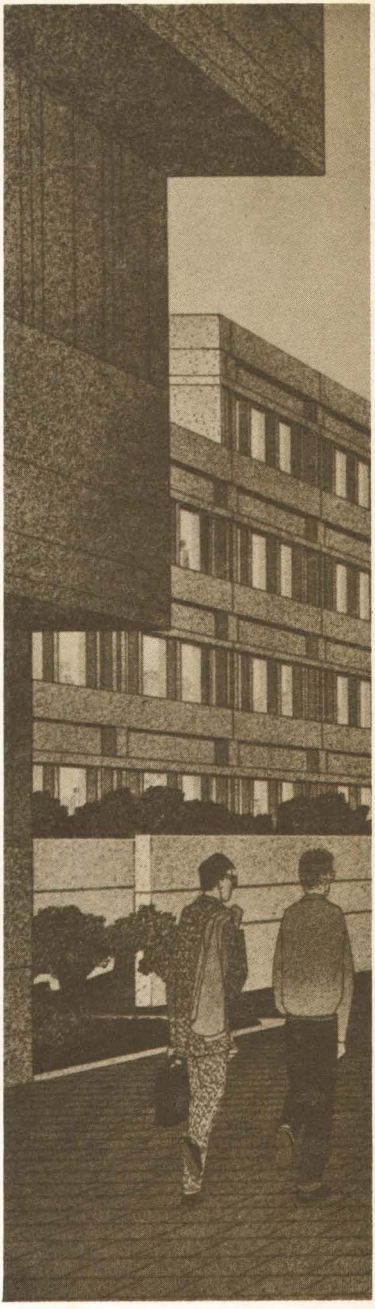
GRADUATE BULLETIN 1966-67



# STATE UNIVERSITY OF NEW YORK
# AT STONY BROOK

# STATE UNIVERSITY OF NEW YORK AT STONY BROOK

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THE GRADUATE BULLETIN

1966–1967

## Cover Illustration

The University's current $50 million expansion program is symbolized by this sketch of a portion of the new 147,000-square-foot Earth and Space Sciences building. See inside pages for artist's renderings of some of major new facilities to be erected over two-year period (1966-68).

## Additional Information

For general information about graduate programs and/or application, please write or phone:

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State University of New York
at Stony Brook
Stony Brook, N.Y. 11790

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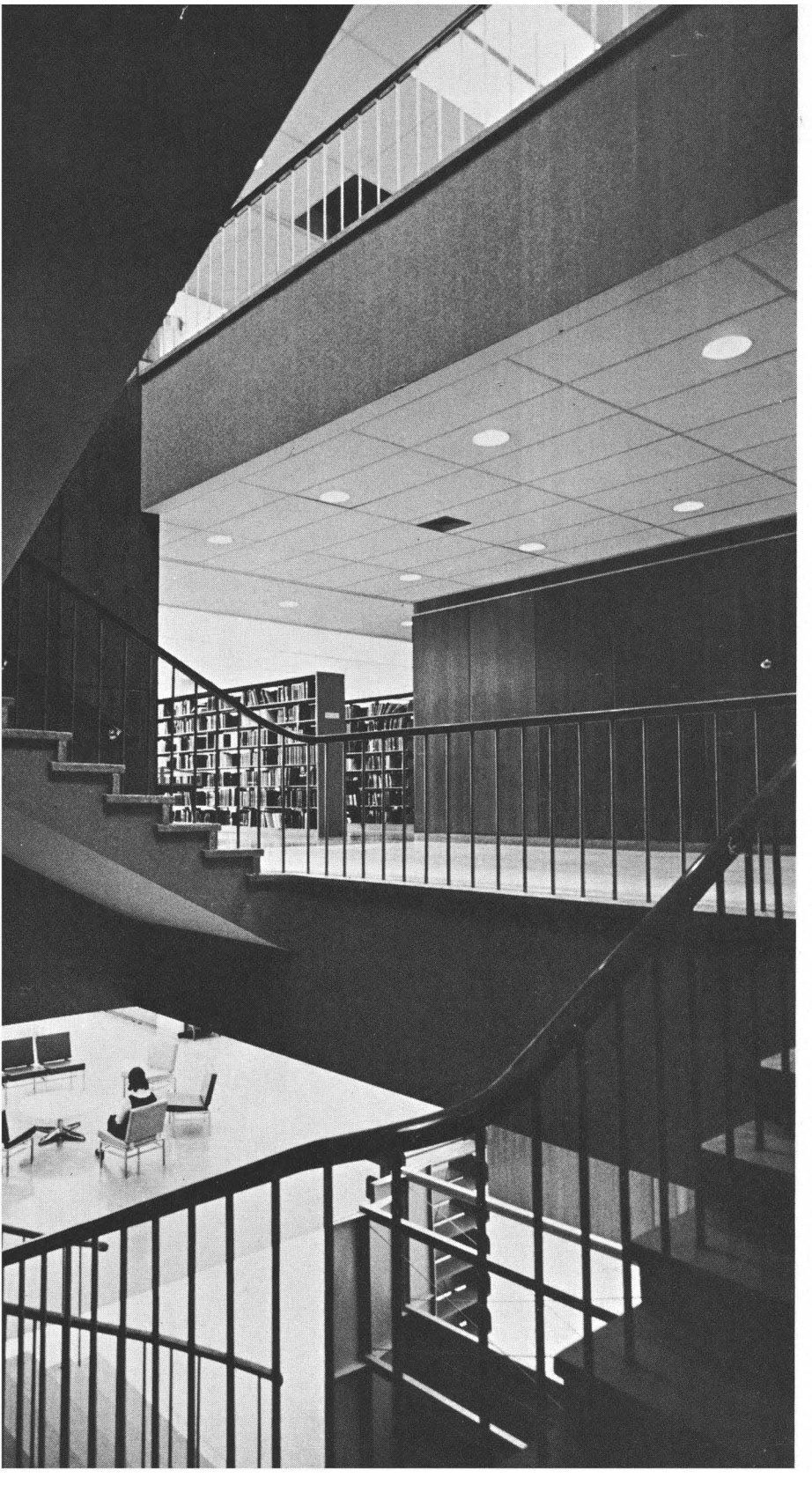
# CONTENTS



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[a]Not in residence, Academic Year 1966-67.

[b]Not in residence, Fall 1966.

[c]Senior Chemist, Brookhaven National Labs. on part-time appointment at SUNY, Stony Brook.

# ACADEMIC CALENDAR
## 1966-1967

| *Fall Semester 1966* | |
|---|---|
| Registration | September 22, 23 |
| Classes Begin | September 22 |
| Thanksgiving Holiday | November 24-27 |
| Classes Resume | November 28 |
| Christmas Holiday | December 22–January 3 |
| Classes Resume | January 4 |
| Last Day of Classes | January 14 |
| Semester Examinations | January 16-26 |

| *Spring Semester 1967* | |
|---|---|
| Registration | February 6, 7 |
| Classes Begin | February 6 |
| Spring Recess | March 26–April 2 |
| Classes Resume | April 3 |
| Last Day of Classes | May 20 |
| Semester Examinations | May 22–June 1 |
| Commencement | June 4 |

# STATE UNIVERSITY AT STONY BROOK

The State University at Stony Brook is one of four University Centers of the State University of New York. The Master Plan of the State University, revised in 1964, calls for the development at Stony Brook of graduate programs leading to the Ph.D. in all departments of the College of Arts and Sciences and the College of Engineering by 1970.

