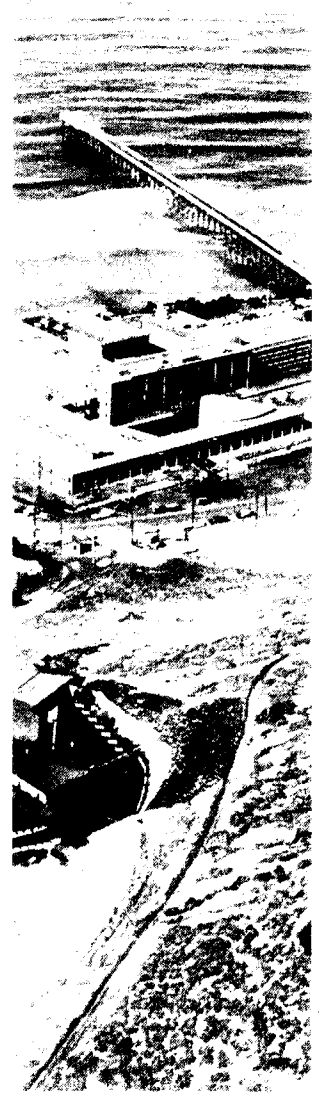
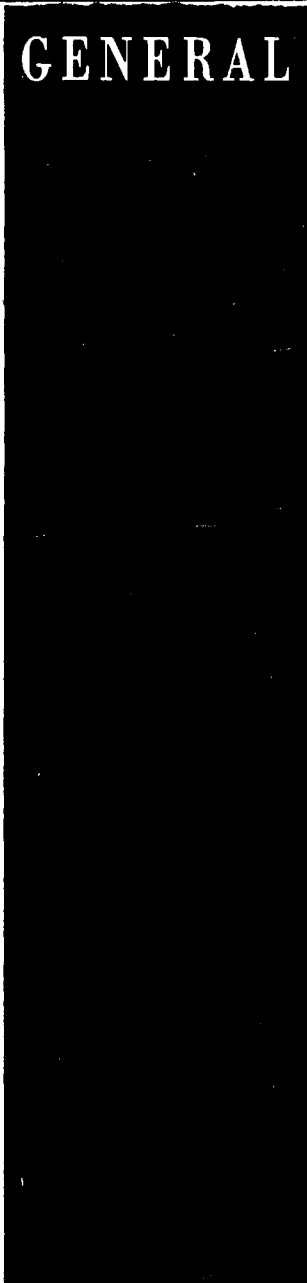


GENERAL



UNIVERSITY OF CALIFORNIA, SAN DIEGO

SCHOOL OF SCIENCE AND ENGINEERING

SCRIPPS INSTITUTION OF OCEANOGRAPHY



UNIVERSITY OF CALIFORNIA, SAN DIEGO / La Jolla, California

SCHOOL OF SCIENCE AND ENGINEERING

SCRIPPS INSTITUTION OF OCEANOGRAPHY

GENERAL CATALOGUE / *Fall and Spring Semesters, 1963-64*

JULY 1, 1963

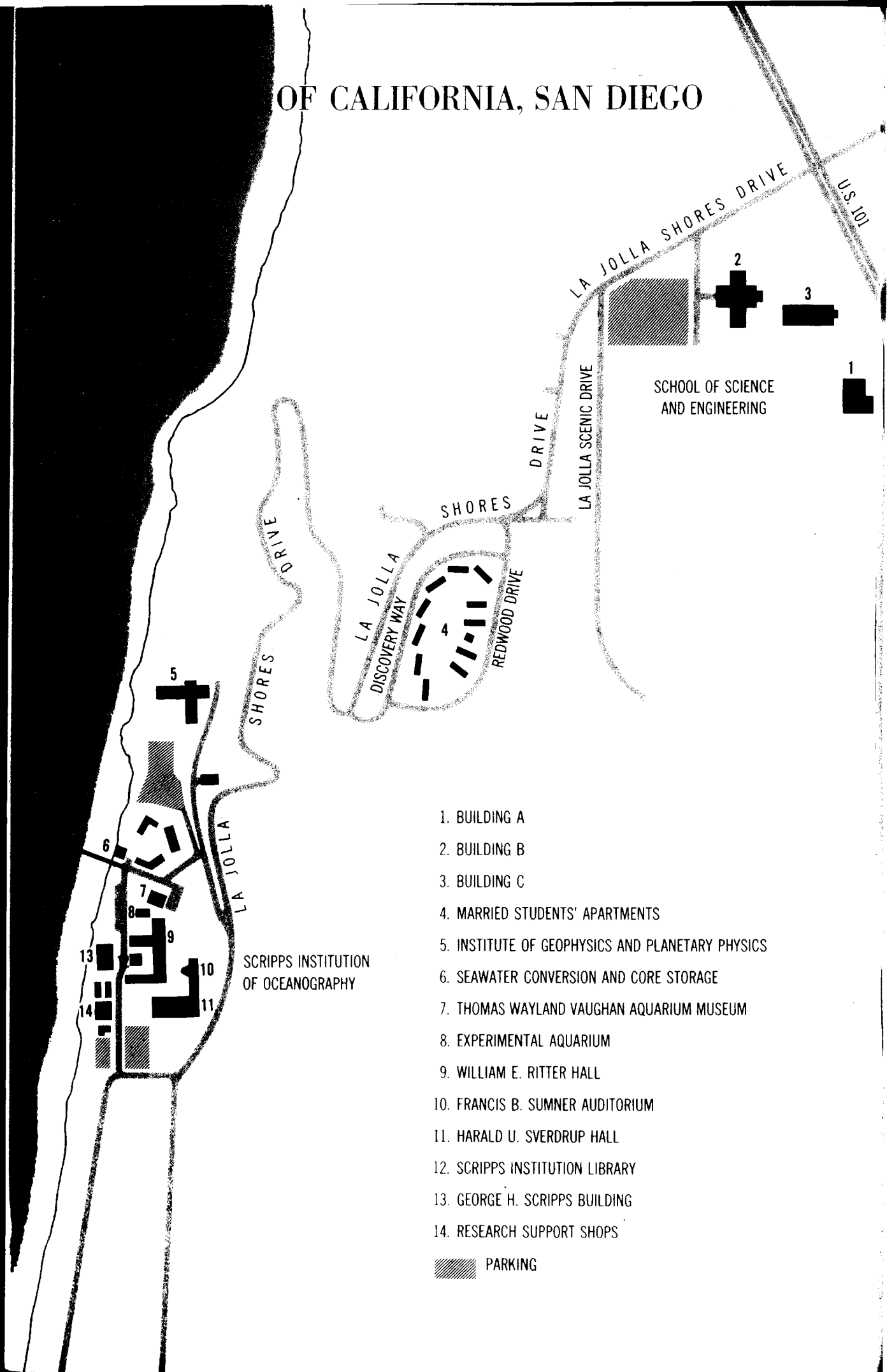


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OF CALIFORNIA, SAN DIEGO



SCRIPPS INSTITUTION
OF OCEANOGRAPHY

SCHOOL OF SCIENCE
AND ENGINEERING

1. BUILDING A
 2. BUILDING B
 3. BUILDING C
 4. MARRIED STUDENTS' APARTMENTS
 5. INSTITUTE OF GEOPHYSICS AND PLANETARY PHYSICS
 6. SEAWATER CONVERSION AND CORE STORAGE
 7. THOMAS WAYLAND VAUGHAN AQUARIUM MUSEUM
 8. EXPERIMENTAL AQUARIUM
 9. WILLIAM E. RITTER HALL
 10. FRANCIS B. SUMNER AUDITORIUM
 11. HARALD U. SVERDRUP HALL
 12. SCRIPPS INSTITUTION LIBRARY
 13. GEORGE H. SCRIPPS BUILDING
 14. RESEARCH SUPPORT SHOPS
- ▨ PARKING

CALENDAR, 1963-1964

5

FALL SEMESTER, 1963-64

- 1963** Aug. 1, *Thursday* Last day for filing new applications for admission (accompanied by official transcripts in duplicate), as well as renewal of applications previously submitted.
- Aug. 15, *Thursday* Last day for filing applications for readmission after an absence.
- Sept. 4, *Wednesday* Examination in English for foreign students.
- Sept. 9, *Monday* Fall semester begins.
- Sept. 9, *Monday through*
Sept. 12, *Thursday* Registration week. For details, see the Registration Circular and official bulletin boards.
- Sept. 16, *Monday* Instruction begins.
- Sept. 20, *Friday* Last day to file registration packets or to change study lists without fee.
- Oct. 7, *Monday* Last day for filing applications for advancement to candidacy for master's degree to be conferred in January, 1964.
- Nov. 9, *Saturday* End of mid-term period.
- Nov. 18, *Monday* Last day for graduate students to add courses to study list and/or drop courses without penalty of F (failure).
- Nov. 25, *Monday* Last day for filing in final form with the committee in charge theses for doctor's degree to be conferred in January, 1964.
- * Nov. 28, *Thursday, and*
Nov. 29, *Friday* Thanksgiving Holiday.
- Nov. 28, *Thursday,*
through
Nov. 30, *Saturday* Fall Recess.
- Dec. 16, *Monday* Last day for filing new applications for admission (accompanied by official transcripts in duplicate), as well as renewal of applications previously submitted.

*Academic and administrative holiday.

*Dec. 16, Monday, through
Jan. 1, Wednesday*

Christmas Recess.

* *Dec. 23, Monday,
through
Dec. 25, Wednesday*

Christmas Holiday.

1964 * *Jan. 1, Wednesday*

New Year's Holiday

Jan. 2, Thursday

Classes resume after Christmas Recess.

Jan. 2, Thursday

Last day for filing in final form with the committee in charge theses for master's degree to be conferred in January, 1964.

Jan. 18, Saturday

Instruction ends.

*Jan. 20, Monday, through
Jan. 29, Wednesday*

Final examinations.

Jan. 27, Monday

Last day for filing with the Dean of the Graduate Division completed copies of theses for master's and doctor's degrees to be conferred in January, 1964.

Jan. 29, Wednesday

Fall semester ends.

SPRING SEMESTER, 1964

Jan. 2, Thursday

Last day for filing applications for readmission after an absence.

Jan. 29, Wednesday

Examination in English for foreign students.

Feb. 3, Monday

Spring semester begins.

*Feb. 3, Monday, through
Feb. 6, Thursday*

Registration week. For details, see Registration Circular and official bulletin boards.

Feb. 10, Monday

Instruction begins.

* *Feb. 12, Wednesday*

Lincoln's Birthday.

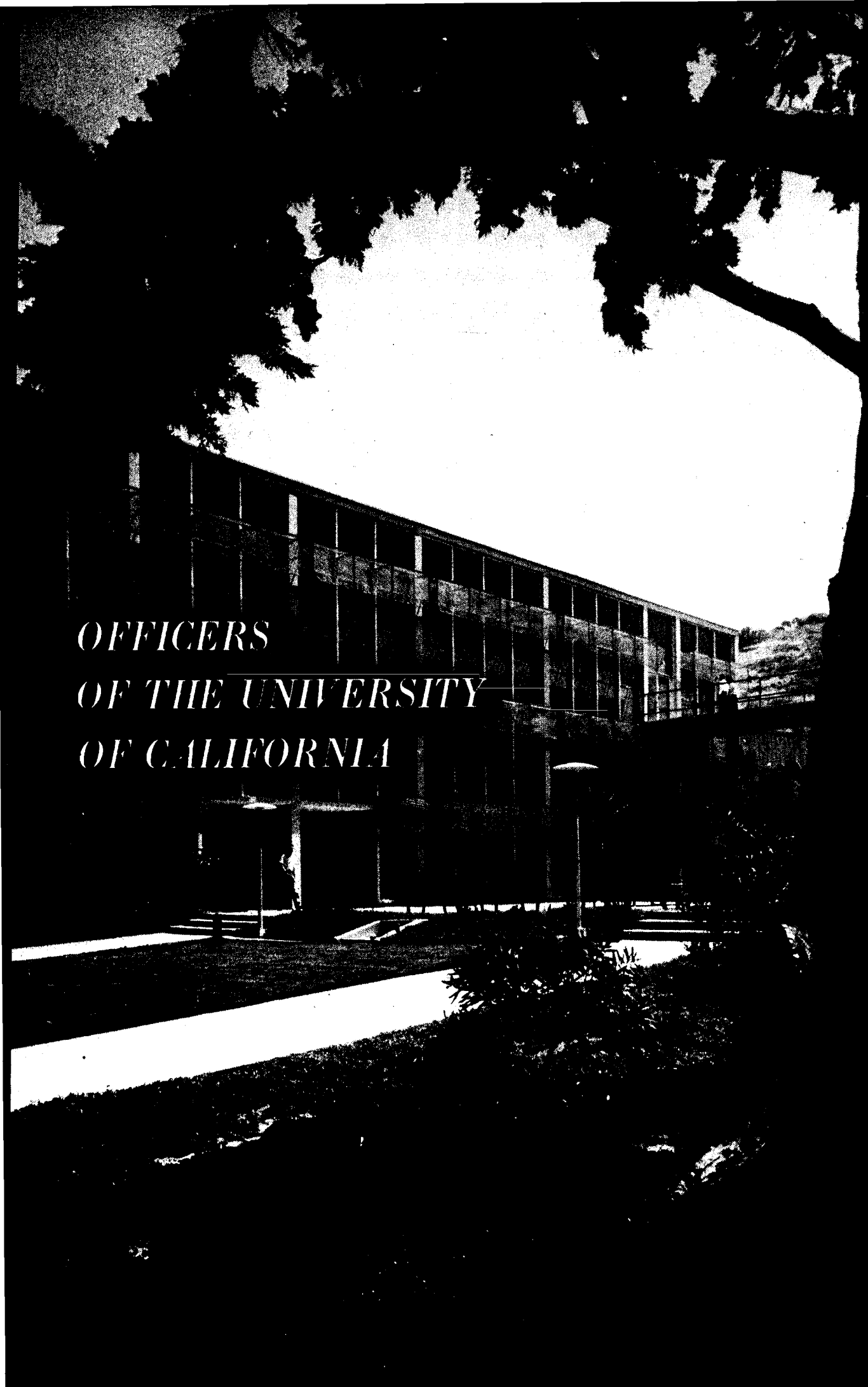
Feb. 14, Friday

Last day to file registration packets or to change study lists without fee.

* *Academic and administrative holiday.*

- Feb. 14, Friday* Last day for filing applications for advancement to candidacy for master's degree to be conferred in June, 1964.
- Mar. 23, Monday, through
Mar. 27, Friday* Spring Recess.
- Apr. 4, Saturday* End of mid-term period.
- Apr. 17, Friday* Last day for students to add courses to study list and/or to drop courses without penalty of F (failure).
- May 4, Monday* Last day for filing in final form with the committee in charge theses for master's degree to be conferred in June, 1964.
- May 15, Friday* Last day for filing in final form with the committee in charge theses for doctor's degree to be conferred in June, 1964.
- May 29, Friday* Instruction ends.
- ° May 30, Saturday* Memorial Day.
- June 1, Monday* Last day for filing with the Graduate Division completed copies of theses for master's and doctor's degrees to be conferred in June, 1964.
- June 1, Monday,
through
June 10, Wednesday* Final examinations.
- June 10, Wednesday* Spring semester ends.

°Academic and administrative holiday.



*OFFICERS
OF THE UNIVERSITY
OF CALIFORNIA*

THE REGENTS OF THE UNIVERSITY

Regents Ex Officio

- His Excellency, EDMUND G. BROWN, LL.B.
Governor of California and President of the
Regents
State Capitol, Sacramento 14
- GLENN M. ANDERSON, A.B.
Lieutenant-Governor of California
State Capitol, Sacramento 14
- JESSE M. UNRUH, A.B.
Speaker of the Assembly
State Capitol, Sacramento 14
- MAX RAFFERTY, A.B., M.A., Ed.D.
State Superintendent of Public Instruction
721 Capitol av, Sacramento 14
- JOHN S. WATSON, B.S.
President of the State Board of Agriculture
498 Pepper rd, Petaluma
- THEODORE R. MEYER, A.B., J.D.
President of the Mechanics' Institute
Brobeck, Phleger & Harrison
111 Sutter st, San Francisco 4
- ROBERT E. ALSHULER, A.B.
President of the Alumni Association of
the University of California
505 Shatto pl,
Los Angeles 5
- CLARK KERR, Ph.D., LL.D.
President of the University
714 University hall, Berkeley 4
2147 Administration bldg, Los Angeles 24

Appointed Regents

The term of the appointed Regents is sixteen years, and terms expire March 1 of the years indicated in parentheses.

- EDWIN W. PAULEY, B.S., LL.D. (1970)
Ten Thousand Santa Monica blvd.
Los Angeles 25
- CORNELIUS J. HAGGERTY (1966)
A.F.L.-C.I.O. bldg, 815 Sixteenth st NW,
Washington 6, D. C.
- DONALD H. McLAUGHLIN, B.S., M.A.,
Ph.D., D.Eng. (1966)
100 Bush st, San Francisco 4
- GERALD H. HAGAR, A.B., J.D. (1964)
1520 Central bldg, 14th and Broadway,
Oakland 12
- EDWARD W. CARTER, A.B., M.B.A., LL.D.
(1968)
14th Floor, United California Bank bldg,
600 S Spring st, Los Angeles 14
- MRS. DOROTHY B. CHANDLER, LL.D.
(1970)
202 W First st, Los Angeles 53
- MRS. RANDOLPH A. HEARST (1974)
233 W Santa Inez av, Hillsborough
- SAMUEL B. MOSHER, B.S. (1972)
1010 Wilshire blvd, Los Angeles 17
- JOHN E. CANADAY, A.B. (1974)
Lockheed Aircraft Corporation, Burbank
- PHILIP L. BOYD, A.B. (1972)
3900 Market st, Riverside
- JERD F. SULLIVAN, JR. (1964)
Crocker-Anglo National Bank,
1 Montgomery st, San Francisco 4
- NORTON SIMON (1976)
1645 W Valencia dr, Fullerton
- WILLIAM E. FORBES, A.B. (1978)
637 S Hill st, Los Angeles 14
- WILLIAM M. ROTH, A.B. (1968)
215 Market st, San Francisco 5
- MRS. EDWARD H. HELLER, A.B., LL.D.
(1976)
99 Faxon rd, Atherton
- FREDERICK G. DUTTON, A.B., LL.B.
(1978)
2700 35th pl, NW, Washington 7, D. C.

