduate students with intensive audio-lingual Japanese language instruction, as well as to further the students' familiarity with Japanese texts and materials preparatory or leading to research in given disciplinary or professional fields. The location of the Center in Tokyo provides maximum opportunities for students to gain fluency in both the written and spoken language in a Japanese-speaking and Japanese cultural environment. Language study is carried on in small classes or in individual tutorial sessions by Japanese instructors. Advanced students 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 113, Building 10A
Stanford University
Stanford, California 94305
INTER-UNIVERSITY PROGRAM for CHINESE LANGUAGE STUDIES in TAIPEI

ADMINISTERED BY
STANFORD UNIVERSITY

The Inter-University Program for Chinese Language Studies in Taipei, Taiwan, was established in September 1963, under the sponsorship of nine American universities, with Stanford University as the administrative agency. The Program is a cooperative effort drawing upon the accumulated experience of the profession in providing advanced language training in a Chinese cultural area and is not intended to be a substitute for strong language offerings at American institutions.

The purpose of the Program is to provide graduate and undergraduate students with intensive audio-lingual language instruction, as well as to further the students' familiarity with Chinese texts and materials preparatory or leading to research in given disciplinary or professional fields.

Undergraduate, graduate, or postdoctoral candidates are eligible to apply to the Program if they have successfully completed a minimum of two academic years, or its equivalent, of Chinese language study at the college level. Applicants must also pass a short written and oral screening examination in the Chinese language.

For further information please address your inquiries to:
Graduate Overseas and Special Programs
Room 113, Building 10A
Stanford University
Stanford, California 94305

LIBRARIES

Emeriti: Elizabeth Hadden, Minna Stillman (Associate Librarians); Alice Charlton (Chief Catalog Librarian); Jeannette M. Hitchcock (Chief of Division of Special Collections); Margaret Wells (Education Librarian); Grace E. Stillson (Assistant Chief Catalog Librarian); Ruth Scibird (Curator of the Stanford Collection)

University Libraries
Associate Directors: Elmer M. Grieder, David C. Weber
Assistant Director and Librarian, J. Henry Meyer Memorial Library: Robert A. Golter
Assistant Director for Automation: Allen B. Veaner
Administrative Services: Lawrence C. Pearson
Financial Manager: Michael Oman
Division Chiefs: Julius P. Barclay (Special Collections); Joseph A. Belloli (Humanities and Social Sciences); Jennette E. Hitchcock (Catalog); Judy H. Fair (Government Documents); Jack Plotkin (Circulation); B. Jack Pooler (Science); Ralph W. Hansen (Acquisition)
University Archivist: Ralph W. Hansen
Curators—Resources Development Program: James Breedlove (Latin America); Peter Frank (German 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 Zachringer, Charles T. Pfingsten; Catalog Librarian: Mildred Wagner; Librarian, International Center for the Advancement of Management Education: David Allen

Lane Medical Library
Chief Librarian: Clara S. Manson
Reference Librarian: A. V. Hoen

Law Library
Law Librarian: J. Myron Jacobstein
OTHER DEPARTMENTS, INSTITUTES, AND PROGRAMS

Acquisition Librarian: Howard W. Sugar-
man; Head Catalog Librarian: Rosalee
Long; Reference Librarian: George Torz-
say-Biber

Linear Accelerator Center Library
Chief Librarian: George Owens
Acquisitions: Louise Addis; Cataloging and
Reference: Robert C. Gex

FACILITIES

All faculty, staff, and registered students
of the University are entitled to use the Uni-
versity Libraries. Information is available
in the booklet Your Libraries at Stanford
University or in special leaflets about gen-
eral borrowing regulations, book stack ac-
cess, interlibrary loans, photocopies, micro-
text reading machines, etc. Persons wishing
an introduction to the library are urged to
see the Chief, Humanities and Social Sci-
ences Division.

Information regarding special borrowing
privileges for individuals not connected with
the University may be obtained at the Ser-
vice Desk in the Circulation Division of the
Main Library. With some exceptions, indi-
vidual cards may be obtained upon payment
of an annual fee of $12.50 for Stanford alum-
ni 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 pay-
ment of fees: Hoover Institution on War,
Revolution and Peace; Law Library; Lane
Medical Library; J. Hugh Jackson Library of
Business; Food Research Institute; and Lin-
ear Accelerator Center. Special regulations
are in force for high school, college, or uni-
versity students from other institutions, who
may consult the Circulation Service Desk
attendant or their own school librarians for
information. Industrial firms wishing to use
the Libraries should consult the Director of
the Technical Information Service for infor-
mation regarding subscriptions.

The Libraries of the University altogether
contain about 3,000,000 volumes, 900,000
manuscripts, 120,000 sheet maps, 300,000
microtext sheets, and considerable other
material. A principal part of the Libraries’
collections is concentrated in the stack of
the Main Library, which houses about 750,-
000 volumes on its seven levels. The various
library units are described in the following
paragraphs; the Library of the Hoover In-
titution on War, Revolution and Peace is
described elsewhere in this catalog.

J. HENRY MEYER
MEMORIAL LIBRARY

The Meyer Memorial Library, with a col-
lection of about 85,000 volumes and hous-
ing 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 mid-
night Monday through Saturday, and from
1 p.m. 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 “re-
serve” 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 disci-
plines, basic reference works, a wide selec-
tion 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, litera-
ture, drama and other significant and his-
torical 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 labora-
tories which provide instructional facilities
for students enrolled in undergraduate lan-
guage courses.

MAIN LIBRARY

When school is in session, the Main Li-
brary 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.
Main Library provides 906 seats and quarters for the following:

The Humanities and Social Sciences rooms, the center for reference service in the Main Library, contain reference and subject collections totaling about 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 Documents Library brings together most of the Library’s collection of municipal, state, federal, foreign, and international documents. It is especially strong in the publications of the United States, Great Britain, Canada, Australia, and the United Nations.

The Division of Special Collections 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: Asian Languages, Briggs Memorial (English), Classics, Communication, Graduate Program in Humanities, Jones Collection (in creative writing), modern European languages, Physical Education for Women, Tanner Memorial Library of Philosophy, and Victor J. West Memorial (political science).

**SPECIAL LIBRARIES IN THE SCIENCES**

The Library’s collections in science and engineering are assembled in eight major groups of departmental libraries—Biology, Chemistry, Computer Science, Engineering, Geology, Marine Biology, Mathematics-Statistics, and Physics.

The Frederic M. Falconer Biology Library, located on the 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 systematic, 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 Mathematics-Statistics Library is located in Room 414 of the Sloan Mathematics Center.

The Computer Science Library, Room 170, Polya Hall, houses a specialized collection covering the full range of computer theory and application.

The Physics Library is located in Room 301 of the Varian Building. Its branches are the Hansen Microwave Laboratory Library, specializing in microwave physics and engineering, and the Plasma Physics Library, serving the Plasma Physics Institute.