During the 1966-67 academic year, graduate programs leading to the Master's and Ph.D. degrees are offered by the Departments of *Biological Sciences, Chemistry, History, Physics,* and *Psychology* in the College of Arts and Sciences and by the Departments of *Applied Analysis, Electrical Sciences,* and *Mechanics* in the College of Engineering. Master's degree programs are offered by the Departments of *Earth and Space Sciences, English* and *Mathematics* and by the Department of *Material Sciences* in Engineering. Programs in other areas now being developed will be approved as the faculty and facilities necessary to assure high standards become available.

### History and Location

The University was founded in 1957 at Oyster Bay, Long Island, as a center for educating secondary school teachers of mathematics and science. In 1960, however, within the context of a fast-growing State University, it was designated a University Center and given the mandate to develop undergraduate and graduate programs through the Ph.D. in the humanities, sciences, social sciences and engineering. As a comprehensive university, it was also to become a center for research.

In order to realize its larger goals, the University moved in 1962 to a new and larger campus at Stony Brook. Today, there are 16 major buildings on the campus with some 35 additional buildings under construction or planned for construction during the period 1966-68.

The academic program continues to expand at both the graduate and undergraduate levels, the aim being a balanced institution with strength in all areas of the arts and sciences and engineering. In addition, a comprehensive Medical Center is being planned for the Stony Brook campus. The Medical Center, which will include schools of Medicine, Nursing, Dentistry and Social Work, will admit its first students in 1971. However, graduate students will benefit from this pending development almost immediately, since members of the Medical Center

Planning Group will participate in the instructional and research activities of the two existing Colleges and will direct some Ph.D. research.

Stony Brook is located in a region of woods and hills and small historic villages on the north shore of Long Island some 50 miles northeast of New York City. The University enjoys the relative seclusion of a semi-rural setting, coupled with proximity to the cultural, scientific and industrial resources of the nation's largest city. The campus is linked to Manhattan by a pattern of four- and six-lane highways and by the Long Island Railroad (see map at back of bulletin). The proximity of the University to Brookhaven National Laboratory makes possible the participation of faculty members and their graduate students in the research program of the laboratory.

#### Students and Faculty

As a relatively new University, Stony Brook is experiencing dramatic growth. The 1966-67 full-time enrollment is estimated at 4,000 students including about 400 graduate students and a number of post-doctoral fellows. Enrollment will reach 10,000 by the early 1970's including approximately 3,000 graduate students.

As of September 1966, Stony Brook had approximately 350 faculty members. A complete directory of faculty members participating in current graduate programs can be found elsewhere in this bulletin.

#### The Stony Brook Campus

The Stony Brook campus is situated minutes away from the coves and beaches of Long Island Sound. The Atlantic shore is about 20 miles to the south. The campus consists of 850 acres of rolling, densely wooded terrain, with the central core area largely cleared for the buildings now in use.

There are five large academic structures which provide classroom, lecture hall, laboratory and office space for the divisions, schools or departments they serve. These include the Humanities Building which also serves the Social Sciences departments until a new two-building complex is completed in Spring, 1967, and buildings for Chemistry, Biological Sciences, and Engineering. The Physics Building houses the Departments of Physics and Mathematics, and, temporarily, Earth and Space Sciences. The Frank Melville, Jr. Memorial Library, in addition to housing the customary books, periodicals, microfilm, music collections, and listening and reading facilities, also provides temporary quarters for the University administration.

Six two-story brick residence halls afford living quarters for 2,000 students and contain numerous lounges and dining halls. (Two additional residential

complexes designed to house an additional 2,000 students in suite-style rooms will be completed by Fall, 1967). The Health and Physical Education Building contains a swimming pool, basketball and squash courts, and rooms for gymnastics and ballet. It also supplies temporary space for the University Theater.

#### Buildings and Research Facilities

The State University Construction Fund envisions an expenditure of $150 million in new facilities (not including the Medical Center) on the Stony Brook campus in the period 1962 to 1970. Prominent among the new buildings to be erected in the current $50 million "second phase" expansion program, in addition to the Social Sciences Center and the dormitory complexes, will be a Nuclear Structure Laboratory (to be completed by Summer, 1967), Graduate Engineering facilities and a Computing Center building (Fall, 1967), a Campus Center (late 1967), an Earth and Space Sciences building (early 1968), a Lecture Hall Center (early 1968), and an Instructional Resources Center (early 1968) in which new methods of visual presentation of instruction will be created. Also on the drawing boards are a Fine Arts Center with buildings for music, art and theater arts, a Marine Science Research Center, an Administration Building and additional dormitories.

Currently, the following fully-equipped buildings are in use:

The *Biology Building,* containing more than 86,000 sq. ft. of floor space, is well equipped for graduate study and research in experimental biology. Research laboratory space is available to graduate students working with individual staff members. The equipment in these laboratories varies with the research activities of the staff member. In addition to the laboratories, facilities directly serving graduate research include a departmental reading room for current scientific journals, a greenhouse with five individually controllable compartments and a potting room, a 250 KV X-ray machine, a well-equipped shop, electron microscope, photographic dark room, isotope counting room, herbarium, a museum, constant temperature rooms, and environmental chambers. An air-conditioned animal wing contains sea water and fresh water aquaria, animal rooms, and research laboratories.

The Department of Biological Sciences has its own boat for use in marine research, and has acquired a shore station at Flax Pond near Long Island Sound, near the campus, for instruction and research in marine biology.

A second and greatly enlarged Life Sciences building, planned for occupancy in 1969, will expand the physical facilities for graduate instruction and research.

The *Chemistry Building* is a spacious, modern structure (86,000 sq. ft. gross floor area) designed for research and instructional activities covering a broad range of specialization in chemistry. Equipment available for research includes one or more examples of virtually all spectrographic instruments such as electron spin resonance, nuclear magnetic resonance, mass, Raman, visible, ultraviolet, infrared, and far infrared spectrometers. Also available is a wide range of instruments for nuclear and radiochemistry, an amino acid analyzer, preparative gas chromatographs, a dichrograph, and X-ray diffraction equipment. Instruments specially constructed for the Chemistry Department's research facilities include a flash-photolysis apparatus, a stop-flow apparatus, cryogenic infrared cells, and a high pressure apparatus. Services available for the support of research include well-staffed glass-blowing, machine, carpentry, and electronics shops, and a departmental library.

The Chemistry Department is currently planning an additional large building. The new building is designed primarily for graduate research, and the tentative date for occupancy is the fall of 1969.