Officers of The Regents

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Governor of California
President
State Capitol, Sacramento 14
- Gerald H. Hagar, A.B., J.D., Chairman
1520 Central bldg, 14th and Broadway,
Oakland 12
- Owsley B. Hammond, B.A., M.B.A., A.M.P.,
Treasurer
615 University hall, Berkeley 4
- Stanley J. Thomson, A.B., Assistant Treasurer
615 University hall, Berkeley 4
- Miss Marjorie J. Woolman, Secretary
689 University hall, Berkeley 4

Officers of The Regents—continued

- Mrs. Elizabeth O. Hansen, A.B.
Assistant Secretary
689 University hall, Berkeley 4
- Thomas J. Cunningham, A.B., LL.B., LL.D.
General Counsel
590 University hall, Berkeley 4
- John E. Landon, A.B., LL.B.
Associate Counsel
590 University hall, Berkeley 4
- John P. Sparrow, A.B., LL.B.
Associate Counsel
590 University hall, Berkeley 4
- Robert C. Field, A.B., LL.B.
Assistant Counsel
590 University hall, Berkeley 4
- Milton H. Gordon, A.B., LL.B.
Assistant Counsel and Assistant Secretary
590 University hall, Berkeley 4
- Mark Owens, Jr., A.B., LL.B.
Assistant Counsel
and Attorney in Residence Matters
590 University hall, Berkeley 4
- Donald L. Reidhaar, A.B., LL.B.,
Assistant Counsel
590 University hall, Berkeley 4

GENERAL ADMINISTRATIVE OFFICERS

- President of the University*
Clark Kerr, Ph.D., LL.D.
- President of the University, Emeritus*
Robert Gordon Sproul, B.S., LL.D., Litt.D.
- Vice-President of the University*
Harry R. Wellman, Ph.D.
- Vice-President of the University, Emeritus,
and Dean of the College of Agriculture,
Emeritus*
Claude B. Hutchison, M.S., LL.D., D.Agr.
(hon.c.)
- Vice-President—Administration*
John W. Oswald, Ph.D.
- Vice-President—Business*
Elmo R. Morgan, B.S.
- Vice-President, and General Counsel of the
Regents*
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LL.D.
- Vice-President—Governmental Relations
and Projects*
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- Vice-President and Treasurer of the Regents,
Emeritus*
Robert M. Underhill, B.S.
- Vice-President—University Relations*
Earl C. Bolton, A.B., LL.B.
- Secretary of the Regents*
Miss Marjorie J. Woolman
- Treasurer of the Regents*
Owsley B. Hammond, B.A., M.B.A., A.M.P.
- University Dean of Academic Planning*
Dean E. McHenry, Ph.D.
- University Dean of Agriculture and
Director of the Agricultural Experiment
Station*
Maurice L. Peterson, Ph.D.
- University Dean of Educational Relations*
Frank L. Kidner, Ph.D.
- Dean of University Extension*
Paul H. Sheats, Ph.D.
- University Dean—Research*
Roger Revelle, Ph.D., D.Sc.
- Chancellor at Berkeley*
Edward W. Strong, Ph.D.
Vice-Chancellor Raymond G. Bressler, Jr.,
Ph.D.
Vice-Chancellor Lincoln Constance, Ph.D.
Vice-Chancellor Alex C. Sheriffs, Ph.D.
- Chancellor at Davis*
Emil M. Mrak, Ph.D.
Vice-Chancellor Everett Carter, Ph.D.
- Chancellor at Irvine*
Daniel G. Aldrich, Jr., Ph.D., Sc.D.
- Chancellor at Los Angeles*
Franklin D. Murphy, M.D., Sc.D., L.H.D.
LL.D.
Vice-Chancellor Foster H. Sherwood, Ph.D.
Vice-Chancellor—Health Sciences,
Stafford L. Warren, M.A., M.D., D.Sc.
Vice-Chancellor William G. Young, Ph.D.
- Chancellor at Riverside*
Herman T. Spieth, Ph.D.
Vice-Chancellor—Academic Affairs,
Robert L. Metcalf, Ph.D.
- Chancellor at San Diego*
Herbert F. York, Ph.D., D.Sc.
- Chancellor at Santa Barbara*
Vernon I. Cheadle, Ph.D.
Vice-Chancellor A. Russell Buchanan,
Ph.D.
Vice-Chancellor Stephen S. Goodspeed,
Ph.D.
- Chancellor at Santa Cruz*
Dean E. McHenry, Ph.D.
- Provost at San Francisco Medical Center*
John B. deC. M. Saunders, M.B., Ch.B.,
F.R.C.S. (Edin.)
Vice-Provost Willard C. Fleming, D.D.S.,
D.Sc.

**DEANS OF THE GRADUATE DIVISIONS OF THE
UNIVERSITY OF CALIFORNIA**

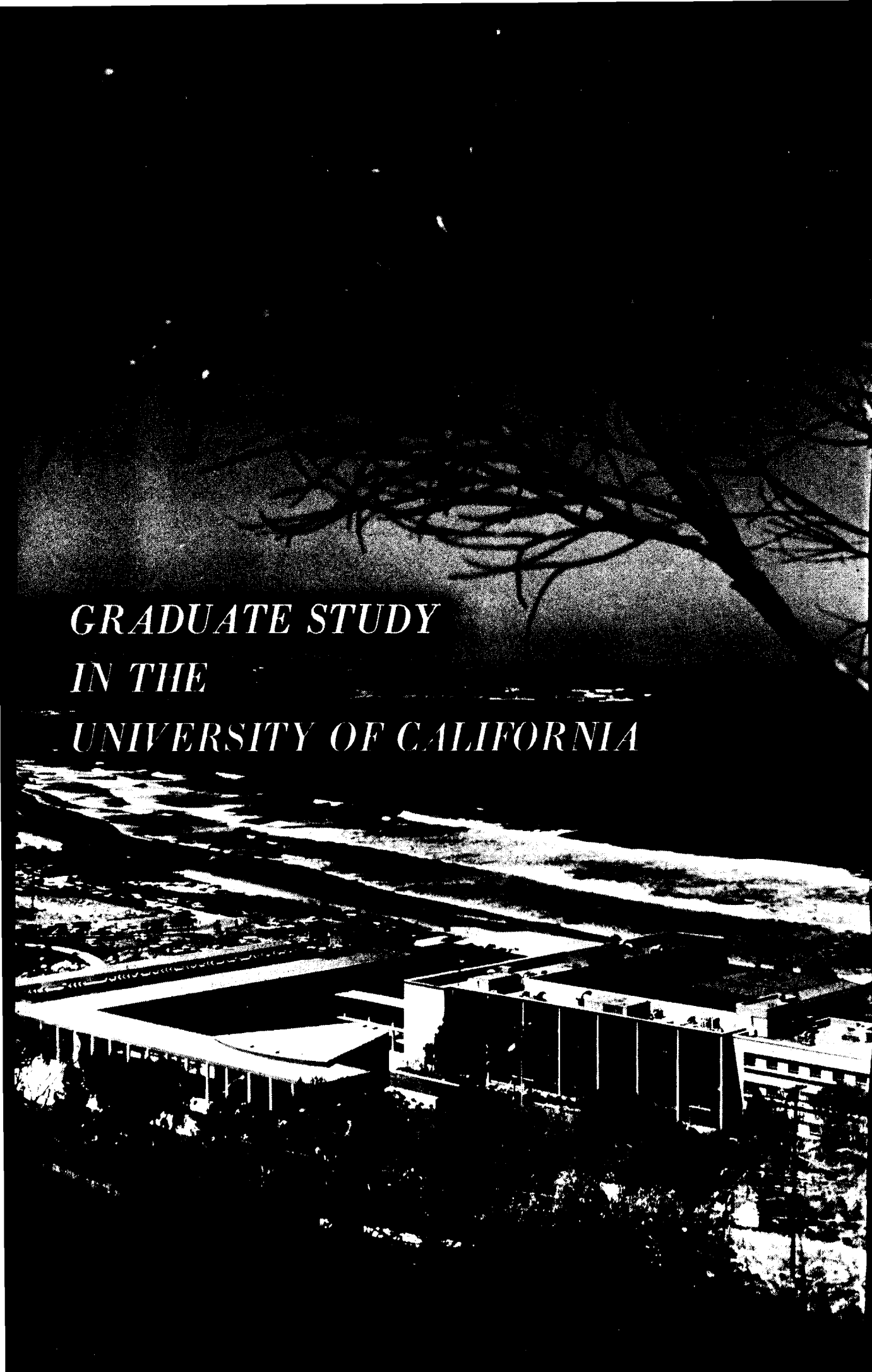
Berkeley – Sanford S. Elberg, Ph.D.
 Davis – Byron R. Houston, Ph.D.
 Los Angeles – Horace W. Magoun, M.D.
 Riverside – Ralph B. March, Ph.D.

San Diego – Norris W. Rakestraw, Ph.D.
 (Acting)
 San Francisco Medical Center – Harold A.
 Harper, Ph.D.
 Santa Barbara –

**GENERAL ADMINISTRATIVE OFFICERS OF THE
UNIVERSITY OF CALIFORNIA, SAN DIEGO**

Chancellor
 Herbert York, Ph.D., D.Sc.
Assistant Chancellor – Business Affairs
 J. H. Clark, M.A.
Dean of the Graduate Division
 Norris W. Rakestraw, Ph.D. (Acting)
Dean of Student Affairs
 Theodore W. Forbes, Ph.D.
*Dean of the School of Science and
 Engineering*
 Keith A. Brueckner, Ph.D.
*Associate Director of the Institute of
 Oceanography*
 Roger Revelle, Ph.D., D.Sc.
*Associate Director of the Institute of
 Geophysics and Planetary Physics*
 Walter H. Munk, Ph.D.
Director of the Institute of Marine Resources
 Milner B. Schaefer, Ph.D.
University Librarian
 Melvin J. Voigt, M.A.
Chairman of the Department of Biology
 David M. Bonner, Ph.D.

Chairman of the Department of Chemistry
 Joseph E. Mayer, Ph.D.
*Chairman of the Department of
 Earth Sciences*
 Freeman Gilbert, Ph.D.
*Chairman of the Department of Marine
 Biology*
 Francis T. Haxo, Ph.D.
Chairman of the Department of Oceanography
 E. W. Fager, Ph.D., D.Phil.
Chairman of the Department of Physics
 Norman M. Kroll, Ph.D.
Director of the Computer Center
 Clay L. Perry, Ph.D.
Accounting Officer
 Herman D. Johnson, B.S.
Building Program Coordinator
 J. W. Tippetts, A.B.
Administrator of Central Services
 J. W. Hutchison
Personnel Manager
 Ruth R. Handley, B.S.
*Manager of Publications and Public
 Information*
 Thomas A. Manar, A.B.



*GRADUATE STUDY
IN THE
UNIVERSITY OF CALIFORNIA*

GENERAL INFORMATION

The University of California offers opportunities for graduate study in academic and professional fields. Graduate Divisions have been created on the Berkeley, Davis, Los Angeles, Riverside, San Diego, and Santa Barbara campuses and at the San Francisco Medical Center. Statewide coordination of graduate study in the University is provided by the Coordinating Committee on Graduate Affairs, a committee of the Academic Senate. On each campus of the University that offers graduate instruction a Graduate Council has been created by the Academic Senate to establish policies for the conduct of graduate study and supervision of graduate students.

The Graduate Divisions administer programs of study leading to the degrees of Master of Arts, Master of Science, Doctor of Philosophy, and such other graduate degrees as from time to time may be approved.

Inquiries regarding graduate study should be directed to the Dean of the Graduate Division on the campus where the student plans to enroll.

ADMINISTRATION OF THE UNIVERSITY

The organization and government of the University of California is entrusted, under the State Constitution, to a corporate body titled The Regents of the University of California. The Board of Regents is composed of twenty-four members, sixteen of whom are appointed by the Governor of the State for sixteen-year terms and eight of whom are members because of offices they hold. These *ex officio* members are the Governor, the Lieutenant-Governor, the Speaker of the Assembly, the President of the State Board of Agriculture, the President of the Mechanics' Institute, the President of the Alumni Association, the State Superintendent of Public Instruction, and the President of the University. The Regents have "full powers of organization and government, subject only to such Legislative control as may be necessary to insure compliance with the terms of the endowments of the University and the security of its funds."

The President of the University is the executive head of the University in all its departments and all its campuses. He is appointed by The Regents and is directly responsible to them. The President and his staff, with headquarters in University Hall at Berkeley, direct the development of major policy for the statewide University.

The Chancellor (or Provost at San Francisco) is the chief administra-

tive officer on the campus and administers the organization and operation of the campus.

To participate in the administration of academic matters, The Regents have established an Academic Senate, consisting of the faculty and certain of the administrative officers. The Senate, subject to the approval of The Regents, determines conditions for admission of students, and for granting certificates and degrees. It authorizes and supervises all courses of instruction in the academic and professional schools and colleges and exercises general supervision of the discipline of students.

THE SAN DIEGO CAMPUS

The name, "University of California, San Diego" has been chosen by The Regents to designate what will eventually become a full-fledged University offering graduate and undergraduate work in the many fields of learning, with chief emphasis during the coming few years on building up a strong curriculum in the physical and natural sciences. At present, however, only graduate work is offered.

The campus originally consisted of 158 acres designated as a "pueblo lot" (a heritage of early Mexican rule in California) of the City of San Diego on the coast two miles north of La Jolla and about sixteen miles north of the center of San Diego. The street address is 8602 La Jolla Shores Drive. Buses from downtown San Diego run directly to the campus, arriving from 6:02 to 8:51 a.m. and 2:39 to 6:10 p.m., but terminating in La Jolla during the rest of the day. In 1960, the City of San Diego, with the authorization of the electorate, formally transferred 60 acres of adjacent lands to be used for the School of Science and Engineering. In addition, the City of San Diego has ceded to the University 450 acres adjacent to the original campus, and it is expected that within a few years several hundred acres more will be added from other sources.

Twenty acres of marshland in Mission Bay belonging to the University constitute a wildlife refuge. It is planned to use some of this land for experimental purposes. Docking facilities for the ships of the Scripps Institution, as well as 49,000 square feet of floor space in fifteen buildings for laboratories, offices, shops, and storerooms, have been provided by the U. S. Navy Electronics Laboratory at Point Loma, about fifteen miles from the campus.

Several units of the University are represented on the San Diego campus:

The Scripps Institution of Oceanography

The Scripps Institution was originally an independent biological research laboratory. It became an integral part of the University in 1912 and at that time was given the Scripps name in recognition of the interest and financial support of Miss Ellen Browning Scripps and Mr. E. W. Scripps. The scientific scope of its research has grown to embrace physical, chemical, geological, and geophysical studies of the oceans as well as biological studies. Continuing investigations are conducted of the topography and composition of the ocean bottom, of waves and currents, and of the flow of heat and interchange of matter between seawater and the ocean bottom or the atmosphere. Its own research ships have extended the geographic scope from the Institution's beach and the adjacent coastal waters to all of the world's oceans.

The educational program has grown hand-in-hand with the research program. Instruction is on the graduate level only and students are not usually admitted except as candidates for the Ph.D. Although there is a rapid rate of increase, there are only a few hundred persons currently active as marine scientists, of whom a significant portion are Scripps graduates. Their studies are marked by a high degree of interdisciplinary and international collaboration. Many nationalities are represented among the staff and student body.

The Institution has nine oceanographic research vessels. Their cruises vary from local, limited-objective trips to far-reaching expeditions designed to gather a variety of data on relatively unexplored tracks. In 1962 and 1963 two Scripps ships circumnavigated the globe in opposite directions and joined enroute for seismic refraction studies of the earth's crust under the Indian Ocean. A third ship will make a cruise around the world in 1964.

The academic departments within the Scripps Institution are the Department of Oceanography and the Department of Marine Biology. There are 28 faculty members of the ranks of Professor, Associate Professor, and Assistant Professor who teach in the two departments; some of these also teach in the School of Science and Engineering Departments of the University of California, San Diego. The remainder of the academic staff of the Institution consists of 80 research scientists all of whom make some contribution to instruction and many of whom have a regularly scheduled part in it.

Investigations supported by contracts and grants funded from extra-University sources, primarily Federal, cover a wide latitude of marine research. The general research effort is conducted by three Divisions, designated Oceanography, Marine Biology, and Earth Sciences. The diversity of their work is extended by three Federally-sponsored laboratories, the Marine Physical Laboratory, the Visibility Laboratory, and the Applied Oceanography Group, and by the Marine Life Research Group sponsored by the State of California.

Organizationally separate, but sharing close affiliation and proximity with Scripps, are the University of California's Institute of Geophysics and Planetary Physics and Institute of Marine Resources and the U. S. Bureau of Commercial Fisheries Biological Laboratory.

The combination of large scientific staff and extensive facilities provides an extraordinary opportunity for the small student body (approximately a hundred) to enjoy close contact with existing oceanographic concepts and active participation in research.

The School of Science and Engineering

The School of Science and Engineering (originally called the Institute of Technology and Engineering) was established in 1958 on the San Diego campus. It is temporarily housed at the water's edge in buildings of the Scripps Institution of Oceanography. The first building on the School of Science and Engineering campus (on the mesa above Scripps campus) was completed and occupied during the 1962-63 academic year. It is intended for graduate instruction and research, as are the two buildings to follow. The School is the first unit of the general campus at San Diego, which will admit upper division students in 1964 and lower division students in 1965.

The School of Science and Engineering presently includes departments of biology, chemistry, earth sciences, and physics, and departments of philosophy, of mathematics and of the engineering sciences are in process of being established. These departments accept students as candidates for graduate degrees in their respective fields.

The Institute of Geophysics and Planetary Physics

The San Diego branch of the University-wide Institute of Geophysics was established in 1960. Present research activities emphasize the study of

microseismic waves on land and on the sea bottom, measurements of the magnetic field at sea, fluctuations in the magnetic field over a wide frequency range, paleomagnetism of sediments, normal modes of the Earth, turbulence of the oceans and atmosphere, ocean waves and ocean tides.

The Institute does not grant degrees, but makes its facilities available to students from various departments who have chosen to write their dissertations on a problem of the Earth. Members of the Institute staff now hold joint appointments with the Departments of Earth Sciences, Physics, Chemistry, and Oceanography.

The Institute of Marine Resources

This is a University-wide institute, devoted to fostering research and investigations into the resources of the sea. With its headquarters on the San Diego campus and a wide interest in the biological, geological, physical, and socio-economic aspects of marine resources, its activities offer many opportunities to graduate students.

Associated Laboratories

The headquarters laboratory of the U. S. Bureau of Commercial Fisheries, Biological Laboratory, La Jolla, is housed on the campus, and at the Point Loma annex to the campus are located the headquarters laboratories of the Inter-American Tropical Tuna Commission and the U. S. Bureau of Commercial Fisheries, Biological Laboratory, San Diego.



GRADUATE DEGREES AWARDED

The fields of study and the specific degrees awarded and the University campuses on which they are offered are listed below: (In this listing the campuses are indicated by the following abbreviations: Berkeley, B; Davis, D; Los Angeles, LA; Riverside, R; San Diego, SD; San Francisco Medical Center, SF; Santa Barbara, SB.)