BUSINESS

The J. Hugh Jackson Library, located in the Graduate School of Business Building, is primarily a working laboratory available to students in the Graduate School of Business in the daily preparation of their work. Members of the Stanford community may use the library upon identification. The library contains over 125,000 cataloged items and additional miscellaneous pamphlets and reports. It maintains extensive holdings of corporate annual reports from the leading stock exchanges. It receives in excess of 2,000 trade, financial, labor, and general business periodicals. In addition, it subscribes to many of the leading labor, financial, marketing, and business research services. 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 170,000 volumes. In addition to extensive holdings in Anglo-American law, there are important special collections of French, German, Italian, Indian, British Commonwealth, and early State laws. The International Legal Studies Collection of international law and organization and of foreign and comparative law is of increasing importance.

The Law Library is primarily intended for use by students, faculty, and research staff of the Law School. Other faculty, staff, and students are welcome to use the Law Library when in need of legal materials.

MEDICINE

The Lane Medical Library, located at Room 100 in the Lane Building of the Medical Center, contains about 200,000 volumes and currently receives about 2,200 journals. The Barkan Library of Ophthalmology and Otolaryngology and the Medical History Collection are notable special collections. Specialized branches include the Anatomy Library and the Medical Microbiology Library.
Course

1. Use of the Library—Introduction to the Library; emphasis on major types of material and use of catalogs, bibliographies, indexes, abstracts, other aids to study. Primarily for freshmen and sophomores.

1 unit, Aut, Win, Spr (Staff) T11
See also Senior Colloquia.

Stanford Linear Accelerator Center

The Stanford Linear Accelerator Center Library (SLAC) is located in Room 308, Central Laboratory Building on Sand Hill Road. The collection is primarily for use by the staff of the Center.

Physical Education for Men

Emeriti: Allen Elward, Edward M. Twiggs, Harry M. Wolter (Directors); C. Myron Sprague (Associate Director); 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: Jack Christiansen (Football), Marshall Clark (Track), Terry Desylva (Football), Clyde F. Devine (Divine), Thomas Dunton (Baseball), Robert Gambold (Football), William Moultrie (Football), Paul Neumann (Basketball), Edward Peasley (Football), Charles Range (Basketball), James Smith (Aquatics), Roger C. Theder (Football), James Troppmann (Football), Richard A. Vermel (Football), Michael White (Football)

offerings and Facilities

Athletics

In keeping with our cultural heritage and American university tradition, Stanford offers its students a wide variety of competitive opportunities in intercollegiate sports. Stanford has always managed to be vigorously competitive in all sports, both within the Conference and on the national level. Our sports effort has, through the years, continually improved both in quantity and quality and we look ahead in anticipation of continued achievement. Through its membership in the National Collegiate Athletic Association, the Athletic Association of Western Universities, and other such organizations, Stanford meets teams of outstanding universities throughout America in a number of sports every year. The Indians usually schedule such teams on a home-and-home basis which means that Stanford athletes travel extensively to major cities throughout the United States. Sports for which the University grants the Stanford Sport Award are football, basketball, track and field, baseball, swimming, golf, tennis, wrestling, gymnastics, rugby, soccer, water polo, and cross country. Other sports which have regular schedules include, among others, crew and rifleshooting.

Physical Education and Intramurals

The Physical Education Program is designed to accommodate the interests and needs expressed by our students. Students may elect the activity of their choice and quality instruction with appropriate facilities can be expected. The Intramural Sports Program is designed to provide competitive sports opportunities for those men who desire competition but do not care to participate in the intercollegiate sports program. All students are encouraged to participate in their favorite sports activities. Proceeding on the premise that man is an integrated, indivisible organism in need of 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, scuba, karate, judo, and archery are offered coeducationally.

Academic Degrees and Teaching Credentials in Physical Education for Men

The Department of Physical Education and Athletics for Men cooperates with the School of Education by providing faculty, facilities, and equipment necessary to the conduct of the Professional 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 enclosing a standard American football field encircled by a quarter-mile track with a 220-yard straightaway.

Angell Field, named for Dr. Frank Angell, pioneer member of the University faculty who devoted much time and interest to the development of athletics. It is a specialized facility for track and field, and its quarter-mile track also has a 220-yard straightaway. The field event runways have recently been covered with a new all-weather surface.

Sunken Diamond, a turfed baseball field used exclusively for varsity baseball. Provides seating for 3,000 spectators.

Harry Maloney Field, a turfed field for soccer, rugby, football practice, and other field sports. It is named for the former director of minor sports at Stanford, an active member of the faculty for 36 years.

Three other turfed fields for football and rugby, intramural sports fields, and a freshman baseball diamond.

Three varsity tennis courts, hard-surfaced, with stands for spectators, and fourteen practice tennis courts.

Roscoe Maples Pavilion, the new basketball pavilion seating 8,000 spectators, has just been completed.

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 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

Courses may be taken for 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 credits 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.

Courses

02. Individual Programs—Individually prescribed exercise programs adapted to fit special needs.
   Aut, Win, Spr (Ruff) three periods a week