The 92,000 sq. ft. *Physical Laboratory* provides space for graduate and faculty research and supporting facilities. A major and continuing program of investment by the State of New York is speeding the development of instruction and research in the Physics Department. Equipped or approaching completion are research laboratories in high energy physics (bubble- and spark-chamber film measurement, counter techniques); nuclear physics (neutron physics, radioactivity, Mössbauer studies, positron processes); solid-state physics (electron transport and resonance phenomena in semi-metals, magnetic resonance in solids); and atomic physics (lifetimes of atomic excited states, molecular and atomic beam resonance). Through the participation of several of the faculty in the research programs of the nearby Brookhaven National Laboratory, a number of the facilities of that Laboratory are available to graduate students. Supporting facilities in the Physical Laboratory include a departmental library, two machine shops, an electronic shop, and a photographic laboratory.

An HVEC FN "King" tandem Van de Graaff accelerator is being installed in the Physics Department as part of the Nuclear Structure Laboratory by the State, with National Science Foundation participation. Commencing in mid-1967, this accelerator will support a large scale program in nuclear structure and reactions. An extension to the Physical Laboratory, greatly enlarging the space available for faculty and graduate research, is now planned for completion in 1969.

The *Engineering Building* contains 96,000 sq. ft. of gross floor area. General facilities available to graduate students include well-equipped research labora-

tories in all fields of specialization. Examples of the kinds of research facilities offered by the College of Engineering are, in the Department of Electrical Sciences: digital and analogue computers, energy converters, microwave instruments for radiation research, solid state equipment, complete selection of oscilloscopes and frequency standards; in the Department of Material Sciences: X-ray diffraction equipment, electron microscopy equipment, laboratories for mechanical testing, single crystal-growing, emission, spectroscopy, and infrared spectroscopy, a radiochemical counting facility, a subcritical reactor facility, thin film evaporator, thermal decomposition apparatus, physical adsorption apparatus, torsional relaxation equipment, and a magnetic properties laboratory. The Department of Mechanics facilities include a low-turbulence wind tunnel, infrared radiation measuring devices, and fundamental fluid mechanics instrumentation.

Among the supporting facilities in the College of Engineering are an Engineering Library, a precision machine shop, faculty and student shops, a photographic shop, and an electronics shop.

Presently being designed and expected to be completed by 1967 are three additional Engineering buildings: the Computing Center; the Heavy Laboratory Building, including shock tunnels, a supersonic wind tunnel, and a materials research laboratory; and the Light Laboratory Building, which will contain the general-purpose graduate laboratory facilities.

The new *Social Sciences Center* will house the Departments of Anthropology, Economics, Education, History, Political Science, Psychology, and Sociology. The first section of the two-structure complex, scheduled to be completed in February, 1967, will contain conference and seminar rooms and faculty offices. The adjoining classroom-laboratory building will be ready three months later. The two buildings will be linked by landscaped courtyards, an elevated gallery and an arcade, providing pleasant surroundings for the 123,000 square feet of working space.

Graduate students in psychology will conduct research in a 20,000 square foot psychology laboratory wing divided by floors into clinical research, human research, and animal research. The special features of this area include shielded rooms, two animal surgeries connected by a central washroom, and closed-circuit television in the clinical and social interaction laboratories.

An oral history center, with Long Island as the primary subject, is notable among the facilities available to graduate students in history.

#### Libraries

The Melville Library, a three-story air-conditioned structure, is designed for 350,000 volumes and will seat 700 students for immediate reading and study pur-

poses. It is intended as the first part of a large structure that will house a million volumes at its next stage of development. Supplemental technical and scientific collections are housed in the science buildings and in the College of Engineering. All are centrally administered from the main library. In all campus libraries, users have free access to the open bookstacks with reading areas and bookstacks integrated throughout and no barriers separating the two.

Seminar rooms and soundproof typing rooms are available in the Melville Library. There is a special room for the housing and use of microform equipment, including reading machines for microfilm, microcards, microprint, and microfiche and a microprint reader-printer. A photocopy machine is available for the purpose of copying pages from magazines and reference books.

The University Library is a selective government depository and receives large numbers of publications issued by the U.S. government. About 3,000 periodicals are currently received covering all areas of knowledge, and the staff is processing books at the rate of 48,000 volumes per year. The document collection, now numbering 48,000 items, is also rapidly expanding.

#### The Computing Center

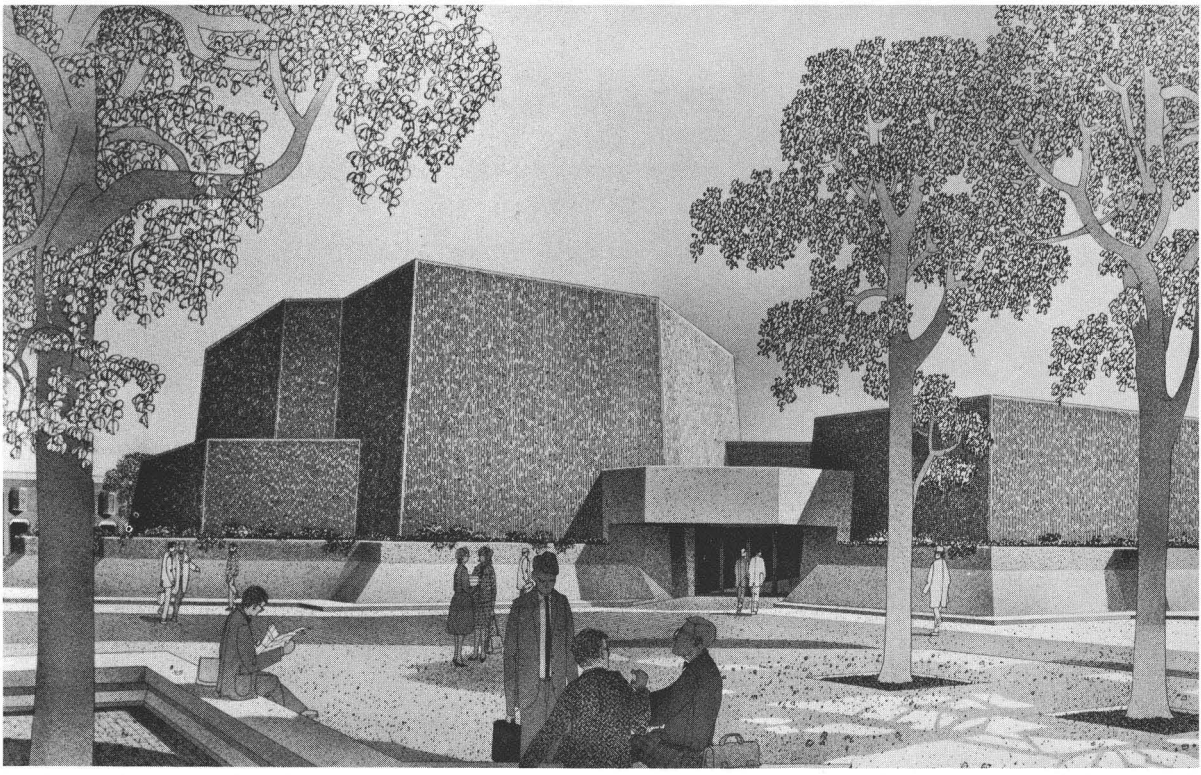
The services of the Computing Center are available to faculty members and their graduate students. The present equipment consists of an IBM 7044/1401 computing system (with 32,768 words of main storage in the 7044 computer), a disk, 10 magnetic tape units (one connected to a high speed automatic plotter) and associated peripheral equipment. Currently, the equipment is housed in two rooms in the basement of the Engineering Building. A major new equipment complex, planned for installation in the Fall of 1967, will be housed in a separate Computing Center building.