- Agricultural Chemistry – Ph.D. (B, D)
 Agricultural Economics – M.S. (B, D);
 Ph.D. (B)
 Agricultural Education – M.Ed. (B)
 Agronomy – M.S. (D)
 Anatomy – M.A. (B, SF); M.S. (LA);
 Ph.D. (B, LA, SF)
 Animal Husbandry – M.S. (D)
 Animal Physiology – M.S., Ph.D. (B, D, SF)
 Anthropology – M.A. (B, LA);
 Ph.D. (B, LA)
 Anthropology-Sociology – M.A., Ph.D. (LA)
 Applied Mathematics – M.A. (SB);
 Ph.D. (B)
 Applied Physics – M.S. (LA)
 Architecture – M.Arch. (B)
 Art – M.A. (B, D, LA); M.F.A. (LA)
 Art History – Ph.D. (LA)
 Asian Studies – M.A., Ph.D. (B)
 Astronomy – M.A., Ph.D. (B, LA)
 Bacteriology – M.A., Ph.D. (B)
 Biochemistry – M.A. (B); M.S. (SF);
 Ph.D. (B, SF)
 Biological Chemistry – M.S., Ph.D. (LA)
 Biology – M.A. (SB); Ph.D. (SB)
 Biophysics – M.S. (LA); Ph.D.
 (B, D, LA, SF)
 Bioradiology – M.Biorad (B)
 Biostatistics – M.A. (B); Ph.D. (B, LA)
 Botany – M.A. (B, D, SB); Ph.D. (B, D)
 Botanical Science – M.A., Ph.D. (LA)
 Business Administration – M.B.A., Ph.D.
 (B, LA)
 Cellular Biology – Ph.D. (SD)
 Chemical Engineering – M.S., Ph.D. (B)
 Chemistry – M.A. (D, R, SB); M.S. (B, LA);
 Ph.D. (B, D, LA, R, SD)
 Child Development – M.A., Ph.D. (B)
 City and Regional Planning – M.C.P. (B)
 Classical Archaeology – M.A., Ph.D. (B)
 Classics – M.A. (B, LA); Ph.D. (B)
 Comparative Biochemistry – M.A., Ph.D.
 (B, D, SF)
 Comparative Literature – M.A. (B)
 Comparative Pathology – M.S., Ph.D. (D, SF)
 Comparative Pharmacology and Toxicology –
 M.S., Ph.D. (D, SF)
 Criminology – M.Crim. (B)
 Dance – M.A. (LA)
- Dental Surgery – M.D.S. (LA, SF)
 Dentistry – M.S. (SF)
 Decorative Art – M.A. (B)
 Earth Sciences – M.S., Ph.D. (SD)
 Economics – M.A. (B, LA, R, SB);
 Ph.D. (B, LA)
 Education – M.A. (B, LA); M.Ed. (LA);
 Ed.D. (B, LA); Ph.D. (B)
 Endocrinology – M.A., Ph.D. (B, D, SF)
 Engineering – M.S. (B, D, LA); M.E. (LA);
 M.Eng., D.Eng. (B, D); Ph.D. (B, D, LA)
 English – M.A. (B, D, LA, R, SB);
 Ph.D. (B, D, LA)
 Entomology – M.A., Ph.D. (B, D, R)
 Epidemiology – Ph.D. (B)
 Food Science – M.S. (B, D)
 Forestry – M.S., M.F., Ph.D. (B)
 French – M.A. (B, LA); Ph.D. (LA)
 Genetics – M.A., M.S., Ph.D. (B, D)
 Geography – M.A., Ph.D. (B, LA)
 Geological Sciences – M.S. (D)
 Geology – M.A. (B, LA, R, SB);
 Ph.D. (B, LA)
 Geophysics – M.A., Ph.D. (B, LA)
 German – M.A. (B, LA); Ph.D. (B)
 Germanic Languages – Ph.D. (LA)
 Greek – M.A. (B, LA)
 Health Education – M.S. (LA)
 Hispanic Languages and Literatures –
 Ph.D. (LA)
 History – M.A. (B, D, LA, R, SB);
 Ph.D. (B, LA, SB)
 History of Art – M.A., Ph.D. (B)
 Home Economics – M.S. (B, D, LA);
 Ph.D. (B)
 Horticulture – M.S. (D)
 Horticultural Science – M.S. (R)
 Infectious Diseases – M.S., Ph.D. (LA)
 International Relations – M.A. (B)
 Irrigation – M.S. (D)
 Islamic Studies – M.A., Ph.D. (LA)
 Italian – M.A. (B, LA)
 Journalism – M.A., M.S. (LA); M.Journ. (B)
 Landscape Architecture – M.L.A. (B)
 Latin – M.A. (B, LA)
 Latin-American Studies – M.A. (LA);
 Ph.D. (B)
 Law – LL.B. (B, LA); LL.M., J.Sc.D. (B)
 Librarianship – M.L.S., Ph.D., D.L.S. (B)

- Library Science – M.L.S. (LA)
 Linguistics – M.A. (B, LA); Ph.D. (B)
 Logic and the Methodology of Science –
 Ph.D. (B)
 Marine Biology – M.S., Ph.D. (SD)
 Mathematics – M.A. (B, D, LA, R, SB);
 Ph.D. (B, D, LA, R)
 Medical Physics – M.A., Ph.D. (B, LA, SF)
 Medicine – M.D. (LA, SF)
 Meteorology – M.A., Ph.D. (LA)
 Microbiology – M.A., Ph.D. (B, D, LA, SF)
 Music – M.A. (B, LA, SB); Ph.D. (B, LA)
 Near Eastern Languages and Literatures –
 M.A., Ph.D. (B, LA)
 Nursing – M.S. (LA, SF)
 Nutrition – M.S., Ph.D. (B, D, SF)
 Nutritional Sciences – M.S. (LA)
 Oceanography – M.S., Ph.D. (SD)
 Optometry – M.Opt. (B)
 Oral Biology – M.S. (SF)
 Oriental Languages – M.A. (B, LA);
 Ph.D. (B)
 Pathology – M.S., Ph.D. (SF)
 Paleontology – M.A., Ph.D. (B)
 Parasitology – M.S., Ph.D. (B)
 Pharmaceutical Chemistry – M.S., Ph.D. (SF)
 Pharmacology – M.S., Ph.D. (LA, SF)
 Philosophy – M.A. (B, LA, SB);
 Ph.D. (B, LA)
 Physical Education – M.A. (B); M.S. (LA)
 Physical and Health Education – M.A. (SB)
 Physics – M.A. (B, D, LA, R, SB); M.S.
 (SD); Ph.D. (B, D, LA, R, SD)
 Physiological Chemistry – M.S., Ph.D. (LA)
 Physiological Optics – M.S., Ph.D. (B)
 Physiology – M.A. (B); M.S. (LA, SF);
 Ph.D. (B, LA, SF)
 Plant Biochemistry – Ph.D. (R)
 Plant Pathology – M.S., Ph.D. (B, D, R)
 Plant Physiology – M.S., Ph.D. (B, D)
 Plant Science – M.S., Ph.D. (R)
 Political Science – M.A. (B, D, LA, SB);
 Ph.D. (B, LA)
 Poultry Science – M.S. (D)
 Preventive Medicine and Public Health –
 M.S. (LA)
 Psychiatry – M.S. (LA)
 Psychology – M.A., Ph.D. (B, LA, SB)
 Public Administration – M.P.A. (LA)
 Public Health – M.S. (LA); M.P.H., Dr.P.H.
 (B, LA, SF)
 Radiology – M.S., Ph.D. (LA)
 Range Management – M.S. (B, D)
 Romance Languages and Literatures –
 Ph.D. (B, LA)
 Romance Philology – Ph.D. (B)
 Sanskrit – Ph.D. (B)
 Scandinavian Languages and Literatures –
 M.A., Ph.D. (B)
 Slavic Languages – M.A. (LA)
 Slavic Languages and Literatures – M.A. (B);
 Ph.D. (B, LA)
 Slavic Studies – M.A. (B)
 Social Welfare – M.S.W. (B, LA);
 D.S.W. (B)
 Sociology – M.A., Ph.D. (LA)
 Sociology and Social Institutions – M.A.,
 Ph.D. (B)
 Soil Science – M.S., Ph.D. (B, D, R)
 Spanish – M.A. (B, LA)
 Speech – M.A., Ph.D. (LA)
 Speech and Drama – M.A. (SB)
 Statistics – M.A., Ph.D. (B)
 Theatre Arts – M.A. (LA)
 Vegetable Crops – M.S. (D)
 Veterinary Medicine – D.V.M. (D)
 Virology – M.A., Ph.D. (B)
 Wood Technology – M.S. (B)
 Zoology – M.A. (B, D, LA, R, SB);
 Ph.D. (B, D, LA, R)

Work leading to teaching credentials is given on the Berkeley, Davis, Los Angeles, Riverside, and Santa Barbara campuses. The teaching credentials offered, together with their requirements, are described in detail in the GENERAL CATALOGUE of the Davis, Riverside, and Santa Barbara campuses and in the ANNOUNCEMENT OF THE SCHOOL OF EDUCATION of the Berkeley and Los Angeles campuses.



*THE NATURE
OF
GRADUATE INSTRUCTION*

A graduate course is a highly advanced course in a field of study already intensively presented in the upper division. It normally carries a number in the 200 series. Graduate courses demand – on the part both of instructors and of students – either a critical analysis or a specialization of research not normally appropriate to an undergraduate major. Graduate courses may be conducted in several ways:

1. As advanced lecture courses.
2. As seminars in which the faculty and students present critical studies of organized fields of knowledge.
3. As independent study or reading courses.
4. As research projects carried on under faculty supervision.

The main purpose of graduate study is to inspire independence of mind and originality in the search for knowledge and truth. The candidate must attain a mastery of his chosen field. He must also conduct a successful program of independent research for the Ph.D. Consequently, graduate students are accorded considerable liberty insofar as enrollment in courses is concerned, provided they meet the minimum enrollment necessary to establish residence.





*ADMISSION
TO
GRADUATE STATUS*

STANDARDS OF ADMISSION

Students seeking admission to graduate status at the University of California must hold a bachelor's degree or its equivalent from an institution of acceptable standing. The program of preparation should be substantially equivalent in both the distribution of academic subject matter and in scholarship achievement to the requirements for a comparable degree at the University of California. Applications for admission are evaluated in terms of scholastic qualifications and formal preparation for the graduate field of study.

The Dean of the Graduate Division or the department in which the applicant wishes to pursue an advanced degree may deny him admission if his scholastic record or his undergraduate program of study is judged not adequate as a foundation for advanced academic or professional study. This procedure applies to all applicants, whether they come from schools or colleges within the University of California or elsewhere. Individual departments may have special requirements for admission to graduate status, and certain departments and schools require an *additional* and special application for admission to their advanced-degree program.

ADMISSION WITHOUT AN ADVANCED-DEGREE OBJECTIVE

Students who do not desire to become candidates for higher degrees must meet the same admission requirements as those who are prospective candidates for degrees. They must be admitted to a specified field of study and they must satisfy the Dean that their program of study has a definite scholarly or professional purpose. Such students are not eligible for exemption from the nonresident tuition fee.

ADMISSION PROCEDURES

Each student seeking admission to the Graduate Division on the San Diego campus must file a formal application and an official transcript of his record in duplicate from each college and university he has attended, not later than August 1 for the fall semester, and not later than January 2 for the spring semester. One set of the official records is retained permanently in the Office of Admissions. These records may not be withdrawn. The duplicate set of records will be sent to the student's major department. The application must be accompanied by a money order or bank draft for

\$5 in payment of the application fee. Payment by check, draft, or money order is acceptable. Any payment must be drawn for the exact amount of the fees, and should be made payable to The Regents of the University of California. Because of the time required to process an application and to prepare the registration forms, applications and/or transcripts received after the deadline date will be considered only as time permits and in the order received. Late applicants are advised, therefore, also to seek admission elsewhere if circumstances require immediate registration in graduate work. The blank for application may be obtained from the Office of Admissions, University of California, San Diego, Box 109, La Jolla, California.

An applicant who has taken the Graduate Record Examination should submit with his application a copy of the results of the examination; this will be especially helpful for a student whose grade-point average is near the minimum requirement for admission in regular graduate status.

INTERCAMPUS EXCHANGE PROGRAM

A graduate student registered on any campus of the University who wishes to go to another campus of the University may, with the approval of his adviser and the Dean of the Graduate Division on the campus visited, become an Intercampus Exchange Graduate Student. This Intercampus Exchange Program will also include those students who take courses on more than one campus of the University in the same semester.

It is anticipated that this privilege will be used by the better graduate students who seek the opportunity for contact with scholars or with fields of study not available on the home campus and for the use of facilities and collections. Whenever possible, personal arrangements between faculty members on the two campuses should be made so as to assure that the courses, seminars, or facilities will be available to meet the students' needs.

The Intercampus Exchange Student will have library, infirmary, and other student privileges on the host campus. The grades obtained in courses taken by these students will be transferred to the home campus to be entered on the official record. As an exchange student, one is considered as a graduate student in residence on his home campus. He has not transferred his enrollment and is not admitted to the Graduate School and Department as a graduate student at the host campus. Unless specifically

restricted, holders of fellowships may participate in this Intercampus Exchange Program.

Application forms for the Intercampus Exchange Program may be obtained from the Office of the Dean of the Graduate Division.

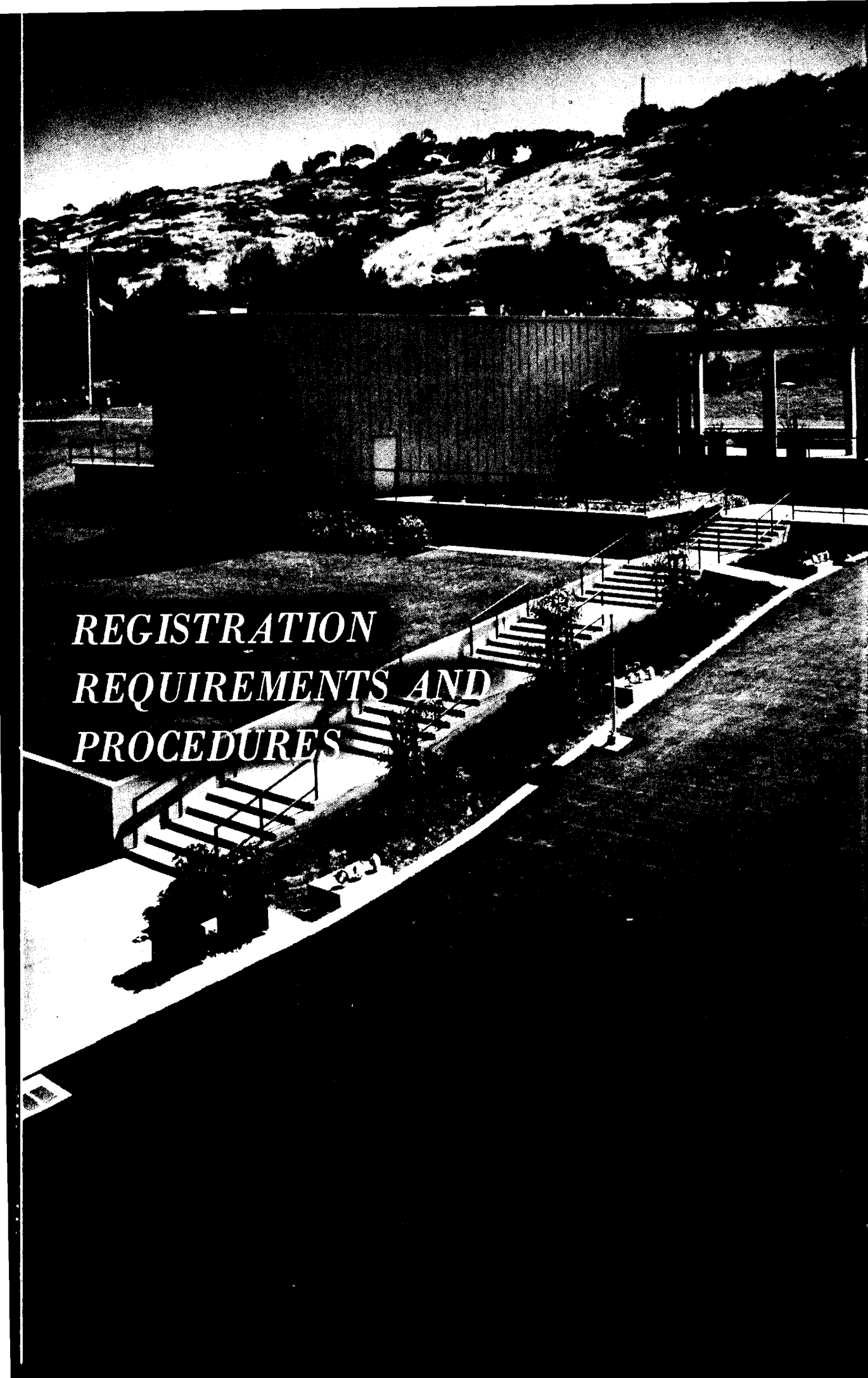
ADMISSION OF FOREIGN STUDENTS

Foreign students are held to the same regulations affecting admission and candidacy as are students from the United States. Every foreign student whose training has been in a language other than English must appear for the University Examination in English for Foreign Students to determine whether he has sufficient command of English to enable him to pursue his graduate studies effectually. Further information regarding this requirement and other provisions for foreign students can be found in the University publication, INFORMATION FOR PROSPECTIVE STUDENTS FROM OTHER COUNTRIES.

For information concerning health insurance requirement for foreign students, see Student Health Service, page 29.

RENEWAL OF APPLICATION FOR ADMISSION

All students who do not register in the semester for which they were accepted for admission in graduate status must file a *renewal of application* form, with supplementary official transcripts, at the office in which their original application for graduate admission was filed. The deadlines for filing are the same as those required for original applications. No additional fee is charged for a renewal of application, but approval for admission to any given semester does not imply approval for admission at some later date.



*REGISTRATION
REQUIREMENTS AND
PROCEDURES*

REGISTRATION

Every graduate student in good standing, unless granted a formal leave of absence or honorable dismissal by the Dean of the Graduate Division, will be required to register with the Registrar of his campus each semester until the completion of all requirements for the degree for which he is working. Failure to register or to obtain formal permission to leave the University will constitute presumptive evidence that a student has withdrawn from the Graduate Division. No graduate student should leave the University without obtaining the form of release appropriate to his situation. In case of doubt, students should seek advice from the Graduate Division.

The regulations pertaining to candidates for higher degrees are as follows:

1. If the student plans to be in residence on the campus, he must register as a regular student.
2. If the student plans to be away from the campus during the semester, but in correspondence with his department and in an instructional relationship with his advisers, he must register in absentia.
3. If the student plans to be away from the campus for a specific period of time, and to have no connection with the University during that specific period, he must apply for leave of absence.
4. Candidates for the master's degree or the doctorate who have completed all degree requirements, including the residence requirement, and who are taking no further work in resident courses or in research may, if they are engaged only in writing the thesis or dissertation or in preparing for the final examination, register for thesis or examination only.

REGISTRATION IN ABSENTIA

Graduate students who have been advanced to candidacy for a master's or a doctor's degree, or graduate students in precandidacy status who have the permission of the Dean of the Graduate Division may, if they plan to be away from the campus through the semester, register in absentia. Permission to register in absentia must be renewed each semester. Petitions for this type of registration can be obtained from the Office of the Dean of the Graduate Division on the campus concerned. At the time a student

requests the petition he should ascertain from the Graduate Division whether he is eligible to apply for the privilege.

Graduate students who have been on leave of absence status and who plan to register in absentia will not have to appear on the campus to re-establish their status as registered students, nor need they return to the campus to prove their status as California residents. They may handle such matters by correspondence. Such students should, however, notify the Dean of the Graduate Division of their intention to register in absentia at least two months prior to the registration period.

LEAVE OF ABSENCE

Graduate students who are severing their connection with the University for a specific period of time, after which they intend to resume their studies, must take a formal leave of absence. Petitions are available at the Registrar's Office. Leave of absence is a privilege requiring the endorsement of the department in which the student is studying and approval of the Dean of the Graduate Division. The privilege may be revoked if the conditions pertaining to it are violated. Leaves of absence should be for a stated period, normally not to exceed one year, with continuation of the leave at the discretion of the Dean of the Graduate Division and of the student's major department. Graduate students on leave-of-absence status are expected *not* to make use of any University facilities or to place demands upon faculty time during the period of their leave.

Graduate students who are granted formal leave of absence are exempt from all fees during the period of their leave.

READMISSION

Persons formerly registered in a regular session as graduate students who wish to return after not having registered formally in the University for a semester or more and who wish to resume their studies must file an **APPLICATION FOR READMISSION**. This application is subject to the recommendation of the chairman of the student's major department and the approval of the Dean of the Graduate Division.

PHYSICAL EXAMINATION

Before his registration can be completed, each student entering graduate status for the first time and each applicant for readmission must undergo

a physical examination at the University.

Each *new student* entering the University must pass a physical examination and must have had a successful smallpox vaccination within three years previous to the entrance date.

The *new student* will be required to register with the Student Health Service and make arrangements for the entrance physical examination, and to submit an acceptable certificate of vaccination which has been signed by a licensed physician or arrange for vaccination at the time of the physical examination.

Each *re-entering student* or student entering graduate status for the first time must report to the Student Health Service for clearance of health records and a recheck of certain items in the physical examination.