03. Freshman Seminars.
   Aut, Win, Spr (Staff) by arrangement

05. Physical Education Leadership.
   Aut, Win, Spr (Ruff) by arrangement

07. Experimental Physical Conditioning.
   Aut, Win, Spr (Ruff) by arrangement

08. Club Sports.
   Aut, Win, Spr (Fehring) by arrangement

   Aut, Win, Spr (Staff) TTh 11

11A. Basketball, Freshman.
   Aut, Win (Neumann) MTWThF 2:15

   Aut, Win, Spr (Lunny) MWF 3:15

14A. Football, Freshman.
   Aut (Troppmann) MTWThF 4:15

   Aut, Win, Spr (Finger) TTh 11, 1:15, 2:15, or 3:15, and nine holes additional

15A. Golf, Freshman.
   Aut, Win, Spr (Finger) MTWThF 3:15–5:30

   Aut, Win, Spr (Millman) MTWThF 2:15

16B. Trampoline.
   Aut, Win, Spr (Millman) TTh 2:15

17. Volleyball.
   Aut, Win, Spr (Staff) MWF 2:15

17B. Volleyball and Team Games.
   Aut, Win, Spr (Staff) TTh 2:15

   Aut, Win, Spr (Staff) TTh 9, 10, 11, or 1:15, MWF 10, 11, or 1:15

19B. Bowling, Tournament.
   Aut, Win, Spr (Staff) MW and by arrangement

   Aut, Win, Spr (Smith) MWF 10

20A. Swimming, Freshman.
   Aut, Win (Gaughran) MTWThF 4:15

21. Tennis, Elementary.
   Aut, Win, Spr (Staff) MWF 11, 1:15, 2:15, 3:15, or 4:15

21A. Tennis, Freshman.
   Aut, Win, Spr (Gould) MTWThF 3:15–5:05

22. Track, Individual Programs.
   Aut, Win, Spr (Clark) TTh 10

22A. Track, Freshman.
   Aut, Win, Spr (Clark, Jordan) MTWThF 3:15

23. Wrestling, Elementary.
   Aut, Win (Reed) MWF 2:15

23A. Wrestling, Freshman.
   Aut, Win (Reed) MTWThF 4:15

24. Diving, Elementary.
   Aut, Spr (Staff) TTh 11

27. Crew, Elementary.
   Aut, Win, Spr (Staff) MTWThF 4:15 and S 9

29. Water Polo.
   Aut, Spr (Smith) TTh 2:15 or MWF 11

29A. Water Polo, Freshman.
   Aut, Spr (Smith) MTWThF 3:15

30A. Baseball, Freshman.
   Aut, Win, Spr (Young) MTWThF 3:15–5:30

35. Kenpo Karate.
   Aut, Win, Spr (Pegelow) TTh 7 p.m.
39A. Soccer, Freshman.
   Aut (Priddle) MTWThF 4:15

41. Physical Conditioning.
   Aut, Win, Spr (Staff) MWF 4:15

45. Badminton.
   Aut, Win, Spr (Staff) T, Th or MW 9

111A. Basketball, Varsity.
   Aut, Win (Dallmar) MTWThF 4:15-6:05

112. Boxing, Advanced.
   Aut, Win, Spr (Lunny) MTTh 4:15

113. Judo, Beginning.
   Aut, Win, Spr (Kitaura) TW 7 p.m.

113B. Judo, Advanced.
   Aut, Win, Spr (Kitaura) TW 8 p.m.

114A. Football, Varsity.
   Aut, Spr (Ralston) MTWThF 3:15-5:30

115. Golf, Advanced.
   Aut, Win, Spr (Finger) MTWThF and by arrangement

115A. Golf, Varsity.
   Aut, Win, Spr (Finger) MTWThF 3:15-5:30

116A. Gymnastics, Varsity.
   Aut, Win, Spr (Millman) MWF 3:15

118. Life Saving.
   Aut (Gaughran) TTh 2:15

   Aut, Win, Spr (Smith) MWF 2:15

120. Swimming, Advanced.
   Aut, Win, Spr (Smith) MWF 10

120A. Swimming, Varsity.
   Aut, Win, Spr (Gaughran) MTWThF 4:15

121. Tennis, Advanced.
   Aut, Win, Spr (Staff) TTh 11, 12:15, 3:15, or 4:15

121A. Tennis, Varsity.
   Aut, Win, Spr (Gould) MTWThF 3:15

122A. Track, Varsity.
   Aut, Win, Spr (Jordan) MTWThF 3:15

123. Wrestling, Advanced.
   Aut, Win (Reed) MTWThF 4:15

123A. Wrestling, Varsity.
   Aut, Win (Reed) MTWThF 4:15-6:05

124. Diving, Advanced.
   Aut, Spr (Staff) TTh 11

124A. Diving, Varsity.
   Aut, Win (Devine) MTWThF 4:15

127A. Crew, Varsity.
   Aut, Win, Spr (Staff) MTWThF 4:15 and S 10

128. Water Safety Instruction, Part I.
   Spr (Gaughran) MTWThF 3:15

128B. Water Safety Instruction, Part II.
   Spr (Gaughran, Staff) MTWThF 3:15

129A. Water Polo, Varsity.
   Aut, Spr (Gaughran) MTWThF 4:15

130A. Baseball, Varsity.
   Aut, Win, Spr (Young) MTWThF 3:15-5:05

139. Soccer, Beginning.
   Aut, Win, Spr (Priddle) MWF 4:15

139A. Soccer, Varsity.
   Aut, Win, Spr (Priddle) MTWThF 4:15

140. Rugby, Beginning.
   Win (Kmetovic) MTWThS 4:15

140A. Rugby, Varsity.
   Win (Kmetovic) MTWThS 4:15

142. Skin and Scuba Diving.
   Aut, Win, Spr (Gaughran, Smith) MWF 2:15

151. Rifle and Pistol Marksmanship—Open to all undergraduate students.
   Aut, Win, Spr (Staff) MTWThF by arrangement

151B. Pistol Marksmanship—Open to all undergraduate students.
   Aut, Win, Spr (Staff) MTWThF by arrangement

153. Weight Training.
   Aut, Win, Spr (Staff) MWF 11, 12:15, 3:15 or 4:15

192, 193, 194. Techniques of Athletic Management.
   Aut, Win, Spr (Taylor, Staff) by arrangement

   Aut, Win, Spr (Fehring) by arrangement

Coeducational classes are offered as listed under Physical Education for Women.
PHYSICAL EDUCATION for WOMEN

Emeriti: Maud L. Knapp (Professor), Margaret C. Barr (Associate Professor), Sylvia P. Cain (Instructor)

Chairman: Pamela L. Strathairn
Associate Professors: Luell W. Guthrie, Marian S. Ruch, Pamela L. Strathairn
Assistant Professors: Carroll S. Gordon, Miriam B. Lidster
Instructors: Judith R. Book, Heidi A. Klaus, Mary Margaret Neal, Inga Weiss
Teaching Specialists: Marianna C. Fowler, Jean P. Helliewell

OFFERINGS AND FACILITIES

The aims of the physical education program for women are threefold: to provide an opportunity for participation in a variety of physical activities, to afford specialization in one or more areas of activity, and to provide instruction for all levels of competency.

The program is designed: (1) to increase understanding of the value and role of physical education activities in developing and maintaining total fitness throughout life, (2) to encourage continued participation, both during and after college, in physical activity appropriate to health status as well as interest, and (3) to develop leadership skills which have particular application to community service, volunteer agencies, recreation groups, and domestic and foreign Peace Corps.

Each student is afforded the opportunity for developing interest in many kinds of physical activity and for developing competency in selected activities in order that future participation is more readily selected for recreational purposes. Instructional, recreational, creative, and several forms of competitive experiences are provided in the variety of aquatic, dance, sports, and other physical education activities. Homogeneous skill groupings for instruction in most activities enable the student, beginner through advanced performer, to achieve success within the limits of her capabilities. The program also includes instruction and recreation for coeducational groups.

COMPETITIVE AND RECREATIONAL OPPORTUNITIES

Recreational and competitive events in the intramural and intercollegiate programs are offered in cooperation with the Women's Recreation Association.

The intramural and intercollegiate programs include: archery, badminton, basketball, fencing, field hockey, golf, gymnastics, swimming, tennis, track and field, and volleyball. A planned co-recreational program includes badminton, swimming, tennis, and volleyball.

The Department is affiliated with the Girls and Women's Sports Division of the American and California Associations for Health, Physical Education and Recreation, the Women's National Officials Rating Committee, the National Association for Physical Education of College Women, the Western Society for Physical Education of College Women, and the Athletic Association of Western Universities. The Women's Recreation Association is a member of the National and Pacific Southwest Regional Athletic and Recreation Federation for College Women.

Policy governing women's participation in intercollegiate competition is formed by the Department and the Women's Recreation Association in keeping with policies of affiliated organizations.