#### Housing

A limited number of rooms are available for unmarried graduate students in the University residence halls. All rooms provide for double occupancy, and are furnished with a bed, mattress, bureau, study desk and chair, and closet for each occupant. Board is purchased by resident students, and consists of 21 meals a week. Non-resident students may purchase meals in the University dining halls also.

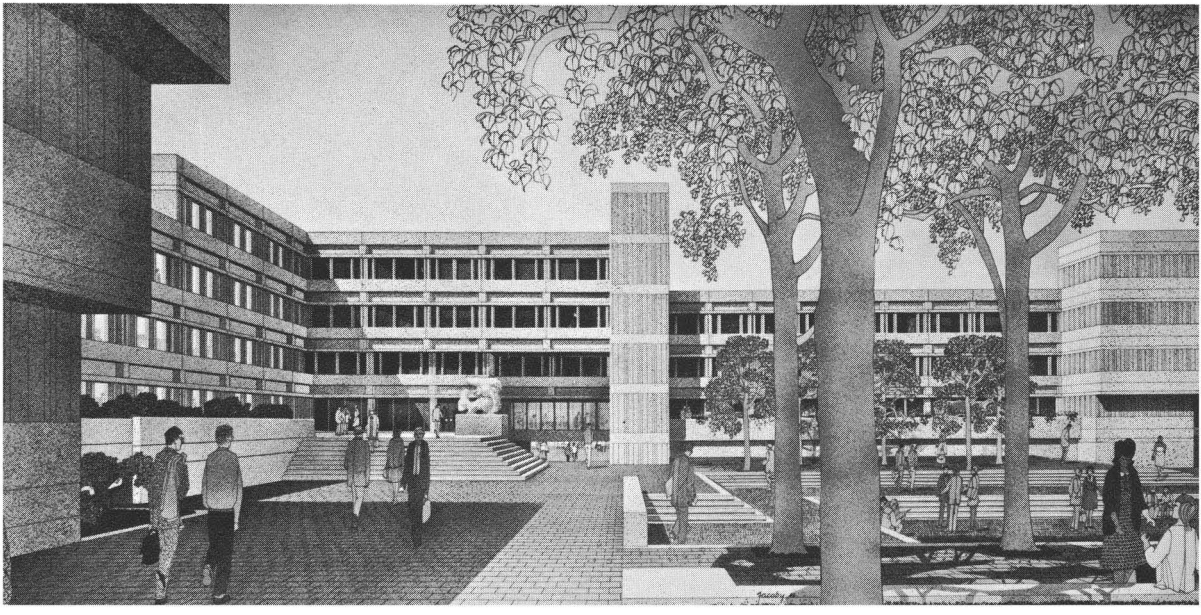
Houses, apartments, and rooms are available within reasonable driving distance of the Stony Brook campus. However, it is somewhat difficult to obtain off-campus accommodations within walking distance.

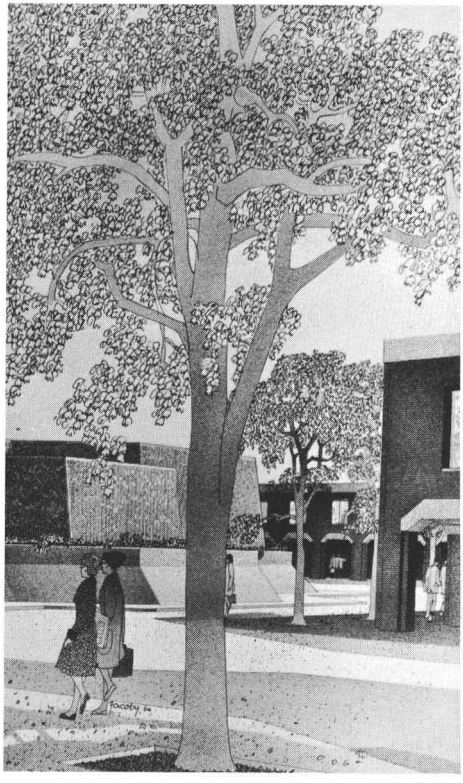
An expanded program of faculty involvement with the students is planned for 1966-67 in the form of a residential "college plan." Graduate students will be invited to participate in this program, which is designed to expand cultural and intellectual opportunities in the residences as well as to foster student identity within the University and improve interpersonal relationships. Individual colleges will range in size from 200 to 400 students each, and each college and its students and faculty associates will have the opportunity to develop an individual program, style and tradition.



Lecture Hall Center, containing seven lecture halls and two classrooms, will accommodate a total of 1450 students at one time.

Massive multi-level Earth and Space Sciences building will be completed in early 1968 at a cost of around $5 million.