STUDENT HEALTH SERVICE

The University provides Medical and Hospitalization services for the student through an insurance policy during the two-semester period of the year. Prescription expenses are handled directly by the Student Health Service office.

All foreign students are required to purchase additional medical and hospitalization insurance to cover health conditions not covered by the Student Health policy, plus coverage during academic holidays.

The University has arranged for this additional coverage through one group plan which will be the only one acceptable to comply with registration requirements.

There is similar insurance available for students' dependents and for summer coverage for non-foreign students at the same reasonable group rates. Information on this insurance is available at the Student Health Office.

LEGAL RESIDENCE IN THE STATE OF CALIFORNIA

The State law requires that a student whose home is not in the State of California shall be subject to a nonresident tuition fee (which is \$300 a semester in 1963-64). Every student of the University is classified as a *resident* or *nonresident* of California. In case of doubt as to legal residential status, the student may write the Attorney for The Regents in Residence Matters, Room 590, University Hall, University of California, Berkeley 4, California.

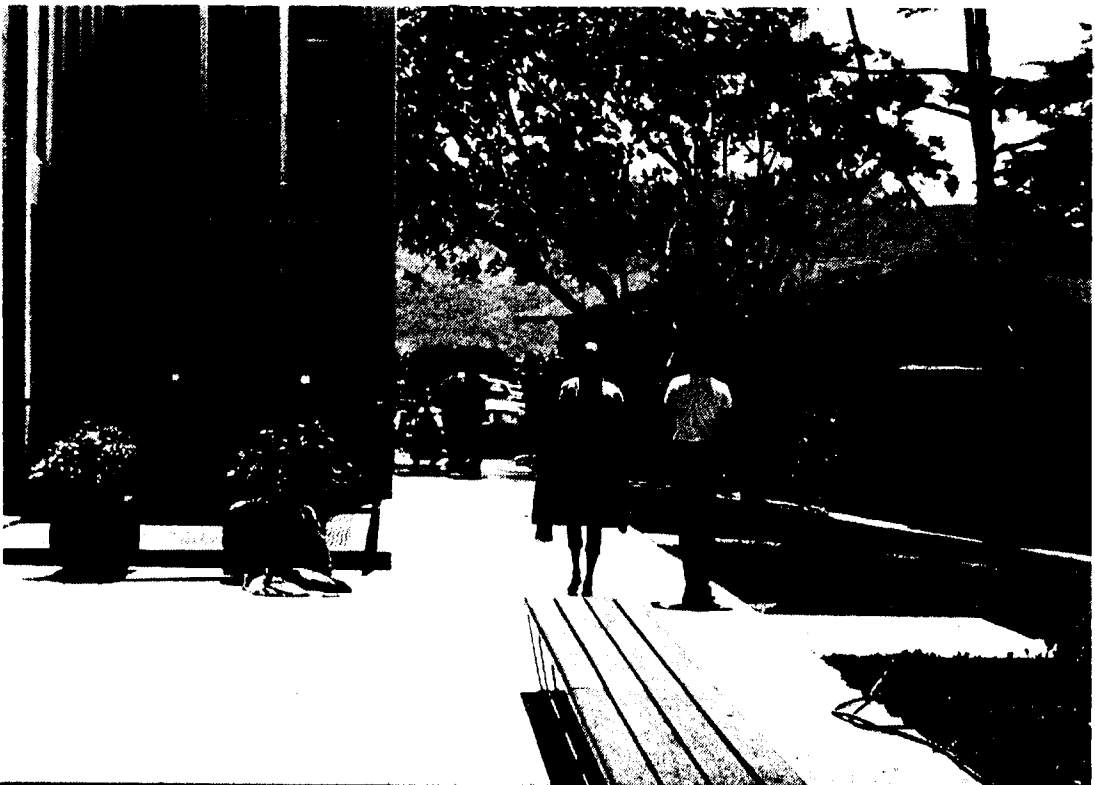
DEFINITION OF ACADEMIC RESIDENCE

Every graduate student must register for, attend, and complete upper division courses (courses in the 100 series), or graduate courses (200 series), amounting to at least 4 units for each semester or 2 units for each summer session, so as to satisfy the minimum residence requirement in candidacy for most of the higher degrees or certificates issued by the University. Each six- or eight-week summer session counts as one-half of one semester of residence. Although residence requirements for some degrees may be satisfied by attendance only in summer sessions, no assurance is given that specific courses required for a given degree will be available in summer sessions.

REGISTRATION PROCEDURES

Each student registers in the University of California, San Diego, at times appointed for this purpose, at the beginning of each semester. Registration covers the following steps: (1) filling out address card, paying fees, and receiving in exchange a Registration Packet; (2) enrolling in courses according to instructions, and (3) filing registration packet according to instructions contained in the packet.

The student or prospective student should consult the University Calendar (see pp. 5-7) and acquaint himself with the dates upon which students should register and begin their work at the opening of the sessions.



STUDY-LIST LIMITS

In order to counteract the tendency to accumulate credits by sacrificing thoroughness and the high scholarly attainment which comes only through intense application, the University restricts the number of units in which a student may enroll.

A graduate student in a regular session is limited to 16 units when he takes only undergraduate courses, to 12 units when he takes only graduate courses, and to a total made up in the proper proportion of 12 to 16 – as for example, 6 graduate and 8 undergraduate – when he takes both undergraduate and graduate courses.

Research assistants and others employed approximately on half-time are limited to three-fourths of these totals. Students engaged full-time in other occupations are limited to 6 units of graduate and/or upper division courses.

Study lists exceeding these limits may be accepted only with the approval of the Dean of the Graduate Division.

Every graduate student is required to file with the Office of the Dean of the Graduate Division by a specified date a study list containing his program of courses which has been approved by the adviser in the department of his major subject. Study lists not signed by a departmental adviser will not be accepted. Instructions for filing registration packets and a list of graduate advisers are issued to all students at the time of registration. The dropping and adding of courses must be done by formal petition which may be obtained from the office of the Graduate Division. Changes in study lists may not be made after the tenth week of classes.

DISQUALIFICATION FROM GRADUATE STATUS

A regular graduate student is normally required to maintain a grade B average in all work taken subsequent to his admission to regular graduate status, and is subject to dismissal if his grade-point average falls below that level at any time. He is also subject to dismissal if his work in any two consecutive semesters falls below a grade B average.

REMOVAL OF "E" GRADES

Regulations on the removal of "E" grades are as follows:

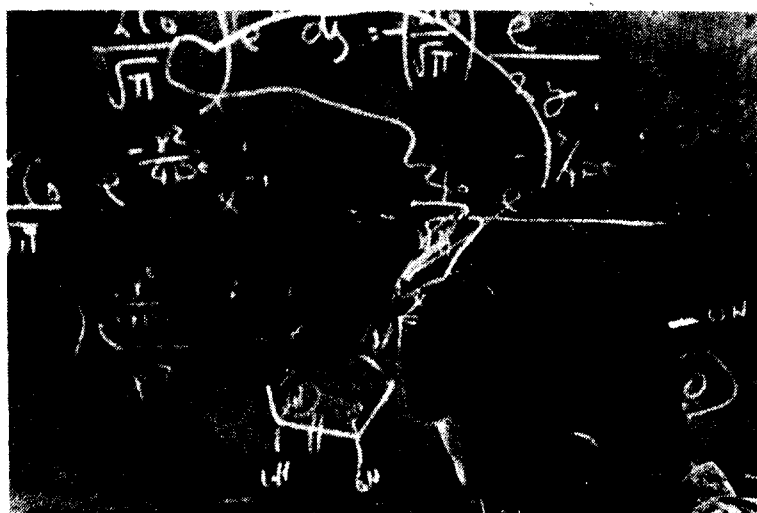
1. An "E" grade in a 100-series course must be removed before the

end of the next semester in which the course is given and the student is in residence, or it lapses to an "F."

2. An "E" grade in a graduate (200 series) course must be removed before the end of the next semester in which the student is in residence, regardless of whether the course is offered in that semester or not.
3. A student with an "E" grade which has not been removed within the time limits and whose grade-point average remains below the required "B" average is subject to dismissal for reasons of scholarship.

FOREIGN LANGUAGE EXAMINATIONS

The examinations in foreign language required by all departments are conducted by an examiner under the supervision of the Graduate Council. Each examination will be in writing and will consist of two parts: (1) a translation, without the aid of a dictionary, of a passage selected from at least 50 pages of material which the student has prepared and which



he has chosen with the approval of his adviser; (2) a translation, with the aid of a dictionary, of a passage selected from material recommended by the department of the student's major. The reading examinations are graded on the basis of both quantity and quality, their purpose being to demonstrate the student's ability to read, with reasonable accuracy and speed, material which properly falls within his field of interest. The reading examinations may be taken by appointment with the examiner.

A student may apply to take the foreign language reading examination provided he has:

1. Completed the 1G reading course in a foreign language and is recommended by the instructor as having done satisfactory work.
2. Completed two years of the language at the college level in the four-year period just prior to the petition with grades of C or better.
3. Presented convincing evidence to the Language Examiner that he has in some other way acquired a substantial knowledge of the language.

Under certain conditions a foreign student whose native language is not English may offer English as a foreign language. The foreign student accorded this privilege must be in this country on a student visa and not remaining permanently but returning to his own country. The substitution must be approved by the department of the student's major, and the department must certify to the Dean of the Graduate Division that the student has a good command of written and spoken English. Request for substitution must be made by formal petition obtained from the office of the Graduate Division.

A high-contrast, black and white photograph of a modern building. The building features a prominent balcony with a metal railing on the upper level. A large, leafy tree stands to the right of the building, its branches extending over the scene. In the foreground, a small, round table on a thin stand is positioned on a paved area. The overall aesthetic is stark and architectural.

*THE MASTER'S DEGREE—
GENERAL REQUIREMENTS*

PREPARATION

The preliminary training of the candidate for the degree of Master of Arts or Master of Science should be substantially the equivalent of that represented by the corresponding bachelor's degree of the University of California. If the candidate's undergraduate course is found to be in any serious respect deficient in its breadth of fundamental training or fails to provide a proper foundation for advanced work in the department or departments of the candidate's choice, he may be required to devote some time to specified undergraduate courses, involving a longer period of residence than would otherwise be required.

A graduate of an institution of acceptable standing is normally admitted to candidacy for a master's degree at the University of California on an equality with a graduate of the University of California if his college course has been of such character as to furnish a satisfactory basis for advanced academic work.

In the departments at San Diego the degree of Master of Science is offered in the fields of earth sciences, marine biology, oceanography, and physics.

AMOUNT AND DISTRIBUTION OF WORK

At the option of the department of his major field, a student must pursue one of the two following plans for fulfillment of the requirements for the master's degree. Under either plan all the requirements for the degree must be satisfied within a calendar year from the time of completion of the course requirement.

PLAN I: THESIS PLAN

At least 20 semester units and a thesis are required. The units must be taken in graduate or upper division courses, and at least 8 of the 20 must be in strictly graduate work in the major subject. No unit credit is allowed for the thesis. In addition, the major department may require any examination which seems necessary to test the candidate's knowledge of his field.

PLAN II: COMPREHENSIVE EXAMINATION PLAN

Twenty-four units of upper division and graduate courses are required, of which at least 12 must be in strictly graduate courses in the major

subject. A comprehensive final examination in the major subject, its kind and conduct to be determined by the department concerned, is taken by each candidate.

APPLICATION FOR ADVANCEMENT TO CANDIDACY

Application for advancement to candidacy must be made through the Dean of the Graduate Division on the campus where the student expects to receive his degree. Application must be made with the recommendation of the department concerned and must contain a general statement of the studies upon which the application is based. Advancement to candidacy shall take place not later than one semester prior to the date of completion of requirements for the degree. Admission to candidacy is not automatic; it requires a formal application distinct from registration.

STANDARD OF SCHOLARSHIP

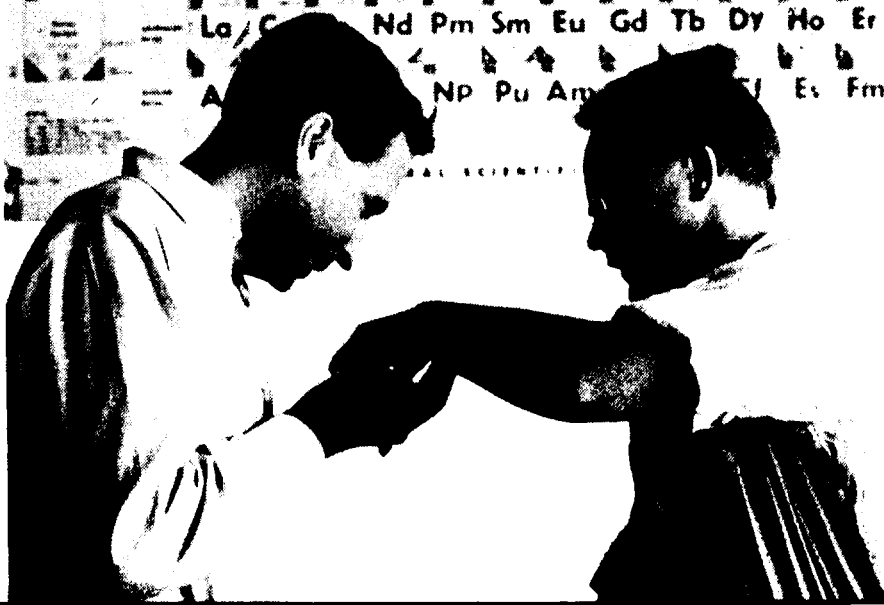
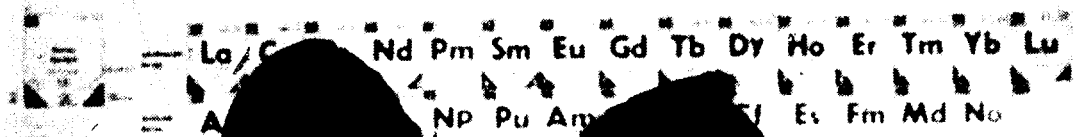
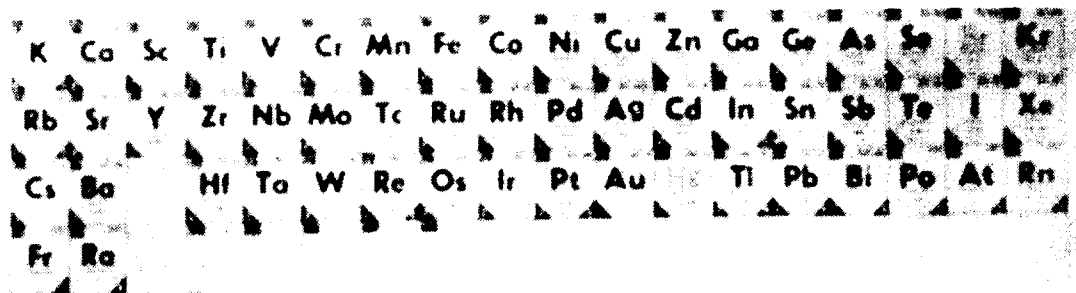
Only courses in which the student is assigned grades A, B, or C may be counted in satisfaction of the requirements for the master's degree. Furthermore, the student must maintain *an average* of at least three grade

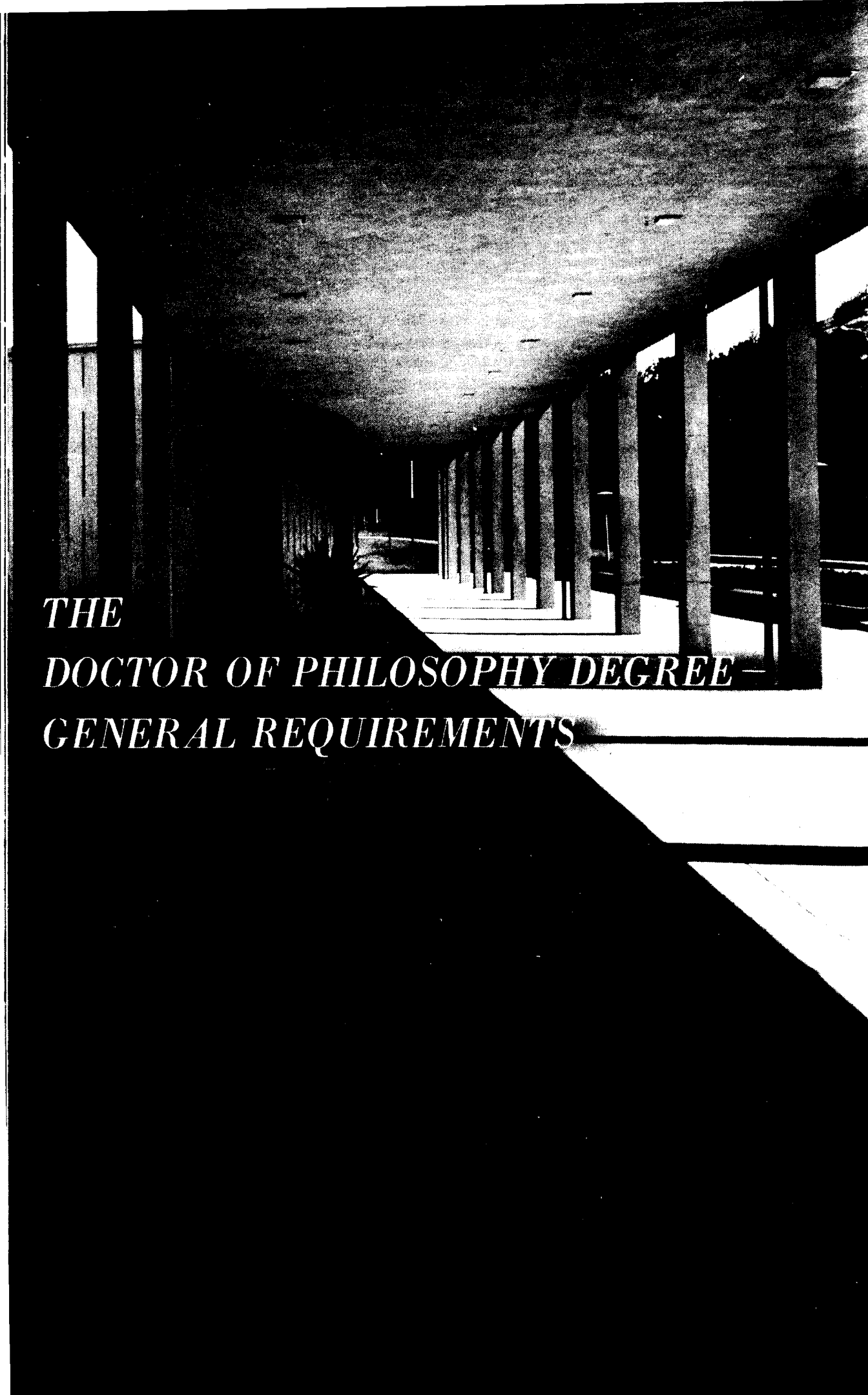


points per unit in those courses, and in all upper division and graduate courses elected during his residence at the University of California as a graduate student.

RESIDENCE REQUIREMENT

The student must be in residence at least two semesters. Two six-week summer sessions may be counted as the equivalent of one semester of a regular session in satisfaction of the residence requirement for the master's degree. It is not always possible, however, to complete subject requirements within the minimum period of residence. A student is regarded in residence if he is actually attending regularly authorized University courses amounting to 4 units of work at the upper division or graduate level during a regular session, or 2 units of similar work during a summer session. Though ordinarily all the work for the master's degree is expected to be done in residence, up to 4 units of credit for work taken elsewhere may be allowed. These units must have been taken at an institution of high standing in graduate status and cannot be used to reduce the minimum residence requirement or minimum requirement in 200-series courses taken at this University.