FACILITIES, EQUIPMENT, COSTUMES, AND FEES

The Women's Gymnasium houses a basketball floor and area for other indoor activities, dance studio, posture studio, small activities room, dance as well as physical education library, study rooms, offices, and shower, 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 archery, 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 stu-
dent must provide her own white socks and tennis shoes, swimming cap, and appropriate riding clothes.

Fees are charged for enrollment in equitation classes.

**Physical Education Courses**

All courses have a 1-unit value although students may elect to enroll for 0-units in any course. Limits in class size necessitate enrollment through the Women's Physical Education Department during preregistration or registration days.

**COURSES FOR PHYSICAL ACTIVITY:** These courses are offered for women students only or as coeducational classes as listed. A maximum of 12 units of credit will be accepted toward graduation.

**COURSES RELATED TO COMMUNITY LEADERSHIP:** These courses are designed for developing competency in skills which have particular application to service in the community. Each course is open to men and women students unless otherwise noted.

**Courses for Physical Activity**

**Coeducational Classes**

12. Fencing, Elementary.
   *Aut, Win, Spr (Helliwell) MWF 10*

13. Fencing, Intermediate — Prerequisite: promoted from 12 or equivalent.
   *Aut, Win, Spr (Helliwell) MWF 11*

19. Bowling — (See Physical Education for Men.)
   *Aut, Spr (Book) MWF 1:15*

41. Archery.
   *Aut, Spr (Book) MWF 1:15*

61. Modern Dance, Elementary.
   *Aut (Weiss) MWF 10*

   *Aut, Win, Spr (Weiss) WF 11:00-12:15*

63. Ballet, Elementary.
   *Win (Weiss) MWF 10*

64. Ballet, Intermediate.
   *Spr (Weiss) MWF 10*

65. Technique and Rhythms for Dance.
   *Aut, Win (Weiss) TTh 2:15-3:30*

70. Ethnic Dance, Elementary.
   *Aut, Win, Spr (Lidster) TTh 11:00-12:15*

72. Folk Dance, Elementary.
   *Aut (Lidster) TTh 3:15-4:30*

73. Folk Dance, Intermediate.
   *Win, Spr (Lidster) TTh 3:15-4:30*

112. Fencing, Advanced — Prerequisite: promoted from 13 or equivalent.
   *Aut, Win, Spr (Helliwell) MWF 2:15*

113. Fencing, Tournament — Members of this class will participate in intramural and intercollegiate bouts. Prerequisite: promoted from 112 or by consent of instructor.
   *Aut, Win, Spr (Helliwell) TTh 11 and T 7 p.m.*

142. Skin and Scuba Diving — (See Physical Education for Men.)

148. Equitation.
   **Elementary.**
   *Aut, Win, Spr (Melville) MTTh 1:15 or 2:15*

   **Intermediate — Prerequisite: ability to canter securely.**
   *Aut, Win, Spr (Melville) MTTh 10 or 4:15*

   **Jumping — Prerequisite: secure in all three gaits, knowledge of leads and diagonals, and previous instruction.**
   *Aut, Win, Spr (Melville) MTTh 3:15*

151. Rifle and Pistol Marksmanship — (See Physical Education for Men.)

160. Percussion and Movement for Dance.
   *Spr (Weiss) TTh 2:15-3:30*

161. Modern Dance, Advanced Technique — Prerequisite: promoted from 62 or equivalent and by consent of instructor.
   *Aut, Win (Weiss) MW 4:15-5:30*

162. Modern Dance, Advanced Repertory — Prerequisite: advanced ability and by consent of instructor.
   *Spr (Weiss) MW 4:15-5:30*

165. Dance Workshop — Prerequisite: intermediate or advanced ability in modern dance.
   *Aut, Win, Spr (Weiss) T 7:00-9:30 p.m.*

172. Folk Dance, Advanced — Prerequisite: promoted from 70, 73 or equivalent.
   *Win, Spr (Lidster) TTh 4:15-5:30*

173. Folk Dance, Exhibition — Members of this class will participate in dance demon-
strations, exhibitions, and festivals. Prerequisite: by consent of instructor.

Aut, Win, Spr (Lidster) M 7:45–10:00 p.m.

177. Historic Dance: Primitive and Ancient.

Aut (Lidster) MWF 1:15

COURSES FOR 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.

Aut, Spr (Klaus) MWF 2:15
Win (Klaus, Ruch) MWF 2:15 or 3:15

3. Rhythmic Exercises—Group exercises with emphasis on rhythm and dance.

Aut, Win, Spr (Book) MWF 11


Aut (Klaus) TTh 11:00–12:15 or 12:50–2:05
Win, Spr (Klaus) TTh 12:50–2:05

5. Gymnastics, Intermediate—Members of this class will participate in gymnastics demonstrations and meets. Prerequisite: promoted from 4 or equivalent.

Aut (Klaus) TTh 2:15–3:30
Win, Spr (Klaus) TTh 11:00–12:15 or 2:15–3:30

8. Track and Field.

Aut, Spr (Klaus) MWF 5:00–5:45


Aut, Spr (Guthrie) MWF 1:15
Win (Fowler) MW 12:50–2:05

15. Tennis, Elementary—For students with no previous experience or limited knowledge of and ability in fundamental strokes.

Aut, Spr (Guthrie) MWF 10;
(Gordon) MWF 1:15;
(Neal) TTh 12:50–2:05
Win (Guthrie) MWF 10; (Neal) MWF 1:15

16. Tennis, Intermediate—Prerequisite:

knowledge of rules and scoring, average ability in fundamental strokes.

Aut, Spr (Guthrie) MWF 9 or 2:15 or
TTh 10 and one hour by arrangement;
(Gordon) MWF 11 or TTh 14:30–5:30
Win (Guthrie) TTh 10 and one hour by
arrangement or MWF 11;
(Neal) TTh 12:50–2:05;
(Gordon) MWF 2:15


Win (Fowler) MW 4:15–5:30


Aut (Book) TTh 3:30–5:00 and alternate W 4:15

31. Swimming, Elementary—For students unable to swim safely in deep water.

Aut (Fowler) MWF 1:15
Spr (Strathairn) MWF 2:15

32. Swimming, Intermediate—Ability to float, tread water, and swim safely in deep water.

Aut (Fowler) MWF 2:15
Spr (Fowler) MWF 3:15

35. Lifesaving—This is the American Red Cross Senior Lifesaving Course. Prerequisites: strong swimmer; ability to swim a quarter mile without rest, to swim underwater, and to surface dive.

Win (Strathairn) MW or TTh 12:50–2:05
Spr (Strathairn) TTh 11:00–12:15

36. Aquatic Art—Synchronized swimming, water ballet, stunts, and figures. Prerequisite: above average ability in performing the crawlstroke, backstroke, breaststroke and sidestroke.