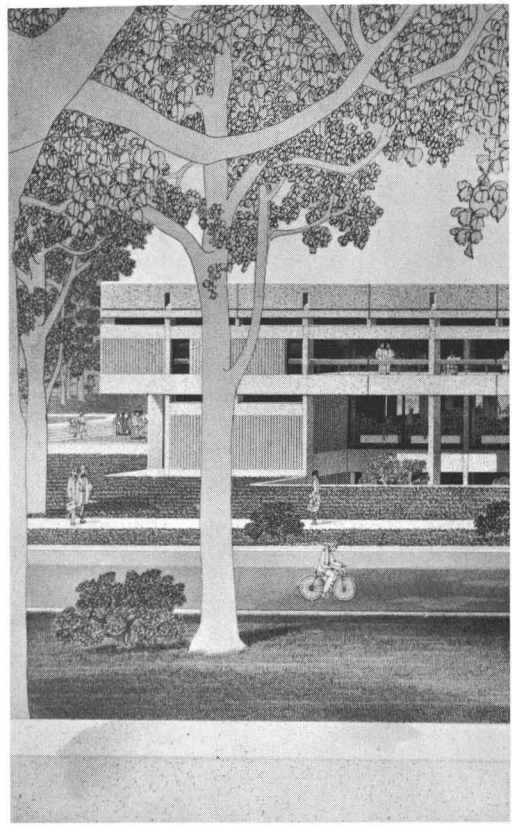


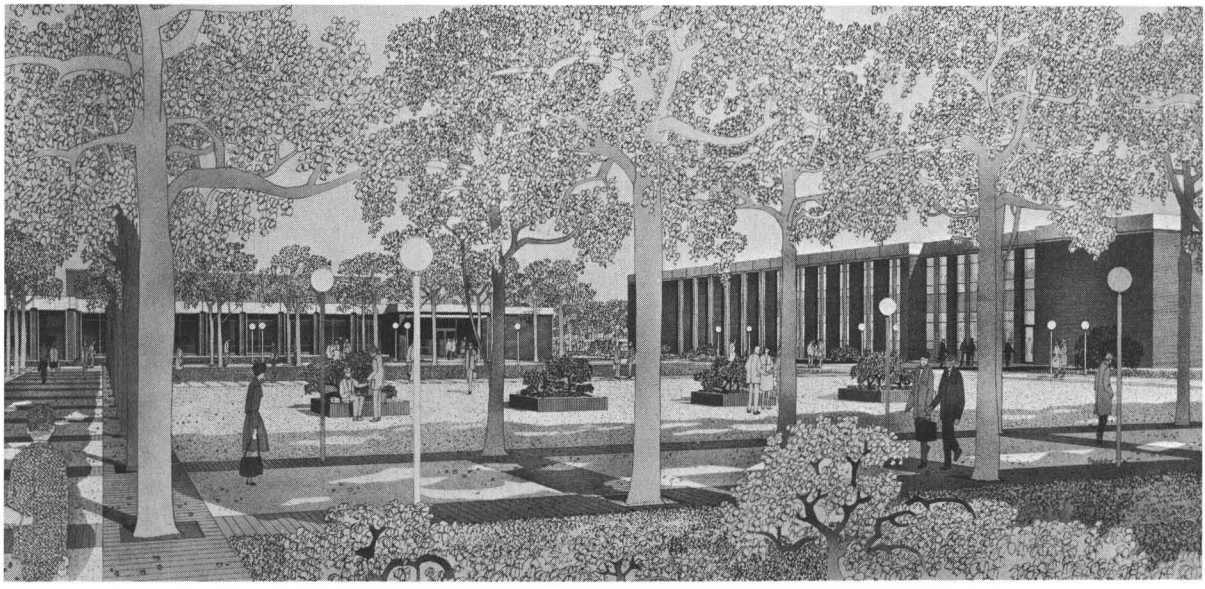
**Campus Expansion**

The University's current $50 million campus expansion program will see the major facilities depicted on these pages, as well as other building projects, completed during 1967 and 1968. Included in the program but not shown, are the Nuclear Structure Laboratory and additional dormitories. Construction of new buildings for Art, Music and Theater will begin in 1967.

Social Sciences Center, consisting of two structures joined by courtyards and arcades, will be ready for occupancy in spring, 1967.

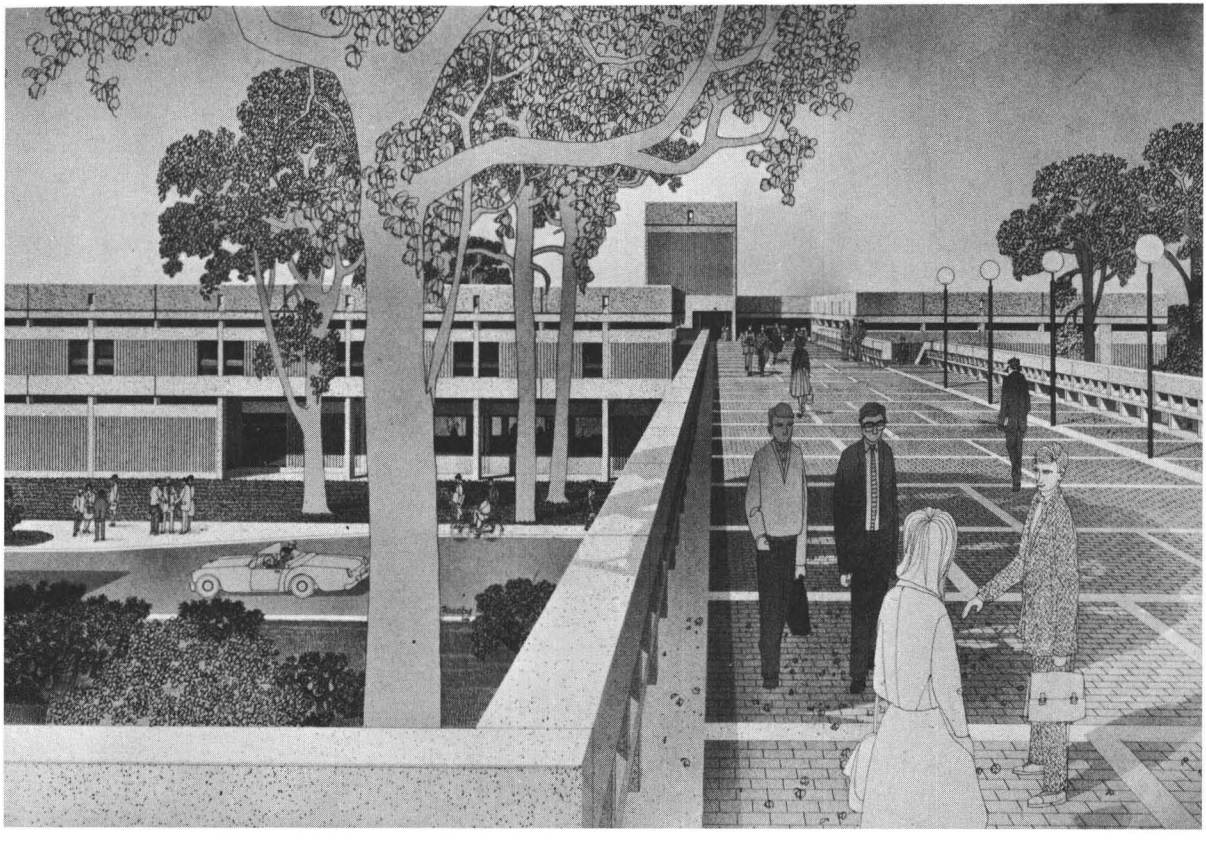
Artist's view of new suite-style dormitory complex to house 1,000 students. This, plus additional complex, will double residential space on campus by fall, 1967.





Engineering complex will include buildings for Graduate Engineering and Computing Center. Additional laboratory building will be constructed in current program.

Large Campus Center, with elevated mall connecting with second floor of library, will serve as social-recreation focus of campus life.



# FINANCIAL INFORMATION

### Tuition

The tuition rate for graduate students is $20 per semester-hour. There is no tuition charge for graduate assistants, research assistants, and certain fellows, but they must pay other fees listed below.

### Other Fees

State University Fee: $0.85 per semester-hour.
Identification Card: $2.00.
Damage Deposit: $20.00.
Telephone Deposit: $15.00 (payable by dormitory residents only).
Student Health Insurance Fee: $26.50.
Late Registration Fee: $15.00 (paid by students registering after the close of the official registration period).
Graduation Fee: $15.00 (payable upon completion of all degree requirements and prior to the award of the degree).
Transcript Fee: $1.00 for each transcript (a student who obtains a degree may receive two transcripts without charge).