*THE
DOCTOR OF PHILOSOPHY DEGREE —
GENERAL REQUIREMENTS*

Students who desire to become candidates for the doctor's degree should bear in mind that the degree of Doctor of Philosophy is granted by the University of California not for the fulfillment of technical requirements alone, such as residence and the completion of fundamental courses within a chosen field, but more for the student's general grasp of the subject matter of a large field of study and his distinguished attainments within it, for his critical ability, his power to analyze problems and to coordinate and correlate the data from allied fields to serve the progress of ideas. In addition, he must demonstrate, through his dissertation, the ability to make an original contribution to the knowledge of his chosen field, and throughout his career as a graduate student must prove himself capable of working independently.

The degree of Doctor of Philosophy is offered on the San Diego campus as a result of work in the fields of biology, chemistry, earth sciences, marine biology, oceanography, and physics.

PREPARATION

A prospective candidate for this degree must hold a bachelor's degree from one of the colleges of this University, based on a curriculum that includes the requirements for graduate status in the department of his major subject, or must have pursued successfully elsewhere an equivalent course of study.

RESIDENCE REQUIREMENT

By regulation of the Academic Senate, the minimum residence requirement for the degree of Doctor of Philosophy is two years. (Experience shows, however, that the time spent by most students in achieving the doctorate is nearer four years than two.) A student is not regarded as a student in residence unless he is actually attending regularly authorized University exercises amounting to at least 4 units of work at the upper division or graduate level during a regular session, or 2 units of similar work during a summer session. Graduates of the University or other approved candidates may complete a part of their work elsewhere, subject to approval of the Graduate Council. A minimum period of study approximately equivalent to two semesters must intervene between formal advancement to candidacy and the conferring of the degree.

FOREIGN LANGUAGE

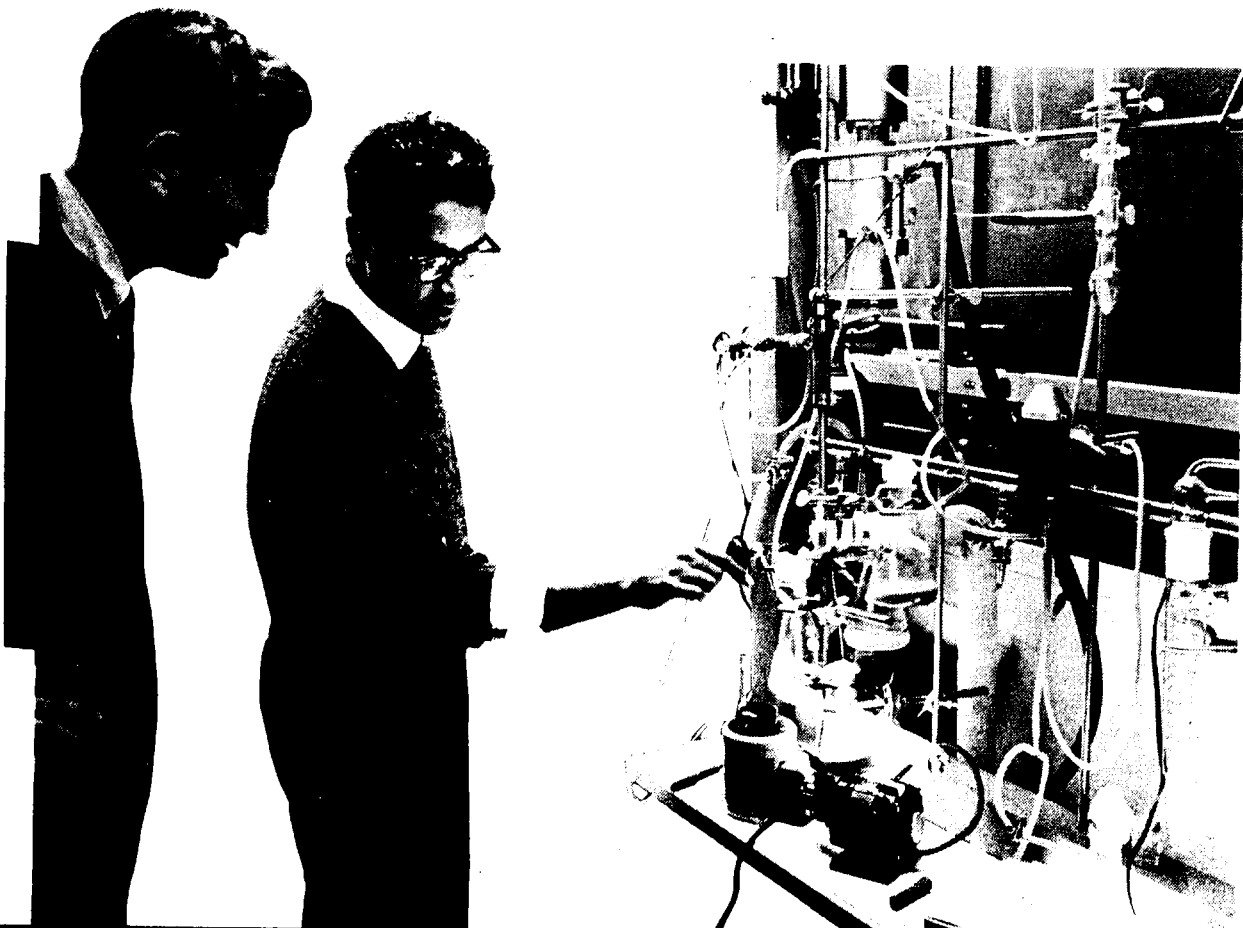
Before taking the qualifying examinations for advancement to candidacy for the doctor's degree, the student must pass examinations in two foreign languages acceptable to the department of his major and the Dean of the Graduate Division. A student's native language will not count as satisfying one of the language requirements above. (For further details, see pp. 32-33.)

PROGRAM OF STUDY

The student's program of study must be approved by the Graduate Council, must embrace a field of investigation previously approved by his department and must extend over the full period of study. However, recommendation for the degree is based on the attainments of the candidate rather than duration of his study. Departmental requirements for the degree will be found under *DEPARTMENTAL ANNOUNCEMENTS*.

NOTICE OF CANDIDACY

As early as possible, preferably at the end of the first semester of graduate study, the student should declare his intention of proceeding to



candidacy for the doctor's degree. Statement of such intention should be made in duplicate, on Form 1, which is available at the Office of the Dean of the Graduate Division. One copy of the form should be filed with the department of the student's field of study, the other with the Dean.

GUIDANCE COMMITTEES

On receiving such notification, or earlier, an informal guidance committee will be appointed by the department of the student's field of study to assist the student in making out his program and in preparing him for the qualifying examinations. This committee must give its written approval to the department before the student is permitted to take these examinations and it ceases to exist as soon as he has passed the qualifying examinations.

DOCTORAL COMMITTEES

Upon nomination of the department or interdepartment group of the student's field of study, a doctoral committee will be appointed by the Graduate Council. Nomination of the doctoral committee shall be made on Form 2, which is available at the Office of the Dean of the Graduate Divi-



sion. This committee shall consist of not fewer than five members, three of whom shall be from the department of the candidate's major (one of whom shall be the principal director of the candidate's research) and two from a department or departments other than the major. The doctoral committee conducts the qualifying oral examination (in some cases also the written examinations), approves the dissertation, and conducts the final oral examination.

QUALIFYING EXAMINATIONS

Before he is admitted to candidacy, the student must pass a series of qualifying examinations, both written and oral. The written examinations may be administered by the department of the student's field of study, but the oral examination must be conducted by his doctoral committee. The qualifying oral examination is never open to the public. The report on the qualifying examinations should be made on Form 3, and must be signed by all members of the doctoral committee.

ADVANCEMENT TO CANDIDACY

Upon receipt of the report on the qualifying examinations, an application form for advancement to candidacy, Form 4, will be sent to the candidate. The candidate must file his application, properly approved by the chairman of his doctoral committee, and must report in person to the Dean of the Graduate Division, who determines whether all formal requirements have been met.

A minimum period of resident study approximately equivalent to two semesters must intervene between the date of formal advancement to candidacy and the date of the final examination. The semester in which a student is advanced to candidacy will be counted as a full semester for the purpose of the residence requirement, provided advancement to candidacy occurs at or before mid-term and the student is registered for 4 or more units.

THE DISSERTATION

A dissertation on a subject chosen by the candidate and approved by his doctoral committee, bearing on his principal study and showing his ability to make independent investigation, is required of every candidate

for the degree. In its preparation the candidate is guided by his doctoral committee, which also passes on the merits of the completed dissertation. The approval of this committee, as well as that of the Graduate Council, is required before he is recommended for the degree. Special emphasis is laid on this requirement. The degree is never given merely for the faithful completion of a course of study, however extensive.

The Librarian will check the physical format of each dissertation, and it will be the responsibility of the candidate to secure from the Librarian a memorandum of approval to submit to the Graduate Division. Instructions for the preparation and submission of theses may be obtained from the Office of the Dean of the Graduate Division.

The dissertation must be approved by the Dean of the Graduate Division before the date of the final examination, for deposition in the University Library.

FINAL EXAMINATION

The candidate's final examination is conducted by his doctoral committee. The examination is oral and deals primarily with the relations of the dissertation to the general field in which its subject lies. Admission to the final examination may be restricted to committee members, members of the Academic Senate, and guests of equivalent academic rank from other institutions. The report on the final examination should be made on Form 5, and must be signed by all members of the doctoral committee.



FEES AND EXPENSES

APPLICATION FEE

An application fee of \$5 is charged all persons seeking admission to any Graduate Division of the University of California as new graduate students. This fee is payable to The Regents of the University of California and should accompany the Application for Admission. *The fee is not returnable under any circumstances.*

INCIDENTAL FEE

All graduate students in the academic departments pay an incidental fee of \$90 each semester at the time of registration, irrespective of the number of units for which they are enrolled. The incidental fee covers certain expenses of students for athletic and gymnasium facilities and equipment on most campuses; for registration and graduation, and for such consultation, medical advice, and hospital care or dispensary treatment as can be furnished by the Student Health Service. Fees are subject to modification.

CANDIDACY FEE

Each applicant for advancement to candidacy for a doctor's degree must pay a fee of \$10 before such advancement may be granted.

TUITION FEE

Tuition is free to legal residents of the State who are engaged in graduate study and research offered solely in fulfillment of the requirements for academic higher degrees in the academic departments of the University.

Nonresidents of California are charged a tuition fee of \$300 each semester. Exceptions will be limited to students who are unable to devote more than half time to academic study. Exceptions will be considered:

1. For reasons of health as certified by the Student Health Service.
2. For reason of full-time employment in salaried positions when certified by a statement from the employer.

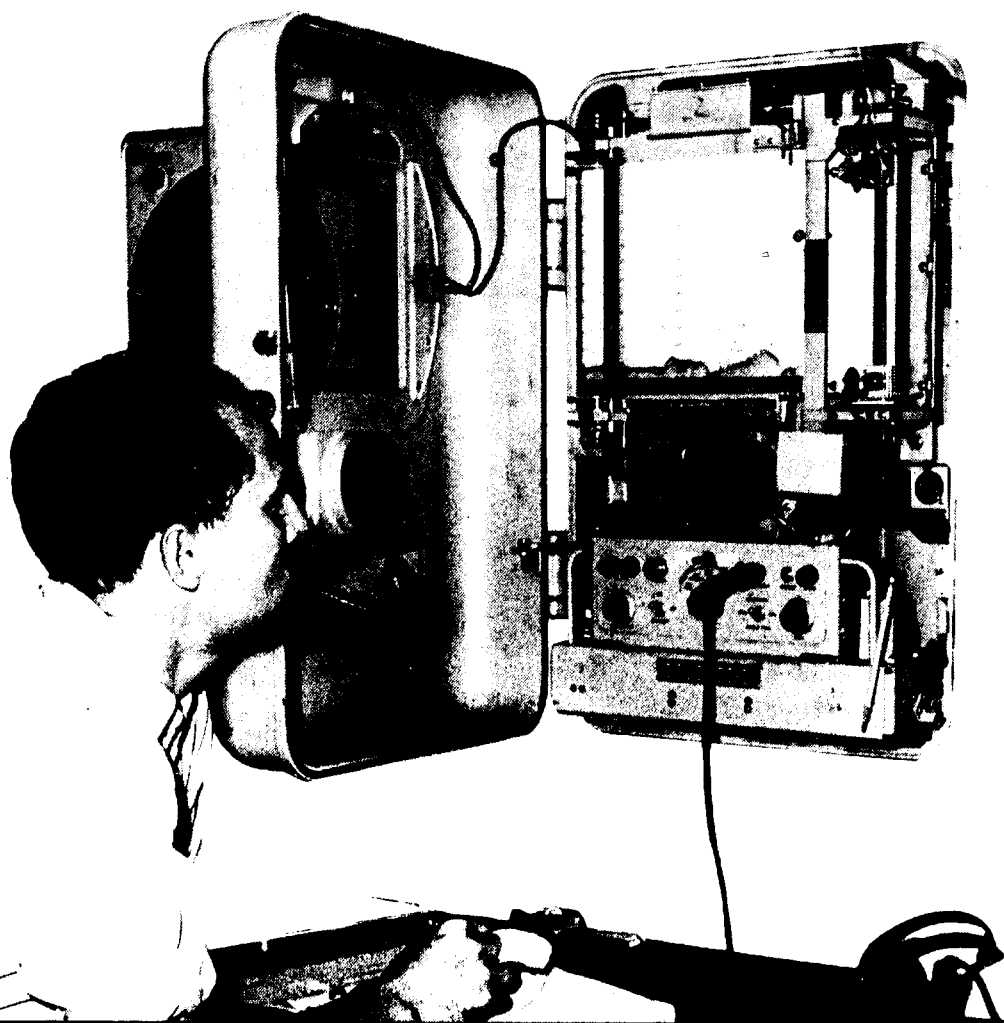
Where exceptions are made on the foregoing basis, the student's program will be limited to 4 units of course work in the 200 series or the equivalent thereof, and the nonresident tuition fee will be \$150.00 a semester. Petition for half fee based on the above criteria must be submitted to the Office of the Dean of the Graduate Division; otherwise, all students are presumed to be full-time students, irrespective of the number of units for which they are enrolled.

WAIVER OF THE NONRESIDENT TUITION FEE

Graduate students who are admitted without deficiencies, who have proved that their scholarship is distinguished, and who are carrying full programs toward the fulfillment of requirements for higher academic or professional degrees or toward the attainment of teaching certificates to be granted by the University, may apply for waiver of the nonresident tuition fee.

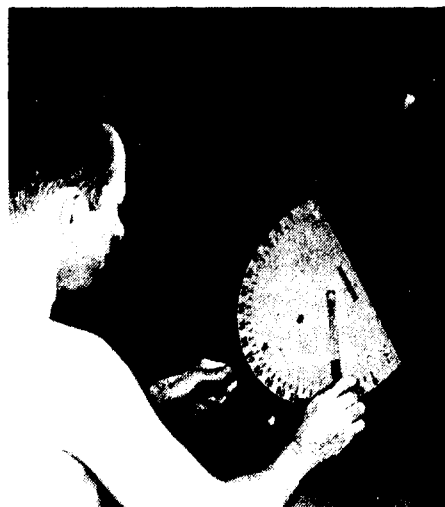
The waiver is granted only on the basis of distinguished scholarship as a recognition of academic excellence. It is not granted on the basis of need and is not to be considered a grant-in-aid. The privilege may be revoked at any time at the discretion of the Dean of the Graduate Division if, in his judgment, a student fails to maintain distinguished scholarship or if he fails to make satisfactory progress toward a degree.

Students who wish to obtain this privilege should apply for the waiver at the time of application for admission to the Graduate Division. If the application for fee waiver is approved, the student will be notified by mail,



time permitting; otherwise, he should inquire at the Office of the Graduate Division of the campus where he has been admitted prior to his registration. Students will be charged the full fees at the time of registration unless they have followed this procedure and have received a fee statement for presentation to the Cashier prior to their registration date. Returning and continuing students should also observe these time limits and procedures if they are applying for waivers. No assurance can be given students who apply for waivers during the registration period that action will be taken prior to their registration date. They must be prepared to register on time and to pay the full fees. If their waiver requests are approved after they have registered, a refund of the nonresident tuition fee will be arranged. Students are also reminded that the waiver is granted for only one semester at a time and that new application has to be made for it each semester. Students exempted from payment of the nonresident tuition fee are still required to pay the incidental fee.

For further information on these and other fees the student should consult the circular on **STUDENT FEES AND DEPOSITS**.



A high-contrast, black and white photograph of a modern building. The building features large windows and a prominent vertical structure. A large tree is visible in the foreground on the right side. The sky is dark and cloudy. The text is overlaid on the left side of the image.

*FELLOWSHIPS,
ASSISTANTSHIPS,
AND LOANS*

FELLOWSHIPS

Graduate Fellowships are available in certain departments and will be announced from time to time.

Among these are the Sverdrup Fellowships in Oceanography. Pre-doctoral Sverdrup Fellowships are available to graduate students who wish to prepare themselves for careers of teaching or research in oceanography. The fellowships will carry a stipend of \$3,000 per year (including the summer months), plus required fees. Loan funds under liberal conditions, in addition to these amounts, are also available to Fellows.

Sverdrup Fellowships are on a one-year basis, but are renewable, and applicants should plan to be candidates for the doctor's degree. Applicants should have an undergraduate major in physics, chemistry, geology, one of the biological sciences, or in mathematics. Fellows may plan to specialize in any of the oceanographic sciences, including physical oceanography, submarine geology, marine chemistry, and biological oceanography.

These fellowships are designated as the Harald Ulrik Sverdrup Fellowships in memory of the third Director of the Scripps Institution, and are supported by a grant to the University by the Ford Foundation.