Aut (Strathairn) MW 3:15 and one practice hour

44. Golf, Elementary—For students who have never had golf instruction.

Aut, Win, Spr (Gordon) TTh 11 or 2:15;
each with one practice hour

45. Golf, Intermediate—Prerequisite: instruction or ability to play nine holes with a score under 60.

Aut, Spr (Gordon) TTh 1:15 or MW 2:15;
each with one practice hour
Win (Gordon) MW 11 or TTh 1:15;
each with one practice hour
56. Jazz Dance, Elementary — Techniques of dance as seen in musicals.
   Aut, Spr (Book) TTh 12:50-2:05
   Win (Book) MWF 1:15 or TTh 12:50-2:05

57. Jazz Dance, Intermediate — Prerequisite: promoted from 56 or equivalent.
   Win (Book) TTh 10 and one hour by arrangement or MW 3:15-4:30
   Spr (Book) TTh 10 and one hour by arrangement

114. Tennis, Advanced—Prerequisite: promoted from 16, or extensive experience which has provided above average ability in all strokes.
   Aut, Spr (Neal) TTh 11:00-12:15 or TTh 2:15-3:30 or MW 3:15-4:30
   Win (Neal) TTh 11:00-12:15 or MW 3:15-4:30

115. Tennis, Tournament—Members of this class will participate in intercollegiate matches. Prerequisite: promoted from 114 or equivalent experience including USLTA tournaments or school team participation.
   Aut, Win, Spr (Neal) TTh 3:15-4:30

121. Basketball, Tournament—Members of this class will play intercollegiate games. Prerequisite: above average ability or one season of playing experience.
   Win (Fowler) TTh 4:15-5:30

124. Field Hockey, Tournament—Members of this class will play intercollegiate games. Prerequisite: one season playing experience.
   Aut (Book) TTh 3:30-5:00 and alternate W 4:15

127. Volleyball, Tournament — Selected members of this class will play intercollegiate games.
   Aut, Spr (Book) MW 3:15-4:30

130. Swimming, Advanced — Prerequisite: promoted from 32, or above average ability in performing the crawlstroke, backstroke, breaststroke, and sidestroke.
   Aut, Spr (Fowler) TTh 3:15 and one practice hour

131. Swimming, Competitive — All members of this class will participate in swimming meets, intramural and/or intercollegiate. No prior experience necessary. Prerequisite: good form in at least one of the racing strokes.
   Aut, Spr (Fowler) MTh or TTh 4:15 and one practice hour

135A. Water Safety Instructor's Course — This is the 15-hour Part I of the American Red Cross W.S.I. course which focuses upon swimming and lifesaving skills of the enrollees. Prerequisite: current American Red Cross Senior Lifesaving certificate and concurrent enrollment in 135B.
   Spr (Strathairn) MW 12:50-2:05

135B. Water Safety Instructor's Course — This is the 15-hour Part II of the American Red Cross W.S.I. course which focuses upon the teaching of swimming and lifesaving by the enrollees. Prerequisites: concurrent enrollment in 135A or current W.S.I. course completion card.
   Spr (Strathairn) MW 12:50-2:05 or by arrangement

144. Golf, Advanced — Prerequisite: promoted from 45, or ability to play 18 holes with a score under 110.
   Aut, Win, Spr (Gordon) MW 3:15 and one practice hour

145. Golf, Tournament — All members of this class will play intramural and intercollegiate matches. Prerequisite: playing experience with average score below 100 for 18 holes.
   Aut, Win, Spr (Gordon) MW 3:15 and one practice hour

COURSES RELATED TO COMMUNITY LEADERSHIP

116. Tennis Officiating — For students desiring to become USLTA rated officials.
   Spr (Guthrie) by arrangement

122. Basketball Officiating — Women only.
   Win (Fowler) by arrangement

138. Aquatics Officiating—All members of this class will officiate intramural and collegiate meets.
   Aut, Spr (Strathairn) MTTh 4:15

180. Aquatic Leadership—A survey course which covers pool management and operation, community programs, and leadership opportunities in aquatic recreation. Women only.
   Aut (Strathairn) by arrangement
181. Golf Tournament Organization —
Women only.

Aut (Gordon) by arrangement

182. Tennis Tournament Organization —
Members of this class will assist in organizing and conducting intramural meets. Women only.

Aut, Spr (Guthrie) by arrangement

183. Fencing Tournament Organization.

Aut, Win, Spr (Helliwell) by arrangement

184. Swimming Meet Organization—Members of this class will assist in organizing and conducting intramural and intercollegiate meets. Women only.

Aut, Spr (Fowler) W 4:15 and by arrangement

190A. Leadership in Recreation for the Retarded—Basic principles, methods and materials. Prerequisites: consent of instructor and concurrent enrollment in 190B.

Aut, Win, Spr (Ruch) MW 8

190B. Leadership in Recreation for the Retarded—Field experience in leading motor activities for retarded children. Prerequisite: concurrent enrollment in 190A.

Aut, Win (Ruch) TTh 11:00–12:05 or 12:50–2:05
Spr (Ruch) TTh 11:00–12:05

191. Directed Field Research in Recreational and Physical Activities for the Handicapped—Individual and group projects relating to devising or modifying games, equipment, visual-aids and instruction for handicapped children. Field work will be conducted at the Stanford Convalescent Home and Palo Alto schools. Prerequisite: consent of the instructor.

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

SENIOR COLLOQUIA


Under the General Studies Program, one Senior Colloquium is required of all seniors who are candidates for the A.B. degree, with a few exceptions. The exceptions are those students entering the Schools of Law or Medicine at the end of their third year, and those enrolled in Honors programs in Humanities or in Social Thought and Institutions. The Colloquia listed below will be offered during the current year unless otherwise indicated in the Time Schedule.

The Senior Colloquia are limited to 15 students each and are structured around subjects or issues of continuing importance, or a basic document of enduring significance. They are designed to stimulate serious thought rather than to impart information for its own sake. Thus the emphasis is on discussion and analysis, not lectures.

Students are not admitted to a Colloquium being taught by a faculty member of their major department. The required Colloquium must be taken for a letter grade; additional Colloquia may be taken for either a letter grade or Pass-Fail. All Colloquia are open to interested B.S. candidates.

Descriptions and reading lists can be found in the current General Studies Program Bulletin.

#4. Identity and the College Student.
2 units, Aut, Spr (Maurer, Cowell Health Center) Th 8–10 p.m.

#5. The Meaning of Death in Western Culture.
2 units, Aut (Black, Counseling and Testing) W 7:30–9:30 p.m.

#8. Economic and Political Aspects of Petroleum Development.
2 units, Win (Marsden, Petroleum Engineering) W 4:15–6:05

2 units, Aut (Peck, Communication) W 7:30–9:30 p.m.