### Residence Charges

Room and board charges for students living on the Stony Brook campus are approximately $815 per academic year, of which $375 represents the rent for a double occupancy room; these charges are payable on a quarterly basis. A $25 advance room deposit is required, this amount being applied to the first quarter payment. The advance room deposit is refundable if application is made in writing before July 1st. Board is $440 per year.

### Refunds

A student who withdraws after the first five days of a semester is entitled to only a partial refund of monies collected. A schedule of refunds is available in the University Business Office.

### Financial Aid

Sources of direct financial aid include the New York State Scholar Incentive Program and the Division of Vocational Rehabilitation of the New York State

Education Department. Both the State of New York and the Federal Government offer low cost loan programs to help graduate students finance their education. Inquiries concerning either financial aid or loan programs should be directed to the Financial Aid Officer in the Dean of Students Office.

#### Graduate Assistantships and Fellowships

Teaching assistantships carry stipends of $2,575 for the academic year and tuition exemption.

Research assistantships for advanced graduate students and University Fellowships are also available, with stipends of $2,575 and higher for the academic year and tuition exemption.

Teaching assistantships, research assistantships, and fellowships are awarded on a competitive basis by the Graduate School on recommendation of the department.

State University of New York at Stony Brook participates in such fellowship and traineeship programs as: NDEA Fellowships, NSF Traineeships and Fellowships, NASA Traineeships, and New York State Regents' Fellowships.

Students from the member States of the Organization of American States who wish to pursue graduate studies may apply, upon seeking admission to the University, for a fellowship grant under the terms of the Program of Fellowships and Professorships of the Organization of American States. Requests for O.A.S. fellowship applications should be directed to the Technical Secretary, O.A.S. Fellowship and Professorship Program, Pan American Union, Washington, D.C. The deadline for receipt of applications for this program is January 31 for those wishing to start their studies in the fall, and July 31 for those who wish to enter the University in the spring semester.

During the 1966-67 academic year, approximately 90% of the graduate students at Stony Brook hold fellowships or assistantships.

## ADMISSION REQUIREMENTS

To be admitted to graduate study, an applicant must have the preparation and apparent ability which (in the judgment of the department and the Graduate School) is sufficient to enable him to progress satisfactorily in a degree program. Admission decisions are based primarily on past records and on letters of recommendation. Ordinarily, a baccalaureate degree in the chosen field of study is required, with an average grade of B in course work in the major and related areas. However, in exceptional cases in which the undergraduate preparation is inadequate, or the grade average is less than B, an applicant may be admitted provisionally, if he is considered to have a reasonable probability of making satisfactory progress in graduate studies. Detailed admission requirements are listed in each department's section of this Bulletin.

The department may set conditions which the admitted student must satisfy during the early period of his graduate work.

Admission application blanks and additional information may be obtained by writing to the appropriate department, or to: *The Office of the Graduate School, State University of New York, Stony Brook, New York 11790.* (No application fee is required.)

## DEGREE REQUIREMENTS

Admission to graduate school does not automatically qualify a student as a candidate for a degree. Advancement to candidacy may be recommended to the Graduate School by the department after a review of the student's performance in courses, individual study, and departmental examinations. A candidate for a degree engages in research, leading to a thesis. (For the master's degree, a department may substitute a comprehensive examination for the research and thesis.)

While individual departments may have certain course requirements, the Graduate School does not specify a minimum number of courses to be completed for each degree. Instead, the granting of the degree is based on the completion of residence, examination, thesis, and special departmental requirements, and the recommendation of the student's department. Ordinarily, however, certain courses should be taken in preparation for comprehensive examinations and

research. The student will follow an approved program of courses, seminars, and individual study, determined so as to meet his needs and to satisfy departmental requirements. A student, well prepared on admission, should normally be able to complete the course work for the Master's degree in about one calendar year of full-time study, and for the Ph.D. preliminary (candidacy) examination in about two years of full-time study.

Requirements for advanced degrees, which vary somewhat among departments, generally include the following:

#### The M.A. and M.S. Degrees

1. Residence: one year
2. Admission to candidacy
3. Research and thesis, or the passing of a comprehensive examination
4. Departmental recommendation

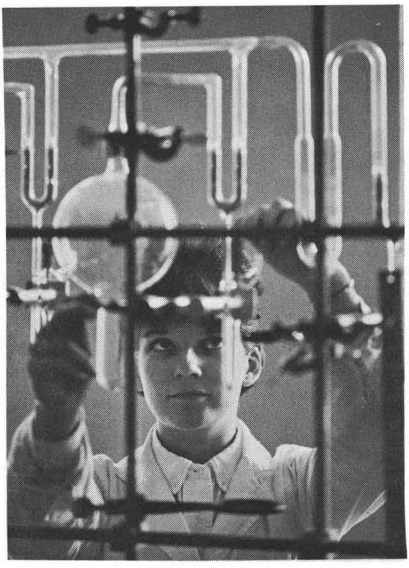
#### The Ph.D. Degree

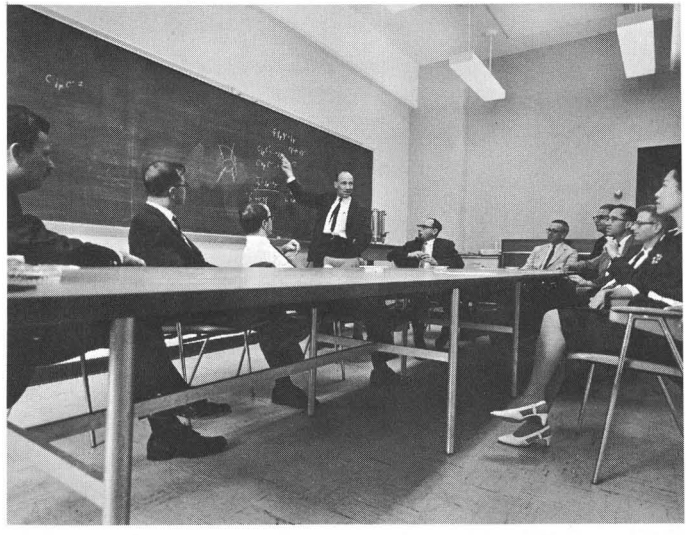
1. Residence: two years
2. The passing of proficiency examinations in foreign languages
3. The passing of the departmental preliminary examination
4. Advancement to candidacy
5. Research and thesis (including oral defense of thesis)
6. Departmental recommendation

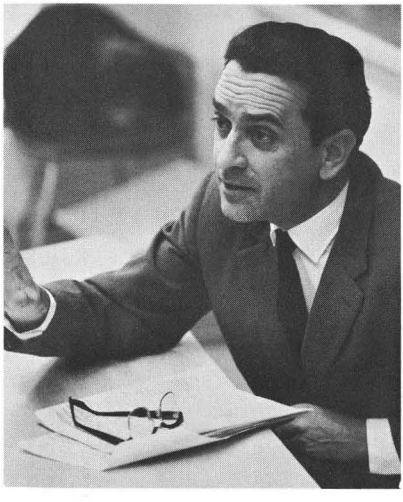
The Ph.D. thesis must demonstrate the ability of the candidate to carry on independent research of high quality and must represent a significant contribution to knowledge. The thesis material must be of such professional quality that it meets the publication standards of leading journals in the field.