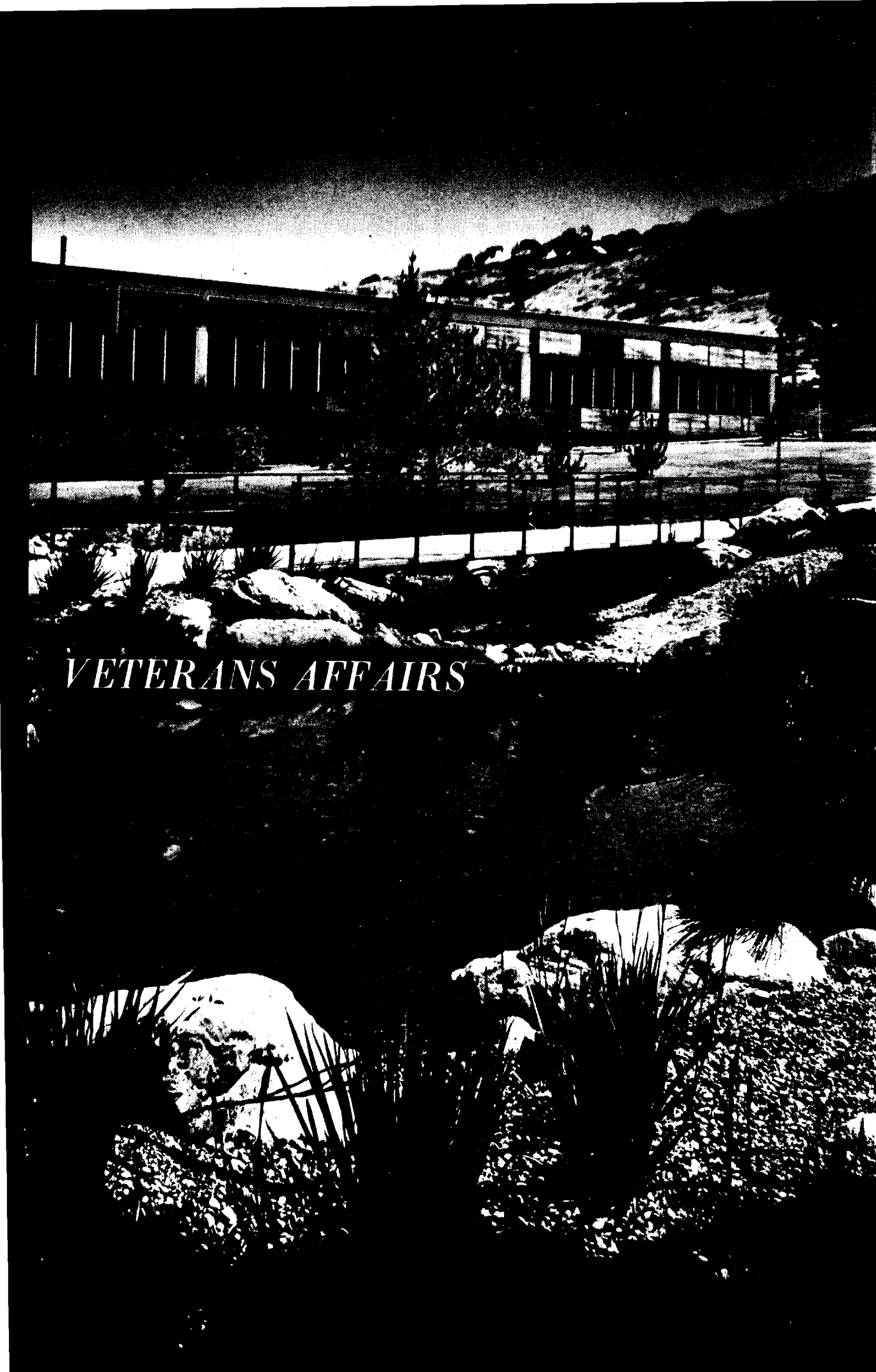
All departments on the campus encourage applications for postdoctoral appointments. Opportunities for such appointments vary from time to time. Among others are the Sverdrup Postdoctoral Fellowships in Oceanography. Postdoctoral Sverdrup Fellowships are available for oceanographic research in physical, chemical, biological oceanography, marine geology, and marine geophysics. They will carry a stipend of \$6,000 per year, including the summer months, and an allowance for travel and for dependents. They are renewable for a second year.

RESEARCH ASSISTANTSHIPS

There are a limited number of Research Assistantships for properly qualified students, with stipends beginning at \$220 monthly for half-time service to an individual or a department. An assistant must be in regular graduate status, in full-time residence, and in good scholarship standing. Application may be made to the Office of Admissions but does not constitute an application for admission, which is a separate process.

LOANS

A limited amount of assistance in the form of loans is available to students, either on a short- or long-term basis. Applications may be made to the Office of the Dean of Student Affairs.

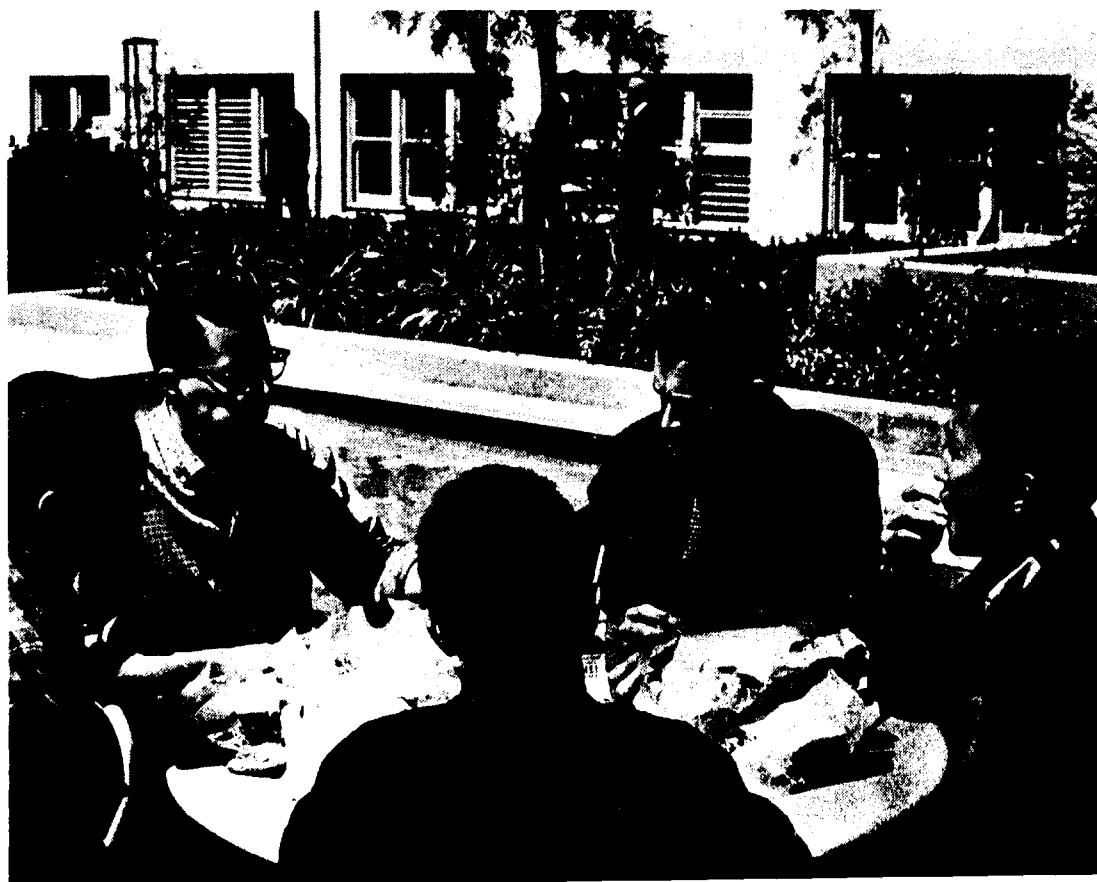


VETERANS AFFAIRS

Information regarding educational benefits available from the State of California (CVEI) may be obtained from the State Department of Veterans Affairs, P.O. Box 1559, Sacramento 7, California; or by writing either to Room 225, 542 South Broadway, Los Angeles 13, California, or 515 Van Ness Avenue, San Francisco 2, California.

Veterans wishing to enroll under the provisions of Public Law 550 (Korean G.I. Bill) and students wishing to enroll under the provisions of Public Law 634 (War Orphans Education Act) should obtain from the United States Veterans Administration a Certificate for Education and Training, which should be filed with the Office of the Dean of Student Affairs. These veterans must be prepared to pay all fees and educational costs at the time of registration as education and training allowances are paid the veterans by the Veterans Administration and the first monthly payment will normally be received 60 to 75 days after enrollment in the institution.

Information on Selective Service and draft status may be had from the Office of the Dean of Student Affairs.



A high-contrast, black and white photograph of a modern building facade. The image is dominated by several vertical, light-colored columns that create a strong sense of height and structure. In the lower-left quadrant, a fountain is visible, with water cascading down. The overall aesthetic is minimalist and architectural. The text 'LIVING ACCOMMODATIONS' is overlaid in the center in a white, italicized serif font.

LIVING ACCOMMODATIONS

LIVING ACCOMMODATIONS

At the present time there are no living quarters on the campus for single students. All students will be assisted by the Housing Services Office to find suitable accommodations in the surrounding communities of La Jolla, Pacific Beach, or Del Mar. These consist of rooms, studios, apartments or houses. Students must call in person at the Housing Services Office to make rental arrangements through the card file. General information is available by mail.

There are limited accommodations for married students on the campus. These consist of 19 studio, 56 one-bedroom, and 31 two-bedroom newly constructed apartments. These units are unfurnished except for stove and refrigerator. Coin operated washers and dryers are supplied in the commons building. Rental prices, including utilities and parking area, per month, are: \$75 for the studio, \$95 for one-bedroom, and \$105 for two-bedroom apartments. Information and application blanks may be obtained by calling in person or writing to the Housing Services Office, where a waiting list is maintained.

CHART OF THE NUCLIDES

Periodic table of elements
with atomic numbers and symbols
of the nuclides of each element
and their relative stability





DEPARTMENTAL ANNOUNCEMENTS

ABBREVIATIONS

In the following announcements, the credit value of each course in semester units is indicated by a number in parentheses after the title. A unit of registration is one hour of the student's time at the University, weekly, during one semester, in lecture or recitation, together with the time necessary in preparation therefor; or a longer time in laboratory or other exercises not requiring preparation. The session in which the course is given is shown by Roman numerals: I for the fall semester, and II for the spring semester. A course given throughout the period September to June is designated Yr. The assignment of hours is made in the SCHEDULE OF CLASSES to be obtained at the time of registration.

A course designated by a double number (for example, Chemistry 110A-110B) is continued through two successive semesters, ordinarily beginning in the fall semester. Each half of the course constitutes a semester's work. The first half is prerequisite to the second unless there is an explicit statement to the contrary. The instructor makes a final report on the student's work at the end of each semester. Unless otherwise noted, the student may take the first half only and receive final credit for it.

BIOLOGY

Instructional Staff

David M. Bonner, Ph.D., Professor of Biology (Chairman of Department)

S. Jonathan Singer, Ph.D., Professor of Biology

John A. DeMoss, Ph.D., Assistant Professor of Biology

Stanley E. Mills, Ph.D., Assistant Professor of Biology

* * *

Marko Zalokar, Ph.D., Associate Research Biologist

Yoshitaka Suyama, Ph.D., Assistant Research Biologist

Leon Wofsy, Ph.D., Assistant Research Biologist

* * *

Frank J. Dixon, M.D., Research Associate

William O. Weigle, Ph.D., Research Associate

Graduate studies for the Ph.D. degree in the Department of Biology are oriented mainly to the development of the capacity for independent, imaginative, and self-critical research. No formal course requirements exist. Although several basic formal courses are given, much reliance is placed on informal instruction through early and close association of the student

with the faculty and research staff, and through regular seminars. After becoming familiar with the research activities of the faculty, the student will begin research on a problem of his choice, generally by the end of the first semester.

At the end of the student's first year, an evaluation of his progress will be made, which may involve an oral examination at the discretion of the department. No later than the end of the second year, the student will be required to take an oral qualifying examination conducted by the Doctoral Committee in order to be admitted to candidacy for the Ph.D. degree. The purpose of this examination is to have the student demonstrate his competence in the field of his major interest and in related fields of biology and natural sciences. The reading examinations in two foreign languages (from German, French, or Russian) must be passed prior to the qualifying examination.

The graduate program in biology emphasizes the molecular approach to biology. To this end, although there are no inflexible entrance requirements, it is recommended that the student's undergraduate preparation include at least a year of calculus, elementary organic chemistry, and elementary physical chemistry.

In his first year, the student will probably take one or more of the courses listed below, or of those offered in the Department of Chemistry, and other associated departments in the University, depending on his background and interests.

GRADUATE COURSES

201A-201B. *General Biochemistry and* Mr. Kamen, Mr. Bonner,
General Microbiology (3-3) Yr. and Staff

The first half of this course is the same as Chemistry 241A, *Enzymes and Intermediary Metabolism*. The second half deals with the physiology and genetics of microorganisms.

202A-202B. *Introduction to Quantitative* Mr. Singer
Biology (3-3) Yr.

Prerequisite: one year calculus or equivalent.

The application of fundamental principles of physics and physical chemistry to problems of biological interest, with emphasis on thermodynamics and molecular structure.

°210A-210B. *Immunology* (2-2) Yr.

Mr. Mills, Mr. Weigle

The first half of this course will involve a description of the immune mechanism in terms of antibodies, antigens, and complement. The second half will be a detailed consideration of special topics with emphasis on the analysis of current literature.

212. *Genetics* (3) I.

Mr. Bonner and Staff

A discussion of all phases of contemporary genetics, with emphasis on molecular genetics.

220. *Microbial Metabolism* (2) I.

Mr. DeMoss

Prerequisite: Biology 201A.

The mechanisms and control of biosynthesis of small molecules and macromolecules by microorganisms.

222. *Macromolecular Biology* (3) II.

Mr. Singer, Mr. Zimm

Prerequisite: Elementary Physical Chemistry or Biology 202.

A quantitative discussion of biologically important macromolecules, of their structure and the techniques used to study them.

224. *Growth and Development* (3) II.

Mr. Zalokar

A discussion of current work in the field of growth and development, with emphasis on ultrastructure and the biochemistry underlying development.

230. *Special Topics in Biology* (1-3) I, II.

Mr. Bonner and Staff

This course to be given by visiting scientists. Topics will depend on the interests of the lecturer, but it is intended that these include at various times developmental biology, virology, plant physiology, and related subjects.

299. *Research in Biology* (1-6), I, II.

Mr. Bonner and Staff

Research interests of the present staff are indicated below:

Bonner: Biochemical genetics in microorganisms; metabolic pathways; genetics of enzyme formation.

DeMoss: Microbial physiology; biosynthesis of proteins and control mechanisms.

Dixon: Experimental pathology; immunology.

Mills: Immunology and immunochemistry; tissue culture; genetics of mammalian cells.

- Singer: Molecular biology; biophysical chemistry; immunochemistry; biochemical genetics; cellular ultrastructure.
Suyama: Genetic fine structure in microorganisms.
Weigle: Immunochemistry; immunological tolerance; histocompatibility.
Zalokar: Growth and development; cellular and genetic ultrastructure.
- * * *

Close collaboration with several members of the Departments of Chemistry and Physics is a vital and stimulating aspect of the biology program. Martin D. Kamen, Stanley L. Miller, T. G. Traylor, and Bruno H. Zimm share many interests with the staff of the Department of Biology, and their physical proximity is a unique feature of this graduate school. Additional strength and breadth in biology is gained by collaboration with the Department of Marine Biology of the Scripps Institution of Oceanography and with the Division of Experimental Pathology of the Scripps Clinic and Research Foundation. Students may carry out their dissertation research in collaboration with members of these groups.

CHEMISTRY

Instructional Staff

- James R. Arnold, Ph.D., Professor of Chemistry
Martin D. Kamen, Ph.D., Professor of Biochemistry
Joseph E. Mayer, Ph.D., Professor of Chemistry (Chairman of the Department)
Hans E. Suess, Ph.D., Professor of Geochemistry
Harold C. Urey, Ph.D., Sc.D., Professor of Chemistry-at-Large, University of California
Bruno H. Zimm, Ph.D., Professor of Chemistry
Joseph Kraut, Ph.D., Associate Professor of Chemistry
Stanley L. Miller, Ph.D., Associate Professor of Chemistry
Robert C. Fahey, Ph.D., Assistant Professor of Chemistry
Gordon G. Goles, Ph.D., Assistant Professor of Chemistry
Charles Perrin, Ph.D., Assistant Professor of Chemistry
Teddy G. Traylor, Assistant Professor of Chemistry
- * * *
- E. D. Goldberg, Ph.D., Professor of Chemistry
Harmon Craig, Ph.D., Associate Professor of Geochemistry

The department accepts only students who wish to seek the Ph.D. The program is designed to encourage initiative on the part of the student and to develop habits of independent study. Courses in the department are handled in part by the tutorial system, with encouragement to the student to concentrate on one or two subjects at a time under the guidance of a faculty member. Formal lectures will be kept to a minimum. Research will be started early, toward the end of the first semester in the case of a student with normal preparation. The qualifying examination for admission to candidacy will require the student to present and discuss propositions that he has prepared independently.

In order that he may participate effectively in this program, the entering graduate student will be required to have a mastery of the subjects usually presented in an undergraduate chemistry curriculum: physical, organic, analytical, and inorganic (descriptive) chemistry. Physical chemists will be expected to present the equivalent of two years of physics and of mathematics through integral calculus. The appropriate background courses in biology or geology are highly desirable for students interested in biochemistry and geochemistry, respectively, but will sometimes be taken after arrival. So that the student may be properly advised, his mastery of these undergraduate subjects will be tested by oral or written examination on his arrival.

Two foreign languages (German and either French or Russian) are required.

In the first year the student will usually take several of the courses listed below. Depending on his special interests, he may also take one or more courses in other departments. In the second year he will usually carry a very light load of formal courses, but will continue to participate in seminars and informal study groups.

The qualifying examination, so far as departmental requirements are concerned, will be conducted as follows:

The candidate will present two propositions, which are to be designated as major and minor, respectively, and be prepared to discuss and defend them.

(a) The major proposition should consist of a statement of an original research problem or scientific idea not closely connected with his doctoral thesis. He should be prepared, in the examination, to discuss the theory and the experimental techniques that may be involved, the significance of

the proposition, and its relation to previous knowledge.

(b) The minor proposition may be similar to the major one, or it may consist of a critical survey of literature in some field of chemistry outside the field of his main interest. The purpose of this prescription is to reveal the ability of the candidate to make a critical survey and an effective, orderly presentation and also to provide him with a further incentive to broaden his understanding of chemistry.

In special circumstances the Doctoral Committee may modify the examination at its discretion.

The courses offered by the department are as follows:

UPPER DIVISION COURSES

110A-110B. *Physical Chemistry* (3) Yr. *Mr. Urey and the Staff*

GRADUATE COURSES

201. *Chemical Thermodynamics* (3) I. *Mr. Zimm*

202. *Molecular Quantum Mechanics* (3) II. *Mr. Arnold*

203. *Statistical Mechanics of Chemical Systems* (3) II. *Mr. Zimm*

210. *Molecular Structure* (3) I. *Mr. Suess*

Valence theory, molecular spectra, chemical binding in solids.

221. *Physical Organic Chemistry* (3) I. *Mr. Traylor*

232. *Special Topics in
Chemistry* (2) I, II.

This course will be given from time to time by visiting or regular members of the staff on topics of special interest.

241A-241B. *Enzymes and Intermediary
Metabolism* (3-3) Yr. *Mr. Kamen*

250. *Seminar in Chemistry* (1) I, II. *The Staff*

Regularly scheduled seminars will be the medium by which students are acquainted with those important subjects that are too specialized for general courses in a small department, *e.g.*, macromolecules, chemical kinetics, solid state, advanced inorganic chemistry, nuclear chemistry, molecular spectroscopy.

299. *Research in Chemistry* (1-6) I, II. *The Staff*

Research interests of the present faculty are listed briefly below.

- Arnold: Cosmic-ray produced radioactivity, meteorites, geochronology, valence theory.
- Fahey: Mechanisms of the addition reactions of olefins and acetylenes; electron distribution in aromatic systems; fast reactions studied by nuclear magnetic resonance spectroscopy.
- Goles: Applications of activation analysis to problems of the origin of meteorites and the solar system and to terrestrial geochemistry, microscopic studies of meteorites, sulfur isotopes in meteorites.
- Kamen: Application of biophysical chemical methods, including isotopic tracer methodology, to study of bacterial metabolism; energy storage, especially in photosynthesis.
- Kraut: X-ray determination of structure of biochemically significant molecules.
- Mayer: Statistical mechanics, quantum statistics and quantum mechanics of molecules and fluids.
- Miller: Synthesis of organic compounds under geologically primitive conditions, active transport in biological systems, mechanism of action of gaseous anesthetics.
- Perrin: Molecular orbital theory, organic polarography, nature of hyperacid solutions, reaction mechanisms.
- Suess: Abundance of the elements, geochemical studies using natural and man-made radioactivity, activation analysis, C¹⁴ dating.
- Traylor: Electrophilic substitution, behavior of free radicals in solution, autoxidation, stereochemistry of electrophilic addition reactions.
- Urey: Origin of the elements and the solar system, meteorites, stable isotopes in nature.
- Zimm: Experimental and theoretical physical chemistry of biological macromolecules and high polymers, statistical mechanics.