#12. Explorations in Science Fiction.
2 units, Win (Driessel, Provost's Office) Th 7–9
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Title</th>
<th>Credits</th>
<th>Units</th>
<th>Time and Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>#14</td>
<td>The Modern German Drama</td>
<td>2</td>
<td>Spr</td>
<td>M 4:15-6:05</td>
</tr>
<tr>
<td>#16</td>
<td>Right of Privacy: Legal and Theoretical Bases</td>
<td>2</td>
<td>Win</td>
<td>(Gregory, General Secretary’s Office) Th 2:15-4:05</td>
</tr>
<tr>
<td>#18</td>
<td>The World of Aldous Huxley</td>
<td>2</td>
<td>Spr</td>
<td>(Gregory, General Secretary’s Office) Th 2:15-4:05</td>
</tr>
<tr>
<td>#20</td>
<td>Homer and Vergil</td>
<td>2</td>
<td>Win</td>
<td>(Wigodsky, Classics) T 2:15-4:05</td>
</tr>
<tr>
<td>#21</td>
<td>U.S. Foreign Policy Toward the Middle East</td>
<td>2</td>
<td>Win</td>
<td>(Nabti, Hoover Institution) Th 2:15-4:05</td>
</tr>
<tr>
<td>#22</td>
<td>Islam and Modernization in the Middle East</td>
<td>2</td>
<td>Aut</td>
<td>(Ownby, General Studies) T 4:15-6:05</td>
</tr>
<tr>
<td>#23</td>
<td>Islam and Modernization in Egypt</td>
<td>2</td>
<td>Spr</td>
<td>(Ownby, General Studies) T 4:15-6:05</td>
</tr>
<tr>
<td>#24</td>
<td>Values, Roles and Identity in Human Development</td>
<td>2</td>
<td>Aut</td>
<td>(Solomon, Psychiatry) M 4:15-6:05</td>
</tr>
<tr>
<td>#25</td>
<td>Photography: Awareness</td>
<td>2</td>
<td>Win</td>
<td>(Holub, Planning Office) W 7-9 p.m.</td>
</tr>
<tr>
<td>#26</td>
<td>Economic Security and Public Policy</td>
<td>2</td>
<td>Win</td>
<td>(R. Campbell, Hoover Institution) Th 2:15-4:05</td>
</tr>
<tr>
<td>#28</td>
<td>The Destiny of Europe</td>
<td>2</td>
<td>Aut</td>
<td>(Win, Spr) (Hilton, Spanish and Portuguese) W 4:15-6:05</td>
</tr>
<tr>
<td>#30</td>
<td>World Political Significance of the Middle East</td>
<td>2</td>
<td>Win</td>
<td>(Keller, Placement Service) T 4:15-6:05</td>
</tr>
<tr>
<td>#32</td>
<td>Political Philosophy and Jurisprudence</td>
<td>2</td>
<td>Spr</td>
<td>(McCoy, General Studies) T 8-10 p.m.</td>
</tr>
<tr>
<td>#36</td>
<td>Crisis and Change in Latin America</td>
<td>2</td>
<td>Spr</td>
<td>(Hanley, Overseas Campuses) T 2:15-4:05</td>
</tr>
<tr>
<td>#38</td>
<td>The Pursuit of Peace: Case Studies in the Western Hemisphere</td>
<td>2</td>
<td>Aut</td>
<td>(Hanley, Overseas Campuses) T 2:15-4:05</td>
</tr>
<tr>
<td>#39</td>
<td>The Influence of Geographic Factors Upon the Development of Nations</td>
<td>2</td>
<td>Aut</td>
<td>(Win, Spr) (Terry, General Studies) W 7:30-9:30 p.m.</td>
</tr>
<tr>
<td>#45</td>
<td>Photography: Composition, Content, and Expression</td>
<td>2</td>
<td>Aut</td>
<td>(Spr) (Kahn, Art and Architecture) T 2:15-4:05</td>
</tr>
<tr>
<td>#47</td>
<td>The Place of Aircraft, Missiles, and Spacecraft in Twentieth Century Civilization</td>
<td>2</td>
<td>Win</td>
<td>(Hoff, Aeronautics and Astronautics) Th 2:15-4:05</td>
</tr>
<tr>
<td>#49</td>
<td>The Russian Revolution</td>
<td>2</td>
<td>Aut</td>
<td>(Mazour, History) W 2:15-4:05</td>
</tr>
<tr>
<td>#50</td>
<td>Human Values in a Technological Society</td>
<td>2</td>
<td>Aut</td>
<td>(Spr) (Thompson, Industrial Engineering) M 2:15-4:05</td>
</tr>
<tr>
<td>#60</td>
<td>The Literature and History of the Organ</td>
<td>2</td>
<td>Aut</td>
<td>(Spr) (Nanney, Music) W 2:15-4:05</td>
</tr>
<tr>
<td>#65</td>
<td>Parapsychology</td>
<td>2</td>
<td>Aut</td>
<td>(Smith, Humanities) M 7:30-9:30 p.m.</td>
</tr>
<tr>
<td>#71</td>
<td>Masters of Modern Architecture</td>
<td>2</td>
<td>Win</td>
<td>(Cole, Speech and Drama) T 2:15-4:05</td>
</tr>
<tr>
<td>#75</td>
<td>Masterpieces of Choral Music</td>
<td>2</td>
<td>Win</td>
<td>(Schmidt, Music) Th 2:15-4:05</td>
</tr>
<tr>
<td>#79</td>
<td>Leisure in Modern Life</td>
<td>2</td>
<td>Win</td>
<td>(Guthrie, Women’s Physical Education) Th 4:15-6:05</td>
</tr>
<tr>
<td>#82</td>
<td>Dance in Patterns of Culture</td>
<td>2</td>
<td>Aut</td>
<td>(Lidster, Women’s Physical Education) W 2:15-4:05</td>
</tr>
<tr>
<td>#85</td>
<td>The History of the Book</td>
<td>2</td>
<td>Aut</td>
<td>(Spr) (Lenkey, Library) T 2:15-4:05</td>
</tr>
<tr>
<td>#90</td>
<td>Current Controversies over American Education</td>
<td>2</td>
<td>Win</td>
<td>(Thomas, Education) T 4:15-6:05</td>
</tr>
</tbody>
</table>
   2 units, Aut (Higgins, Education) Th 2:15-4:05

#93. The Tragic Sense of Life in Unamuno.
   2 units, Spr (Schevill, Spanish and Portuguese) W 4:15-6:05

#94. Civil Disobedience.
   2 units, Aut (Schrader, Speech and Drama) Th 2:15-4:05

#96. The Underdeveloped Countries: Population, Food Supply, Industrialization.
   2 units, Win (White, General Studies) Th 3:15-5:05

#98. Issues in Science and Religion.
   2 units, Aut, Spr (Bube, Materials Science) T 4:15-6:05

#99. Ceremony and Symbol in Religion and Society.
   2 units, Spr (Minto, University Chaplain) Th 2:15-4:05

#100. Man's Quest for Meaning.
   2 units, Win (Rathbun, Law and Business Schools) W 4:15-6:05

#102. Concepts of Individuality.
   2 units, Win (S. Levine, Psychiatry) given 1970-71

#103. Lenin-Stalin-Khrushchev.
   2 units, Spr (Drachkovitch, Political Science) Th 4:15-6:05

#104. Symbols and Meaning in Science and Culture.
   2 units, Aut (Ripley, Physical Sciences) W 2:15-4:05

#105. The Outsider in Literature.
   2 units, Spr (Weinstein, French and Italian) T 2:15-4:05

   2 units, Spr (Wallin, Sociology) Th 4:15-6:05

#110. Man as a Factor in Evolution.
   2 units, Win (Holm, Biological Sciences) Th 2:15-4:05

#111. The Human Maturation Process.
   2 units, Aut (Fitton, General Studies) W 8-10 p.m.