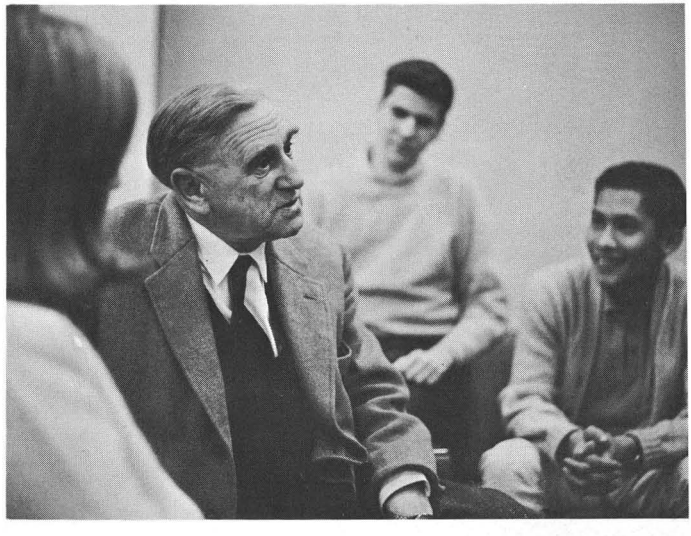
## DEGREE PROGRAMS AND COURSES

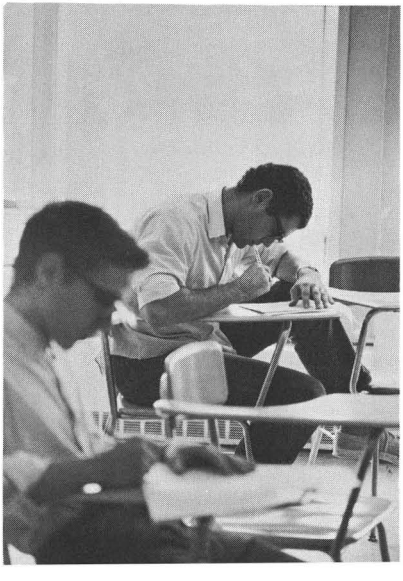
Courses numbered 201 to 399 are for advanced undergraduates; detailed descriptions of these courses are given in the Undergraduate Bulletin (which may be obtained by writing to the Admissions Office, State University of New York, Stony Brook, New York 11790). Graduate courses are numbered 501 and above.











# GRADUATE PROGRAMS IN ARTS AND SCIENCES

## BIOLOGICAL SCIENCES

*Professors:* ERK (*Chairman*), GLASS, SIMPSON, WILLIAMS[a]

*Associate Professors:* BATTLEY, CIRILLO, JONES, MERRIAM, MOOS, RILEY, SMOLKER,[a] TUNIK[a]

*Assistant Professors:* CARLSON, EDMUNDS, FOGG, FOWLER, FREUNDLICH, GAUDET,[a] HECHTEL, KERNAGHAN, KRIKORIAN, WOHLMAN, WURSTER

(*Professors of Medicine:* KNUDSON, PELLEGRINO)[b]

### Admission to Graduate Study

A. A baccalaureate degree, with at least the following undergraduate preparation: four laboratory courses in the biological sciences; chemistry, including one year of organic chemistry; one year of physics; one year of calculus; two years of a foreign language or equivalent proficiency.

B. A minimum grade-point average of 2.75 (B–) in all undergraduate course work, and 3.00 (B) in science and mathematics courses.

C. Letters from three previous instructors, and results of the Graduate Record Examination.

D. Acceptance by the Department of Biological Sciences and the Graduate School.

In special cases, students not meeting requirements (A) through (C) may be admitted on a provisional basis. These students must act immediately to fulfill deficiencies in basic courses before being enrolled as regular students. Credits earned in these courses do not count toward graduate degree requirements.

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[a]Not in residence, Academic Year 1966-67.
[b]Medical faculty who may supervise graduate research in the Biological Sciences.

**Requirements for the M.A. Degree**

A. Residence: one year

B. Qualification to candidacy

C. Formal course requirements: successful completion of an approved course of study of at least 24 semester credits, including two semesters of Interarea Seminar.

D. Thesis: Independent laboratory, field, or theoretical research under the supervision of a staff member of the Department.

E. Comprehensive examination: When the thesis is completed, a comprehensive examination will be given no later than two weeks before the end of the semester in which the final work in the Master's program is done.

F. Oral defense of thesis: Upon acceptance of the thesis by a reading committee an oral examination on the thesis will be given.

**Requirements for the Ph.D. Degree**

A. First year program: During the first year of course work a student participates in the Interarea Seminar both semesters. In each case the student will present an oral and written account of an appropriate topic related to the general area of discussion. The graduate committee of the department must reach a consensus that the overall performance of the student during his first year has been satisfactory.

B. Formal course requirements: Successful completion of an approved course of study.

C. Preliminary examination: After completing the major portion of course work, a student may apply for the preliminary examination. The examination will usually be both written and oral, and may be taken no later than the sixth semester after entrance.

D. Language requirement: Reading knowledge of two foreign languages selected usually from German, French, and Russian in consultation with the graduate committee.

E. Advancement to candidacy: The department's recommendation

with respect to candidacy for the Ph.D. degree will be based upon the satisfactory completion of the above requirements.

F. Thesis examination: An examining committee will read the thesis and give the candidate an oral examination on the thesis research and related areas.

G. Residence requirements: Two years of full time graduate study.

#### Graduate Examination on Entrance

All entering graduate students will take an advisory examination within two weeks of the beginning of classes. The examination will include 30-minute oral examinations, in five of the following areas: genetics; evolution; development; cellular biology; biochemistry; physiology; ecology; behavior. Designated professors will give examinations in their areas; students will make appointments with five professors in five areas. Students must satisfy the graduate committee of their competence in five areas before applying either for a Master's degree or a Ph.D. preliminary examination.

#### Teaching Responsibilities

All graduate students are expected to spend at least one year as a teaching assistant.

#### Courses

*Advanced Undergraduate Courses*

Certain advanced undergraduate courses (300 level) may be taken for graduate credit. Students should consult their advisors about the suitability of such courses in their program of studies.

*Graduate Courses*

**BIO 501 Biochemistry**

A survey of the structure of the major chemical constituents of the cell including carbohydrates, lipids, nucleic acids, and proteins. Emphasis will be placed on enzyme structure, enzyme kinetics, reaction mechanisms including the role of coenzymes; metabolic pathways of biosynthesis and degradation involved in cellular activity.