Related Areas of Study

The Interdisciplinary tradition is strong on the San Diego campus and is already well established in chemistry. It is expected that the biochemistry faculty and student body will develop close ties with the Department of Biology under the leadership of Dr. David Bonner. The two departments are sharing a floor of Sverdrup Hall temporarily.

Three members of the chemistry faculty are strongly interested in the Department of Earth Sciences. In addition to Harmon Craig and E. D. Goldberg, who are associate members of the Department of Chemistry in a reciprocal arrangement, other earth scientists, for instance G. O. S. Arrhenius and A. E. J. Engel, have common research interests. Gordon Goles is a member of both departments. The ties with oceanography, through marine chemistry and tracer studies of ocean circulation and sedimentation, are also strong. The facilities of the Scripps Institution for marine research are available to all qualified persons in the School of Science and Engineering. A high speed computer is used by graduate students.

Joint student programs with the Department of Physics, especially in the areas of solid state and nuclear research, will be developed as needed. This and the other collaborative programs described above are being carried on with a minimum of formal organization.

EARTH SCIENCES

Instructional Staff

Gustaf O. S. Arrhenius, D.Sc., Professor of Marine Geology

George E. Backus, Ph.D., Professor of Geophysics

Albert E. J. Engel, Ph.D., Professor of Geology

Freeman Gilbert, Ph.D., Professor of Geophysics (Chairman of the Department)

Edward D. Goldberg, Ph.D., Professor of Chemistry

Henry W. Menard, Ph.D., Professor of Geology

Walter H. Munk, Ph.D., Professor of Geophysics

Russell W. Raitt, Ph.D., Professor of Geophysics

Roger Revelle, Ph.D., D.Sc., Professor of Oceanography

Victor Vacquier, M.A., Professor of Earth Sciences

Harmon Craig, Ph.D., Associate Professor of Geochemistry

Richard A. Haubrich, Ph.D., Associate Professor of Geophysics

Manuel Bass, Ph.D., Assistant Professor of Geology

Gordon Goles, Ph.D., Assistant Professor of Chemistry

Alexander McBirney, Ph.D., Assistant Professor of Geology

Daniel F. Weill, Ph.D., Assistant Professor of Geology

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Theodore R. Madden, Ph.D., Visiting Associate Professor of Geophysics

• • •

James R. Arnold, Ph.D., Professor of Chemistry
Hans E. Suess, Ph.D., Professor of Geochemistry
Harold C. Urey, Ph.D., D.Sc., Professor of Chemistry-at-Large

The Department of Earth Sciences offers a graduate curriculum leading to the M.S. and the Ph.D. in Earth Sciences. Two general curricula are offered: geology-geochemistry and geophysics. The programs of study emphasize the application of the analytical, experimental, and theoretical methods of physics and chemistry to fundamental problems in the terrestrial, marine, and atmospheric sciences.

Requirements for Admission

Geology-Geochemistry Curriculum – A baccalaureate major in one of the physical or earth sciences, or mathematics, or engineering. The student's preparation should include:

1. General physics, equivalent to Physics 1A, 1B, 1C, 1D on the Los Angeles campus. Physics courses designed specifically for medical, biological, or agricultural students will normally not be acceptable for this requirement.

2. Two years of chemistry, including physical chemistry (advanced physics may be substituted for one year of chemistry).

3. Mathematics through differential and integral calculus.

Geophysics Curriculum – Normally, a bachelor's degree in physics or mathematics will be necessary. The student's preparation should also include introductory courses in geology.

Requirements for the Master's Degree

The Master of Science degree will be offered under Plan II (Comprehensive Examination) according to the general rules of the Graduate Division. All programs must include the basic curriculum of courses described under the doctoral program, and a reading knowledge of either French, German, or Russian is required.

Requirements for the Doctor's Degree

Students will normally concentrate their work in one of two basic curricula:

(1) *Geology-Geochemistry*. Geology and geochemistry students will

be responsible for the material included in the following courses: Earth Sciences 120, 150, 215, 220, 221, 230A-230B, 236, 240, Oceanography 110, and either Physics 191A or Chemistry 201. (Students found to be deficient in physical chemistry will be required to take Chemistry 110A-110B as a prerequisite.) These courses constitute the basic curriculum in preparation for the qualifying examination. Recommended electives include Earth Sciences 133, 231, 241-247, 253; Physics 190A-190B, 191B; Chemistry 202, 203, 210; Oceanography 210, 229.

(2) *Geophysics*. Geophysics students will be responsible for the material included in the following courses: Earth Sciences 130A-130B, 150, 241A-241B through 247; any two of Earth Sciences 215, 217, 220, 221, 230A-230B. Electives may be selected from the following courses: Chemistry 201, 202, 203, 210, 232, 250; Earth Sciences — all courses; Oceanography 110, 111, 113, 118, 119, 210, 211, 220, 224, 229, 250, 251, 255; Physics — all courses.

Near the end of the second year in residence the student in either the geophysics or the geology-geochemistry curriculum will normally have completed his basic course work and preparation for the qualifying examinations. Before taking the qualifying examination he must pass reading examinations in two foreign languages (German, French, or Russian).

The qualifying examination for the Ph.D. will emphasize the student's ability to integrate the material covered in his course work with his knowledge of the basic physical sciences for the analysis of general problems in the earth sciences. A written examination may be administered by the department in some instances, but in all cases an oral examination will be conducted by the student's Doctoral Committee. The oral examination will be based on the presentation and defense of propositions prepared independently and submitted by the student.

When the student is ready for the qualifying examination he will submit to his adviser two or three propositions, at least one of which must be outside of his major field. The propositions will be statements or conjectures concerning research problems in the earth sciences or allied problems in other fields. Upon acceptance of the propositions by the department, the Doctoral Committee will conduct the examination, in which the student will be expected to discuss the significance of the propositions and the experimental and theoretical problems involved in studies designed to prove or disprove the propositions.

Advanced Work for the Doctor's Degree

Advanced study and research for the doctoral thesis may be done in theoretical or experimental geophysics and geochemistry, marine and terrestrial geology, or other specialized areas of the earth sciences. Students specializing in geochemistry or geophysics will normally take some advanced courses in physics and chemistry as well as some of the departmental option courses. Other courses available are listed in the oceanography curriculum. See page 17 concerning the Institute of Geophysics and Planetary Physics.

UPPER DIVISION COURSES

120. *Mineralogy* (3) I. Mr. Arrhenius

Prerequisite: consent of the instructor.

Lectures and laboratory work in crystallography, X-ray, and optical mineralogy.

121. *Petrology* (3) I, II. Mr. McBirney

Prerequisite: course 120.

Petrology of igneous, metamorphic, and sedimentary rocks.

130A-130B. *Topics in Geology* (2-2) I, II. Mr. Engel, Mr. Menard

Reading course, with preparation of written reports, dealing with basic subjects and problems in the earth sciences.

133. *Instrumental Geochemistry* (3) I. Mr. Goldberg, Mr. Goles

Prerequisites: physical chemistry and consent of the instructor.

Lectures and laboratory work on instrumental methods with applications to geochemistry.

150. *Field Geology* (3) II. Mr. Bass

Prerequisite: consent of the instructor.

Field work in local areas, with preparation of maps and a report.

199. *Special Studies in Earth Sciences* (1-4) I, II. The Staff

Prerequisite: consent of the instructor.

GRADUATE COURSES

215. *Tectonics* (3) II. Mr. Menard

Prerequisite: consent of the instructor.

The large-scale structural and morphological features of the earth, crustal deformation, mountain building, permanency of continents, etc.

220. *Petrology* (3) I. Mr. McBirney

Prerequisite: Earth Sciences 120 (may be taken concurrently) or consent of the instructor.

The petrology of igneous rocks with emphasis on the products and processes of volcanism.

221. *Advanced Petrology* (3) II. Mr. Engel

Prerequisites: Physical Chemistry, Earth Sciences 120, 121, 236, 230A-230B, or consent of the instructor.

The properties, origin, and evolution of the rocks in the earth's crust.

222. *Theoretical Petrology* (3) I. Mr. Weill

Prerequisites: Earth Sciences 120 and 121; Chemistry 201.

Some applications of thermodynamics to rock formation. Interpretation and evaluation of experimental work in petrology with emphasis on mineral synthesis and solubility.

223. *Sedimentary Petrology* (3) I. Mr. Arrhenius

Prerequisite: Earth Sciences 120.

Sources, stability relations and quantitative determinations of the components of sedimentary rocks; discussion of assemblages in terms of geological agents.

230A. *Geochemistry* (3) I. Mr. Goldberg, Mr. Murthy

Prerequisites: Chemistry 201, or concurrently.

Chemistry of the lithosphere, atmosphere, and oceans; the geochemical balance; marine chemistry, geochemical cycles of major and minor elements; geochronology.

230B. *Geochemistry* (3) II. Mr. Craig

Prerequisite: Chemistry 201 or Physics 191A.

Applications of thermodynamics to general problems in the earth sciences; geochemistry of stable and radioactive isotopes; mixing and exchange phenomena, etc.

231. *Nuclear Geochemistry* (2) II. Mr. Suess

Prerequisite: physical chemistry or atomic physics.

Radioactive and stable isotopes; stability of nuclei; radioactive decay schemes; natural radioactivities and geological applications; origin and relative abundances of the elements; fission elements and extinct natural radioactivities.

236. *Summer Field Course* (4). Mr. Engel

Prerequisite: consent of the instructor

Geological mapping of land areas, and reconnaissance mapping and geophysical studies of adjacent areas of the continental shelf and slope. Field parties operate from ships, boats, and camps ashore for a period of four to six weeks. A report is prepared summarizing field studies.

240. *Geophysics* (4) I. Mr. Raitt, Mr. Vacquier

Prerequisite: Oceanography 110.

Elastic wave propagation in the ocean, the solid earth, and the atmosphere; gravity, earth magnetism; tides, and other topics in geophysics.

°241A-241B. *Continuum Mechanics* (3-3) I, II. Mr. Backus, Mr. Gilbert

Prerequisites: differential and integral calculus. 241A is a prerequisite for 241B.

Matrix theory; strain tensors and stress tensors; stress strain relations; perfect elasticity; elastic equilibrium; thermal stress; relaxation phenomena; Onsager relations; conservation theorems; perfect fluids; viscous fluids; elements of hydromagnetics; plane wave theory in elasticity; Rayleigh and Stoneley waves.

°°242. *Geophysical Measurements* (3) I. Mr. Haubrich, Mr. Vacquier

Prerequisite: elementary complex variables.

Design of geophysical experiments and analysis of geophysical measurements; interpretation of geophysical time series; wave number filters; theory of arrays; geophysical systems analysis.

†243. *Geomagnetism and Geoelectricity* (3) II. Mr. Vacquier, Mr. Backus

Prerequisites: Earth Sciences 241A-241B, Physics 203A (Physics 203B may be taken concurrently with 243).

Review of electromagnetic theory; earth-ionosphere cavity resonances; low

°Offered every year

°°Offered in even-numbered fall semesters

‡Offered in even-numbered spring semesters

frequency E. M. induction problem; boundary value problems; geomagnetic dynamo problem; ground conductivity problem; effects of anisotropy of material constants; paleomagnetic methods and results.

***244. *Gravity, Tides and Geodesy* (3) II. *Mr. Munk, Mr. Haubrich*

Prerequisites: Earth Sciences 241A-241B, Physics 201.

Spherical harmonics; tide generating potentials, static and dynamic theory of tides; analysis of gravity observations; determination of subsurface mass distributions; seismo-gravitational phenomena; isostasy and crustal compensation; figure of the earth determined from gravity surveys and satellite observations.

†245. *Rotation of the Earth* (3) I. *Mr. Munk*

Prerequisites: Earth Sciences 241A-241B, Physics 201.

Introduction to geodynamics; Liouville equation; perturbation solutions; Love numbers; variations of length of day; Chandler wobble; historical variations; geological variations; dissipation mechanisms; reduction of observational data; polar wandering.

†247. *Seismology* (3) II. *Mr. Gilbert, Mr. Raitt*

Prerequisites: Earth Sciences 241A-241B, Physics 200A (Physics 200B may be taken concurrently), Physics 201.

Equation of motion; exact transient solution of canonical problems; interface pulses; geometrical diffraction theory; ray theory and mode theory in plane layered media; free oscillations of the earth; radiation from moving sources; source determination; aeolotropic and heterogeneous media; dissipation; interpretation problems.

253. *Seminar in Geochemistry-Cosmochemistry* (3) II. *The Staff*

The subject matter will vary from year to year and will normally cover an area of study not treated extensively in other Earth Sciences courses. In 1962, the history of the solar system with reference to the properties of meteorites and theories of their origin was treated.

299. *Research* (1-6) I, II. *The Staff*

IGPP Seminar (No credit) I, II. *The Staff*

A geophysical seminar given every term in which students, staff, and visitors report on recent papers or results of interest on their own work or reading.

LANGUAGES

Instructional Staff

Conny J. Sabo, B.S., Lecturer in German and Russian and University Language Examiner

(—————), Lecturer in French

These courses are open to all registered students, and to certain others by permission of the instructor and the Dean of the Graduate Division. The courses are intended to prepare students for the foreign language examinations.

German 1G. *Reading Course* (No credit) I, II. Mr. Sabo

French 1G. *Reading Course* (No credit) I, II. (—————)

Russian 1G. *Reading Course* (No credit) I, II. Mr. Sabo

MARINE BIOLOGY

Instructional Staff

Andrew A. Benson, Ph.D., Professor of Biology

Denis L. Fox, Ph.D., Professor of Marine Biochemistry

Carl L. Hubbs, Ph.D., Professor of Biology

Per F. Scholander, M.D., Ph.D., Professor of Physiology

Benjamin E. Volcani, Ph.D., Professor of Microbiology

Claude E. ZoBell, Ph.D., Professor of Marine Microbiology

Francis T. Haxo, Ph.D., Associate Professor of Biology (Chairman of the Department)

Ralph A. Lewin, Ph.D., Associate Professor of Biology

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Martin W. Johnson, Ph.D., Professor Emeritus

Edward W. Fager, Ph.D., D.Phil., Associate Professor of Biology

The Department of Marine Biology offers a program of studies leading to the M.S. or Ph.D., emphasizing experimental, as well as some areas of descriptive biology of marine organisms. These studies presently include microbiology, cellular and comparative physiology and biochemistry, physiological ecology, systematics and life histories, genetics and evolution.

Students intending to specialize in marine biology should be broadly oriented toward biology but with training in at least one specific discipline, *e.g.*, microbiology, animal or plant physiology, biochemistry, inverte-

brate or vertebrate zoology. Students in marine biology at San Diego are encouraged to supplement their training by course offerings in other departments of this campus, *e.g.*, oceanography, other teaching units in the biological sciences, the earth sciences, and chemistry. Qualified students in marine biology may, with the approval of both departments concerned, pursue their research under the joint guidance of a member of the Department and a faculty member of another department.

Provisions are also made for certain students to pursue work toward the Ph.D. in botany, microbiology, or zoology under the supervision of UCLA faculty members in cooperation with marine biology faculty members at San Diego. Arrangements may be made for properly qualified students working under faculty members at Berkeley or other branches of the University of California to complete part of the requirements for an advanced degree at San Diego.

Requirements for Admission to the Graduate Curriculum

1. A baccalaureate degree major in one of the biological sciences or the substantial equivalent.
2. Two semesters in each of the following: English, mathematics, and physics with appropriate laboratory.
3. At least 12 semester units of chemistry, including organic chemistry. Biochemistry and physical chemistry are recommended, especially for students in experimental biology.
4. At least 20 semester units of biology, including basic courses in both botany and zoology.
5. Preparation is recommended in two foreign languages (one is required for the M.S. degree), chosen from the following: German, Russian, or French.

Requirements for the Master of Science in Marine Biology

Offered on either Plan I (20 units and thesis) or Plan II (24 units and comprehensive examination). Unit requirements may be satisfied by approved selections from courses listed in either Marine Biology, Oceanography, or other departments, but must include Oceanography 110, 112, and 113 and a total of 12 units of graduate courses, ordinarily including seminar work, *e.g.*, Marine Biology 252 or Oceanography 253, during each semester in residence. A reading knowledge of German, Russian, or French is required.

Requirements for the Doctor of Philosophy in Marine Biology

The required courses listed for the M.S. degree; a reading knowledge of German and either Russian or French (to be demonstrated before the end of the second year.) The student is required to pass a departmental examination, ordinarily by the end of his second year, and a qualifying examination, ordinarily before the end of the first semester of his third year. Independent study and research, with thesis, in such fields as those listed below in Marine Biology 299.

UPPER DIVISION COURSES

114. *Marine Vertebrates* (3) II. Mr. Hubbs
 121. *Marine Microbiology* (3) II. Mr. ZoBell

Prerequisites: Oceanography 110, 112, 113. Additionally, the student should have had course work in general bacteriology or microbiology and in biochemistry.

Methods of studying bacteria and allied microorganisms, with particular reference to the importance of bacteria as biochemical and geological agents in the sea.

- *125B. *Laboratory in Algal Physiology* (2) I. Mr. Haxo
 *125C. *Physiology of Marine Algae* (2) I. Mr. Haxo

Prerequisite: basic courses in biology and chemistry.

Comparative physiology and biochemistry of algae with emphasis on marine problems.

199. *Special Studies* (1-4) I, II. The Staff

Prerequisite: consent of the instructor.

GRADUATE COURSES

- *222. *Biochromes* (2-3) II. Mr. Fox, Mr. Haxo

Prerequisites: course work in organic chemistry and in the biochemistry or the physiology of plants or animals.

Physical and chemical foundations of color manifestation; the chemistry, distribution, metabolism, and significance of pigments occurring in the living world.

- *226. *Marine and Comparative Biochemistry* (3) II. Mr. Fox

*Offered in alternate years

Prerequisites: preparation in biology and in biochemistry or physiology, or consent of the instructor. Oceanography 112 and 113 are recommended.

Chemistry of living matter; osmotic adaptations; marine colloids; comparative biochemical and physiological activities of marine organisms; biochemical cycles in the sea; animal pigments.

252. *Seminar in Experimental and Comparative Biology* (2) I, II. *Mr. Volcani and the Staff*

*260. *Seminar in Advanced Ichthyology* (2) II. *Mr. Hubbs*

285. *Laboratory in Physiology* (2-4) II. *Mr. Scholander*

Research techniques and problems in selected areas of environmental physiology.

299. *Research* (1-6) I, II. *The Staff*

Research in such biological fields as: phycology, biophysics, genetics, evolution, microbiology, vertebrate and invertebrate zoology, comparative biochemistry or physiology of marine plants and animals. Students must present evidence of satisfactory preparation for the work proposed.

The following courses in other departments will also be of interest to students in Marine Biology:

Oceanography 110, 111, 112, 112C, 113, 118, 220, 225, 253.

Chemistry 110A-110B, 241A-241B.

Earth Sciences 133.

Biology 201A-201B and others.