   2 units, Aut (Syed, General Studies) Th 2:15-4:05

#121. The Succession of Life Through Geologic Time.
   2 units, Aut (Thalmann, Geology) T 4:15-6:05

#122. Fossil Man and the Ice Age.
   2 units, Win (Thalmann, Geology) T 4:15-6:05

#123. Voltaire and Johnson.
   2 units, Win (Loftis, English) W 4:15-6:05

#124. Contemporary African Drama and Literature.
   2 units, Aut (Okpaku, General Studies) Th 7:30-9:30 p.m.

#127. Herman Melville's Moby Dick.
   2 units, Win, Spr (H. Trimpi, English) Th 2:15-4:05

#131. The Position of Women in Different Civilizations.
   2 units, Aut (Sokol, Political Science) T 4:15-6:05

#146. Mystics and Mysticism.
   2 units, Spr (Watkins, Political Science) T 2:15-4:05

#149. The Age of Jefferson.
   2 units, Win (Miller, History) T 2:15-4:05

#157. Law and the Social Structure.
   2 units, Aut, Spr (Davis, Dean of Students Office) T 7:30-9:30 p.m.

#159. The Pattern of Cities.
   2 units, Spr (Sanders, Planning and Architecture) W 7:30-9:30 p.m.

#178. The Writing of Albert Camus.
   2 units, Spr (Cohn, French and Italian) Th 4:15-6:05, given 1970-71

   2 units, Aut, Win (Wallia, General Studies) M 7:30-9:30 p.m.

#180. Education and Social Change in Arab Countries of the Near East.
   2 units, Aut (Abu-Hilal, General Studies) M 7:30-9:30 p.m.
#183. Christian Impact on Africa.
2 units, Win (Minto, University Chaplain)
Th 2:15-4:05

#195. Social Science Approaches to Music.
2 units, Aut (Farnsworth, Psychology)
T 2:15-4:05

#196. Mozart and His Music.
2 units, Spr (Kuhn, Music) M 2:15-4:05

#200. Psychiatry for Amateur Psychiatrists.
2 units, Aut (Paulsen, Cowell Health Center and Medical School)
T 8-10 p.m.

SPECIAL OPPORTUNITIES IN GRADUATE STUDY

INSTITUTE FOR PLASMA RESEARCH

Executive Committee: Peter A. Sturrock (Chairman), Daniel Bershader, Oscar Buneman, I-Dee Chang, Marvin Chodorow, Frederick W. Crawford, Donald A. Dunn, Von R. Eshleman, Robert H. Eustis, Krishnamurtz Karamcheti, Gordon S. Kino, Charles H. Kruger, Morton Mitchner

The Institute is an interdepartmental organization coordinating teaching and research in plasma physics at Stanford and incorporates five specialized research groups.

The Aerophysics Group (Baganoff, Bershader, Chang, Karamcheti) 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 (Sturrock) is engaged in astrophysical studies related to the sun, supernova remnants, radio galaxies, quasars and cosmic rays.

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) 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, Dunn) concentrates on the kinetic theory of low-density plasmas as related to plasma containment, with supporting laboratory experiments and computer simulation.

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 Bershader, 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 circumlunar 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 Engineering, Aeronautics and Astronautics, Electrical Engineering, Geophysics, and Applied Physics.

The Space Science and Related Programs are available to any interested and qualified graduate student, who must be admitted by and registered in a department. The Departments of Aeronautics and Astronautics, 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 Executive Committee.

STANFORD LINEAR ACCELERATOR CENTER

Director: Wolfgang K. H. Panofsky
Deputy Director: Matthew Sands
Associate Directors: Joseph Ballam (Research Division); Robert H. Moulton, Jr. (Administrative Services Division); Richard B. Neal (Technical Division); Frederick V. L. Findar (Business Services Division)


Associate Professors: David Leith, Richard E. Taylor
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. The major experimental facility of the Center is a two-mile-long linear electron accelerator which has been constructed and is operated under a contract with the United States Atomic Energy Commission.

The accelerator, which began operations for physics research during 1966, can provide an electron beam at energies up to 20 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 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, intended for use in spark-chamber and streamer-chamber experiments. A variety of general purpose apparatus is also available.

The Center is operated by Stanford as a national facility so that qualified scientists from universities and research centers throughout the country and the world, as well as those at Stanford, may participate in
the high energy physics research program of the Center. As of January, 1969, physicists from 22 other universities have had research programs 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.

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 SPECIAL PROGRAMS

**Undergraduate Special Courses**

**Committee on Undergraduate Education:**

Philip M. Rhinelander (Chairman), Michael J. Benefiel, Sarah Main (Secretary), John W. Meyer, Nancy O. Oswald, Herbert L. Packer, Robert M. Polhemus, John K. Vennard, Robert A. Walker, Richard R. Young

In 1964 the Committee on Undergraduate Education established a new category of courses for undergraduates to be called "Undergraduate Special Courses." One category of these courses is special offerings for undergraduates by members of the graduate professional schools. These are not intended to introduce the technical content of the professional schools into the undergraduate curriculum, but are to be general in character. Their principal purpose is to enrich the curriculum for undergraduates by drawing upon the resources of the professional schools as well as other parts of the University which customarily have not participated in undergraduate work. A second purpose is to offer an opportunity to introduce experimental courses, interdisciplinary courses, and other types which for various reasons might be listed as "Undergraduate Special" rather than under the 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 up to 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 Education. 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:
Quarter in which the course will be offered | Filing Deadline
--- | ---
Summer or Autumn | May 15
Winter | Nov. 15
Spring | Feb. 15

6. No more than one Undergraduate Special course may be taken for academic credit in any one quarter without the express approval of the Committee on Undergraduate 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 Education.

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.

2 units, Aut (Lederberg, Staff) TTh 11

102. Risk and Insurance—The course will cover the general or “classical” theory of risk, an introduction to the theory of games, and analytical case study. It will give the student the kind of knowledge needed to analyze and solve problems involving personal and business decisions in the field of risk and insurance management.

2 units, Aut, Spr (Serbein) MTh 4:15

103. Modern Thought and Literature: The Impulse to Confess. The impulse to true and false confession as reflected in autobiography and fiction, and in historical events, and as seen by students of literature, psychology, history, religion and law. Limited to 15. Students should apply to Professor Guerard before the end of the autumn quarter.

5 to 10 units, Win, by arrangement

**FRESHMAN SEMINARS**

*Program for Undergraduate Creative Development*

The Freshman Seminar program, inaugurated in 1965–66, allows first-year students to explore in depth a subject that holds special personal interest for them and introduces them to other members of the University community who share this interest. Led by a faculty member, each seminar group of eight students meets for two quarters one afternoon or evening each week in the instructor’s home or laboratory. The seminar offers an opportunity for the kind of extended study which can lead to the development of a genuine sense of intellectual and social community between student and instructor.

The Freshman Seminar program is neither an honors program nor an advanced placement program. Although a few seminars do have prerequisites, most are open to any student in the freshman class who is interested in the subject of the seminar and in the challenges of study in a seminar group. Each seminar carries a total of six units of academic credit (three units for each quarter), but fulfills neither the University’s General Studies nor major subject requirements. Although students do receive a grade for their seminar work, in most cases this grade is not given until the end of the second quarter of the seminar.

In 1968–69 thirty-one departments or schools in the University participated in the seminar program, offering a total of 60 seminars to 480 members of the freshman class. Departments participating in the program were Aeronautics and Astronautics, Asian Languages, Biology, Classics, Communication, Computer Science, Controllers Office, Economics, Education, Electrical Engineering, English, French and Italian, General Studies Office, Geology, Geophysics, History, Committee on Linguistics, Mathematics, Medicine, Music, Operations Research, Petroleum Engineering, Physics, Political Science, Psychology, Slavic, Sociology, Spanish and Portuguese, Speech and Drama, Stanford Linear Accelerator Center, and Statistics. In addition, there were five special seminars offered by distinguished members of the local community.

**APPLICATIONS AND ADMISSION PROCEDURES**

All students who accept admission to Stanford University receive in June a copy of the Freshman Seminar booklet describing seminar offerings for the coming academic year. Approximately two-thirds of these
seminars are scheduled for autumn-winter, with the remaining seminars meeting in winter-spring. Applications for the autumn-winter seminars are received and processed late in the summer; students are notified of their seminar status before they arrive at Stanford for preregistration. Except for seminars with prerequisites, seminar participants are chosen at random from among those who apply. Applications for the winter-spring seminars are processed in a similar manner late in the autumn quarter.

Correspondence regarding the program should be addressed to the Freshman Seminar Office, Stanford University, Stanford, California 94305.
INDEX

Administration credentials, 46
Advanced degrees, 8
Aeronautics and Astronautics, 79
Aerospace Studies, 169
African Language and Area Center, 413
African and Afro-American Studies, 413
Allied Medical Sciences, 396
Anatomy, 398
Anthropology, 172
Applied Mechanics, 94
Applied Physics, 179
Archaeology, Roman, 225
Architecture, 182
Art, 182
Asian Languages, 192
Astronomy, 337
Automation, 409
Automating computing, 414
Bachelor of Arts degree, 8
Bachelor of Laws degree, 11
Bachelor of Science degree, 8
Biochemistry, 399
Biomedical Engineering, 73
Biological Sciences, 198
Biophysics Program, 207
Business, Graduate School of, 15
Calendar, 2
Chemical Engineering, 103
Chemistry, 211
Chinese, 192
Chinese-Japanese Language Center, 193
Civil Engineering, 105
Classics, 219
Communication, 225
Communication Research, Institute for, 230
Computation Center, 414
Computer Science, 234
Courses of Instruction, 14
Degrees, 5
Digital computer, 234
Doctor of Education degree, 10
Doctor of Medicine degree, 11
Doctor of Musical Arts degree, 10
Doctor of Philosophy degree, 11
Doctor of Science of Law degree, 11
Drama, 378
Dual Degree Program, 71
Dudley Herbarium, 210
Earth Sciences, School of, 15
East Asian Studies, 240
Economics, 240
Economics, School of, 41
Electrical Engineering, 115
Education degree, 10
Engineering, 75
Engineering, School of, 65
Engineering-Economic Systems, 75
English, 251
English for Foreign Students, 302
Entomological collections, 208
Food Research Institute, 415

French, 264
Freshman Seminars, 443
General Studies Program, 419
Gene, 400
Geology, 17
Geophysics, 26
German, 271
Graduate Division Special Programs, 420
Greek, 222

Hansen, W. W., Laboratories, 337
Hebrew, 294
High Energy Physics Laboratory, 337
History, 277
Honors Program, Humanities under-graduate, 290
Honors Program in Social Thought and Institutions, 365
Hoover Institution, 422
Hopkins Marine Station, 208
Humanities and Sciences, School of, 169
Humanities, Graduate Program, 290
Humanities Special Programs, 289
Hydrology, Committee on, 423

Industrial Engineering, 136
Inter-University Center in Tokyo, 424
Inter-University Program in Taipei, 425
Italian, 264

Japanese, 192
Journalism, 225

Lane Medical Library, 425
Language Laboratory, 297
Latin, 219
Latin American Studies, 297
Law, School of, 393
Libraries, 425 (Special, 427)
Linguistics, 396
Literature in translation, 192, 219, 264, 271, 362, 372

Main Library, 426
Major requirements, 7
Marine biology, 208
Master of Architecture degree, 9
Master of Arts degree, 9
Master of Arts in Teaching, 44
Master of Business Administration degree, 9
Master of Fine Arts, 10
Master of Laws degree, 11
Master of Science degree, 9
Materials Science, 142
Mathematics, 303
Mechanical Engineering, 148
Medical Microbiology, 402
Medicine, School of, 395
Metallurgical Engineering—See Materials Science and Mineral Engineering

Microwave Laboratory, 337
Military Science, 314

Mineral Engineering, 29
Mineral Sciences—See Earth Sciences
Mineralogy, 23
Music, 316

Natural History Museum—See Systematic Biology
Naval Science, 323
Nuclear Engineering, 160
Nursing, School of, 396
Oceanography, 208
Operations Research, 163

Paleontology, 24
Pathology, 399
Petroleum Engineering, 26
Pharmacology, 405
Philosophy, 325
Physical Education, Co-education programs, 434, 436
Physical Education, Men, 429
Physical Education, Women, 433
Physical Sciences, 335
Physical Therapy, Division of, 396
Physics, 337, 7
Physics, Applied, 179
Physiology, 407
Plasma Research, Institute for, 440
Polish, 363
Political Science, 345
Portuguese, 372
Preliminary requirements, 200
Preprofessional requirements, 200
Product Design, 185
Psychology, 355
Public School Credentials, 46

Religious Studies, 292
Russian, 362

Senior Colloquia, 437
Slavic, 362
Social Sciences, 362
Sociology, 366
Space Science, 440
Spanish, 372
Speech, 375
Speech and Hearing Sciences, Program in, 409
Stanford Linear Accelerator Center, 441

Statistics, 386
Stratigraphy, 24
Summer Session courses, 14
Supervision credentials, 48
Systematic Biology, Division of, 21

Teaching credentials, 47

Undergraduate Program in African and Afro-American Studies, 413
Undergraduate Special Programs, 442
U.S. History and Constitution Requirement, 7

Varian, Russell H., Laboratory, 337

Zoological collections, 2