OCEANOGRAPHY

Instructional Staff

John D. Isaacs, B.S., Professor of Oceanography

Fred B Phleger, Ph.D., Professor of Oceanography, Director of Foraminifera Laboratory

Norris W. Rakestraw, Ph.D., Professor of Chemistry

Roger Revelle, Ph.D., D.Sc., Professor of Oceanography and Director of the Scripps Institution of Oceanography

Milner B. Schaefer, Ph.D., Professor of Oceanography and Director of Institute of Marine Resources

Francis P. Shepard, Ph.D., Professor of Submarine Geology
Fred N. Spiess, Ph.D., Professor of Oceanography and Director of the
Marine Physical Laboratory

Warren S. Wooster, Ph.D., Professor of Oceanography

Robert S. Arthur, Ph.D., Associate Professor of Oceanography

Charles S. Cox, Ph.D., Associate Professor of Oceanography

Edward W. Fager, Ph.D., D.Phil., Associate Professor of Biology
(Chairman of the Department)

Douglas L. Inman, Ph.D., Associate Professor of Geology

Edward L. Winterer, Ph.D., Associate Professor of Geology

Klaus F. Hasselmann, Ph.D., Assistant Professor of Geophysics

John A. McGowan, Ph.D., Assistant Professor of Oceanography

Melvin N. Peterson, Ph.D., Assistant Professor of Oceanography

Philip Rudnick, Ph.D., Research Physicist, and Lecturer

Gifford C. Ewing, Ph.D., Associate Research Oceanographer and Lecturer,
Chairman, Division of Oceanic Research

Jeffery D. Frautschy, B.A., Associate Research Engineer, Lecturer, and
Assistant Director of the Scripps Institution of Oceanography

Tjeerd H. van Andel, Ph.D., Associate Research Geologist and Lecturer

Joseph R. Curray, Ph.D., Assistant Research Geologist, and Lecturer

William R. Riedel, M.S., Assistant Research Geologist, and Lecturer

Edwin L. Hamilton, Ph.D., Research Associate and Lecturer

Milton N. Bramlette, Ph.D., Professor Emeritus

Carl H. Eckart, Ph.D., Professor of Geophysics

Edward D. Goldberg, Ph.D., Professor of Chemistry

Carl L. Hubbs, Ph.D., Professor of Biology

Martin W. Johnson, Ph.D., Professor Emeritus

Walter H. Munk, Ph.D., Professor of Geophysics

Francis T. Haxo, Ph.D., Associate Professor of Biology

The Department of Oceanography offers a program of studies designed to reveal the interdependence of the biological, chemical, geological, and physical processes operating in the oceans. Students are required to gain a general knowledge of all these fields. Although most students will specialize in one, the Department encourages qualified students to become competent in any appropriate combination of these fields.

Biological studies in the Department of Oceanography include systematics, life histories, and geographical distribution of zooplankton; distribution patterns, behavior, population dynamics and community relationships of marine invertebrates; ecology and population dynamics of marine fishes.

Chemical studies in the Department of Oceanography include the use of chemical techniques in the effort to understand the behavior of the ocean; the part that the ocean plays in general geochemistry; the distribution of the chemical elements; the chemical processes that go on within the ocean and in the exchange between the ocean itself and the atmosphere and the sea bottom.

Geological studies in the Department of Oceanography include marine micropaleontology; mechanics of sedimentation; petrology of sediments; and the structure and morphology of the ocean floor and the continental margins.

Physical studies in the Department of Oceanography include observation, analysis, and theoretical interpretation of problems of general circulation and the distribution and variation of properties in the ocean; interchange of kinetic and thermal energy across the ocean surfaces; propagation of sound and light and other electromagnetic energy in the ocean; properties of ocean waves.

Requirements for Admission

1. A baccalaureate degree in one of the physical or biological sciences, which must include the following:

2. Mathematics through differential and integral calculus.
3. Physics and chemistry, one year of each with laboratory.

Students intending to specialize in physical oceanography should ordinarily have an undergraduate major in physics, including three years of physics, and mathematics through differential equations; vector analysis is recommended.

4. An additional year of either physics or chemistry. If chemistry is selected, either quantitative analysis, physical chemistry, or organic chemistry is recommended; if physics is selected, the course should stress the fundamentals of mechanics, electricity, magnetism, optics, thermodynamics, or a combination of these topics.

5. Biology, one year with laboratory.

Students intending to specialize in biological oceanography should ordinarily have an undergraduate major in biology. Courses in limnology or ecology, invertebrate zoology, and general or comparative physiology are recommended.

6. Geology, one semester.

Students intending to specialize in marine geology should ordinarily have an undergraduate major in geology including courses in physical geology, historical geology, structural geology, paleontology, optical mineralogy, petrology, and a field course in geology.

7. Preparation in at least one foreign language chosen from the following: French, German, Russian.

Students may be admitted with a single deficiency, other than mathematics, on condition that they make it up during their first year in residence.

Students with only a minor in their intended field of specialization may be admitted if their preparation and record are considered satisfactory by the Department.

Requirements for the Master's Degree

Because of limited facilities, the Department does not at the present time encourage students who wish to proceed only to the master's degree. Special arrangements can, however, be made if circumstances warrant it.

Requirements for the Doctor's Degree

The Department requires all students to take courses 110, 111, 112, 113, 123, and 250 and to obtain experience at sea in a research vessel. Each student must also acquire a minimum of 21 additional graduate units, or their equivalent, in courses in oceanography and basic sciences, pass a reading examination in two of the following languages: French, German, Russian, and perform and report on independent study and research in such fields as physical oceanography, marine geology, chemical oceanography, biological oceanography, or marine physics.

UPPER DIVISION COURSES

110. *Introduction to Physical Oceanography* (3) I.

Mr. Arthur

Physical description of the sea; physical properties of sea water; boundary processes including interaction between sea and atmosphere; principles of

dynamics applied to motion and distribution of variables; methods of measurement with demonstration at sea.

110C. *Introduction to Dynamical Oceanography* (1) I. *Mr. Arthur, Mr. Cox*

Prerequisites: consent of instructors and concurrent registration in Oceanography 110.

Mechanics of fluids on a rotating earth; Navier-Stokes equations, boundary layer phenomena, turbulent flows, and wave motion with oceanographic applications.

111. *Submarine Geology* (2) I. *Mr. Shepard*

The topography and sediments of the ocean floor, and their recent history; sedimentary processes as they affect the shore, continental shelf, and ocean floor; comparison between recent sediments and sedimentary rocks; the development of coral reefs.

112. *Biology of the Sea* (3) I. *Mr. McGowan*

An integrated survey course dealing with fundamental aspects of the biological economy of the sea; the explanation of biologically associated marine phenomena; and the interrelation of biological, chemical, and physical processes in the environment.

112C. *Marine Organisms* (1) I. *Mr. McGowan*

Prerequisites: consent of the instructor and concurrent registration in Oceanography 112.

Laboratory and discussion of the phylogeny, comparative morphology, life histories and taxonomy of marine organisms. Emphasis will be placed on planktonic groups.

113. *Chemistry of Sea Water* (3) I. *Mr. Rakestraw, Mr. Goldberg*

Chemical composition of sea water; physical properties of sea water; biochemical activity in the oceans; marine sedimentation; thermodynamic considerations; history of the oceans; models of oceans from chemical considerations; problems of measuring composition.

*118. *Statistics* (3) II. *Mr. Fager*

Methods of statistical analysis; sampling and design of experiments applicable to marine studies.

*118C. *Computer Programming* (1) II. Mr. Perry

Prerequisite: consent of the instructor.

The logic of computer programming for statistics applications using automatic coding systems; median, mean, range, variance-covariance, regression, distributions. Especially designed for students in marine geology and biological oceanography.

*119. *Time Series* (3) I. Mr. Rudnick

Prerequisites: integral calculus and algebra of complex variables. Spectra; correlation functions; linear filtering; applications to geophysical time series.

123. *Introduction to Mechanics of Marine Sedimentation* (2) I. Mr. Inman

Marine sedimentary processes, including waves, currents, tides and turbidity flows, and their effect on sediment transport and the formation of sedimentary structures.

199. *Special Studies* (1-4) I, II. The Staff

GRADUATE COURSES

210. *Physical Oceanography – General* (3) II. Mr. Arthur

Dynamics of ocean currents; turbulence; wind currents; atmospheric boundary layer; water masses and circulation of the ocean.

211. *Waves* (3) II. Mr. Cox

Generation and propagation of surface and internal waves; wind waves, swell and surf; wave action on beaches; methods of observation; field work.

217. *Hydrodynamics* (3) I. Mr. Eckart

Prerequisite: Consent of the instructor.

Application of hydrodynamics to the motion of stratified fluids, such as the atmosphere and oceans. Internal waves, steady currents, and related phenomena.

219A. *Marine Micropaleontology* (3) II. Mr. Phleger, Mr. Riedel

Prerequisite: Oceanography 111 or permission of the instructors.

Introductory lectures and laboratory study of the principal groups of marine microfossils, with special emphasis on the applications to problems of oceanography and paleoceanography.

219B. *Marine Micropaleontology* (3) I. *Mr. Phleger, Mr. Riedel*

Prerequisites: Oceanography 219A and permission of the instructors.
Advanced study of specific groups of microfossils in the marine environments, emphasizing their ecology and stratigraphic applications.

220. *Special Topics in Oceanography* (1-4) I, II. *The Staff*

Within the next few years the following subjects will be covered: principles of oceanographic research systems, sound and light in the sea, population dynamics, zoogeography of the sea, advanced methods of fisheries research, numerical analysis, studies of turbulence and waves.

*223. *Littoral Processes* (2) II. *Mr. Inman*

Prerequisites: Oceanography 110, 123.

Study of the physical processes in the nearshore environment, including waves and currents and their effect on the transportation of sediments and the formation of sedimentary features.

*225. *Marine Ecology* (3) II. *Mr. Fager*

Behavior, single-species population dynamics, interspecific relationships and environmental factors as they relate to the distribution and abundance of marine organisms.

226. *Advanced Invertebrate Zoology* (4) II. *Mr. Newman*

Prerequisite: Oceanography 112 and 112C, or consent of the instructor.

This course will cover the natural history, zoogeography, taxonomy, and phylogeny of selected invertebrate groups. Emphasis will be on the broader aspects of current research. Two special problems will be undertaken during the semester, original problems will be encouraged.

*229. *Marine Sediments* (2) II. *Mr. van Andel*

Prerequisites: sedimentary petrography and Oceanography 224 or consent of instructor.

Advanced treatment of special topics in sedimentology; selected examples of sediment research; trends of sediment research and their influence on geological thinking; application of sediment studies to stratigraphy and paleogeography.

230. *Sedimentary Petrology* (3) I. Mr. Winterer

Prerequisite: Consent of the instructor.

Characteristics and origin of sediments and sedimentary rocks; mechanical analysis; determination with petrographic microscope.

231. *Minerals and Mineral Assemblages of Sediments* (3) II. Mr. Peterson

Prerequisite: Consent of the instructor.

Origin and distribution of minerals and mineral assemblages of sediments. Important mineral groups, clays, zeolites, feldspars, etc. considered by crystal structure and composition. Directed toward oceanic sediments. Laboratory on instrumental methods, X-ray diffractometry and spectroscopy.

250. *Seminar in Oceanography* (1) I, II. The Staff

251. *Problems in General and Physical Oceanography (Seminar)* (2) I. The Staff

Presentation of reports, review of literature, and discussion of current research in general oceanography and physical oceanography.

253. *Problems in Biological Oceanography (Seminar)* (2) I. The Staff

Presentation of reports, review of literature, and discussion of current research in biological oceanography.

255. *Problems in Marine Geology (Seminar)* (2) I. The Staff

Origin and structure of ocean basins and continental margins, and their physiographic features. Origin, distribution, interpretation, and methods of study of marine sediments.

280. *Field Course: Marine Geology* (4) Summer The Staff

Prerequisite: Consent of the instructional staff.

Methods of study, on sea and on land, of sediments and sedimentary rocks. Oceanic cruise dealing with problems of current interest.

299. *Research* (1-6) I, II. The Staff

Research in one or more of the oceanographic sciences.

PHYSICS

Instructional Staff

Keith A. Brueckner, Ph.D., Professor of Physics
Carl Eckart, Ph.D., Professor of Geophysics
George Feher, Ph.D., Professor of Physics
Walter Kohn, Ph.D., Professor of Physics
Norman M. Kroll, Ph.D., Professor of Physics (Chairman of the
Department)
Leonard N. Liebermann, Ph.D., Professor of Physics
Bernd T. Matthias, Ph.D., Professor of Physics
Maria Goepfert Mayer, Ph.D., Professor of Physics
Oreste Piccioni, Ph.D., Professor of Physics
Marshall Rosenbluth, Ph.D., Professor of Physics
Norman Rostoker, Ph.D., Professor of Physics
Harry Suhl, Ph.D., Professor of Physics
Geoffrey R. Burbidge, Ph.D., Associate Professor of Astrophysics
Carl E. McIlwain, Ph.D., Associate Professor of Physics
William R. Frazer, Ph.D., Assistant Professor of Physics
Donald R. Fredkin, Ph.D., Assistant Professor of Physics
John M. Goodkind, Ph.D., Assistant Professor of Physics
Francis R. Halpern, Ph.D., Assistant Professor of Physics
Marshal F. Merriam, Ph.D., Assistant Professor of Physics
Manuel Rotenberg, Ph.D., Assistant Professor of Physics
Sheldon Schultz, Ph.D., Assistant Professor of Physics
Robert A. Swanson, Ph.D., Assistant Professor of Physics
Meir Weger, Ph.D., Assistant Professor of Physics
David Y. Wong, Ph.D., Assistant Professor of Physics

* * *

Peter A. Wolff, Ph.D., Visiting Professor of Physics

The Department of Physics in the School of Science and Engineering offers a graduate program leading to the M.S. and the Ph.D. in Physics.

The entering graduate student will be required to have a sound knowledge of undergraduate mechanics, electricity, magnetism, and optics and also to have had a senior course or its equivalent in nuclear physics and atomic physics. Provision will be made in exceptional cases to allow the

graduate student to take courses in these subjects without graduate credit to supply deficiencies.

Requirements for the Master's Degree

The Master of Science degree is offered according to Plan II, the Comprehensive Examination Plan. Course requirements may be fulfilled by any of the courses offered by the Department, and courses in other departments may be approved by the student's Guidance Committee. A reading knowledge of one language (German, French, or Russian) will be required.

Requirements for the Doctor's Degree

The curriculum for the doctor's degree is divided into two parts.

During the first two years the student will prepare himself for the general departmental examinations, both written and oral, which will normally be completed by the end of the second year. These examinations will test the student's knowledge of basic fields of physics at the graduate level, particularly the following:

- Mathematical Methods of Theoretical Physics
- Hamiltonian and Lagrangian Mechanics
- Electricity and Magnetism
- Statistical Mechanics
- Quantum Mechanics
- Nuclear Physics

After satisfactory completion of the departmental examination, a Doctoral Committee will be appointed, which will conduct the student's oral qualifying examination. Prior to this qualifying examination, a student must pass a reading examination in two foreign languages: one language must be German or Russian; the second may be French, Italian, or Spanish.

Following the qualifying examination, a number of courses in the 230 series will be available to the student which will be taught primarily as research courses and will provide the student with specific knowledge in his research field and acquaint him with current techniques in experiment and theory.

UPPER DIVISION COURSES

Undergraduate courses in the 190 series may be offered for students who

have minor deficiencies in undergraduate training.

190A-190B. *Atomic and Nuclear Physics* (3-3) I, II. *Mr. Schultz, Mr. Burbidge*

Prerequisites: introductory physics and intermediate courses in mechanics, electricity, and magnetism.

Atomic structure, spectra, the periodic table, X-rays, electron optics, nuclear systematics, radioactivity, experimental procedures, nuclear energy.

191A-191B. *Thermodynamics, Kinetic Theory, Statistical Mechanics* (2-2), I, II. *Mr. Merriam, Mr. McIlwain*

Prerequisites: introductory physics and intermediate courses in mechanics, electricity, and magnetism.

Laws of classical thermodynamics, entropy, thermodynamic potentials; applications to thermomechanical, electric, and magnetic phenomena; phase equilibria; kinetic theory of gases; introduction to statistical mechanics; applications to physical properties of solids.

GRADUATE COURSES

200A-200B. *Methods of Theoretical Physics* (3-3) I, II. *Mr. Rosenbluth, Mr. Frazer*

Prerequisites: advanced calculus, ordinary differential equations, vector analysis.

Develops the mathematical procedures useful in physics, including the theory of functions of a complex variable, matrices, Fourier series and transforms, elementary group theory, integral equations, partial differential equations and boundary problems, and the special functions.

201. *Analytical Mechanics* (3) I. *Mr. Liebermann*

Prerequisites: undergraduate mechanics, partial differential equations or advanced calculus.

Lagrangian theory and its applications to the motion of mass points and rigid bodies; small oscillations; Hamilton-Jacobi theory; contact transformations.

202. *Introductory Quantum Mechanics* (3) II. *Mr. Weger*

Prerequisite: Physics 201.

Experimental and theoretical basis of quantum mechanics, operator formalism, application of Schroedinger equation, scattering theory.

203A-203B. *Electricity and Magnetism; Classical Electron Theory* (3-3) I, II. *Mr. Rostoker, Mr. Halpern*

Prerequisite: Physics 200A-200B; or Physics 200A-200B taken concurrently.

Potential theory, magnetostatics, electromagnetic induction, Maxwell's equations, electromagnetic waves, special theory of relativity, motion of charged particles in electromagnetic fields; classical electron theory.

210. *Statistical Mechanics* (3) I. *Mr. Kroll*

Prerequisite: Physics 202.

Systems of weakly interacting elements; general ensemble theory; applications to systems with interactions such as imperfect gases, plasmas, liquids, order-disorder transitions; fluctuations; irreversible processes.

211. *Introduction to Solid State Physics* (3) II. *Mr. Kohn*

Prerequisites: Physics 202, Physics 203A-203B.

Principles of the dynamics of ions and electrons in solids; applications to electric, magnetic, and thermal properties.

212A-212B. *Quantum Mechanics* (3-3) I, II. *Mr. Rotenberg*

Prerequisite: Physics 202. *Mr. Suhl*

The quantum mechanical description of atomic spectra; analysis of the rotation and permutation groups; the formal theory of scattering with applications in atomic physics; perturbation theory, Dirac electron theory; elements of second quantization and field theory.

213A-213B. *Theoretical Nuclear Physics* (3-3) I, II. *Mr. Swanson, Mrs. Mayer*

Prerequisite: Physics 202.

Nuclear forces, two-nucleon system, interaction of nucleons with the electromagnetic field, beta transformation of nucleons; nuclear systematics, models of nuclear structure, nuclear transformations and reactions.

215. *Advanced Mechanics* (3) I. *Mr. Eckart*

Prerequisite: Physics 201.

Elasticity, hydrodynamics, shock waves, elements of magnetohydrodynamics.

230. *Advanced Solid State Physics* (3) I. Mr. Goodkind, Mr. Feher,
Mr. Weger

A selection of advanced topics such as: electrical and thermal transport phenomena; cooperative magnetic phenomena; nuclear and electron magnetic resonance; many-body theory.

231. *Advanced Nuclear Theory* (3) I. Mr. Brueckner

Topics in nuclear structure and reactions.

232. *Advanced Classical Physics* (3) II. _____

Boltzmann equation, plasma physics, magnetohydrodynamics, and topics in statistical mechanics.

233A-233B. *Elementary Particle Theory* (3-3) I, II. Mr. Frazer, Mr. Wong

Quantum electrodynamics, pion and strange particle physics, dispersion relations.

234. *High Energy Experimental Physics* (2) II. Mr. Piccioni

Topics in experimental techniques and current research.

235. *Numerical Methods in Theoretical Physics* (3) I. _____

Computer structure, programming, generation of special functions, interpolation, smoothing, numerical solution of systems of algebraic, differential, and integro-differential equations.

250. *Solid State Physics Seminar* (1) I, II. Mr. Matthias

Discussion of current research in solid state physics.

251. *Nuclear Physics Seminar* (1) I, II Mr. Halpern, Mr. Piccioni

Discussion of current research in nuclear physics, principally in the field of elementary particles.

252. *Plasma Physics Seminar* (1) I, II. Mr. Rostoker

Discussions of recent research in plasma physics.

253. *Astrophysics and Space Physics Seminar* (1) I, II. Mr. McIlwain

Discussions of recent research in astro- and space physics.

299. *Research in Physics* (1-6) I, II. The Staff



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San Diego**

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