*Fall, 3 credits*

**BIO 505 Microbial Regulatory Mechanisms**

A series of lectures and discussions devoted to current concepts of microbial regulatory mechanisms. Some of the topics to be discussed are feedback inhibition; allosterism; the operon theory and repression; the role of sRNA in repression; control of RNA and DNA synthesis. The genetic and biochemical aspects of these subjects will be stressed.

*Fall, 3 credits*

### BIO 509 Experimental Biochemistry I

An introduction to modern methods of biochemical analyses. Students will spend various periods of time working in close association with members of the staff engaged in biochemical research.

*Fall, 2 credits*

### BIO 510 Experimental Biochemistry II

A continuation of BIO 509.

*Spring, 2 credits*

### BIO 512 Cellular Biology

A course designed to present current thinking and progress in problems concerning cell structure, function, and the relationship between the two. The approach is basically analytical, striving where possible to explain cellular phenomena in terms of molecular and biochemical organization. Laboratory work will give instruction in the critical use of some tools and methods of investigation at the cellular level. Each student will undertake a limited project in which he will do independent work in the laboratory. One hour lecture, one hour discussion, and four hours of regularly scheduled laboratory.

*Spring, 4 credits*

### BIO 522 Microbial Genetics

Methods and principles involved in studies of heredity in microorganisms. Emphasis is placed upon those features of microorganisms which make them specially appropriate for study of the nature of the genetic material and the fundamental mechanisms concerned in its mutation, replication, recombination, interaction with cytoplasmic components, and metabolic functioning.

*Spring, 3 credits*

### BIO 523 Physiological Genetics

A course dealing with genic function from the molecular to the organismic level. The biochemical correlates of inheritance are studied as developmental consequences of gene actions. Topics considered include recombination, gene interactions, position and dosage effects, mutation, enzyme formation and role in development, modification of gene expression, cytoplasmic inheritance and the evolution of genic function. The genetic control of nutrition and metabolism in relation to problems of physiological genetics will be discussed.

*Fall, 3 credits*

### BIO 525 Developmental Genetics

A course concerned with the genetic analysis of developmental events in higher organisms. Topics considered include genetic control of biosynthetic pathways; genic effects on growth and metabolism; nuclear differentiation; pleiotropism; sex differentiation and determination; environmental effects on hereditary traits.

*Fall, 3 credits*

### BIO 530 Experimental Genetics

A series of selected experiments to acquaint students with modern methods of genetic analysis, including induction and selection of mutants; fine structure analysis by recombination, transduction and transformation; enzyme induction and repression.

*Spring, 2 credits*

### BIO 531 Plant Morphogenesis

A course concerned with the analysis in depth of certain aspects of plant development. The areas from which specific problems will be selected include photomorphogenesis, hormonal control of plant growth, and plant tissue culture. Discussion will involve an examination of the classic and contemporary literature. The laboratory will provide experience in research methods and opportunity for independent investigation. Two hours of discussion each week and laboratory by arrangement.

*Fall, 4 credits*

### BIO 534 Experimental Embryology

Animal development is examined from various theoretical points of view. Embryological phenomena are considered at the organismal, cellular, biochemical, and genetic levels. The experimental basis of contemporary theory is

emphasized. Two hours lecture and discussion with 3 hours of laboratory.

*Spring, 3 credits*

### BIO 535 Physiology and Development of Higher Plants

A survey of selected topics in plant physiology with emphasis on developmental aspects. The relationship of cells, tissues, and organs to water and solutes; inorganic plant nutrition; plant metabolism (photosynthesis, respiration, nitrogen metabolism); translocation and physiology of growth; and development of vascular plants are topics considered. Particular emphasis is placed on principles and their application to higher plants.

*Fall, 4 credits*

### BIO 536 Physiology and Development of Lower Plants

A consideration of the major problems and current research dealing with the physiology and biochemistry of growth and development in bacteria, algae, fungi, slime molds and bryophytes. The course will include a study of the life cycles of representatives of the above group of plants and a critical discussion of certain important physiological and biochemical processes, concepts, experiments, and problems relating to growth and development. Emphasis will be placed on those aspects of enzyme regulation and control of protein synthesis that relate to growth and differentiation in these organisms.

*Spring, 3 credits*

### BIO 545 Comparative Animal Physiology

A course which approaches the study of the physiological functions of vertebrate and invertebrate animals on a comparative basis. The student will examine physiological mechanisms controlling feeding and digestion, osmotic regulation and excretion, respiration, receptor and effector systems, and behavioral responses in widely diverse animal phyla. He will be introduced to the diversity of mechanisms which serve to ensure a unity of life processes and to the techniques and equipment required for their study. Two hours of lecture and two three-hour laboratories.

*Fall, 4 credits*

### BIO 561 The Invertebrata I

An examination of the protozoa, acoelomates, pseudoacoelomates, echinoderms, and possible echinoderm allies, including protochordates. Emphasis is on diversity of form, functional and comparative morphology, evolution, and classification. A basic knowledge of major phyla is assumed. Course to be given in alternate years. Three hours lecture and discussion with three hours of laboratory.

*Fall, 4 credits*

### BIO 562 The Invertebrata II

An examination of the annelids, annelid allies, arthropods (excluding detailed treatment of insect orders), annelid-arthropod allies, and mollusks. Emphasis on diversity of form, functional and comparative morphology, evolution and classification. Course to be given in alternate years. Three hours lecture and discussion with three hours of laboratory.

*Spring, 4 credits*

### BIO 570 Population and Community Ecology

A course which uses both cultured and naturally distributed organisms to examine the control and interactions of populations. Emphasis is placed on the development of theoretical concepts and biological implications through the use of physical, stochastic, and biological models. Topics include mortality, fertility, growth of populations, competition, predator-prey interaction, and community analysis.

*Spring, 4 credits*

### BIO 581, 582 Interarea Seminar

Two members of the staff combine their interests to develop a series of topics and review of the literature which touches on both fields of interest.

*Each semester, 2 credits*

### BIO 583-598 Special Seminars.

Topics to be arranged.

### BIO 599 Research

Original investigation undertaken with the supervision of a member of the staff.
*Each semester, credit to be arranged*

### BIO 670 Seminar in Marine Biology

Selected topics from the recent literature on the ecology biogeography, and evolution of marine organisms. BIO 336 or its equivalent is a prerequisite for this seminar course.
*Spring, 2 credits*

### BIO 681-698 Advanced Seminars.

Topics to be arranged.

### BIO 699 Research

Original investigation undertaken as part of Ph.D. program under supervision of a research committee.
*Each semester, credit to be arranged*

### Departmental Colloquium

A weekly series of talks and discussions by members of the staff, advanced graduate students, and visiting biologists, in which current research and thinking in various areas of biology will be presented.
*Each semester*

## CHEMISTRY

*Professors:* BONNER (*Chairman*), FRIEDMAN, HAMILTON (*Visiting*), KOSOWER, RAMIREZ, SUJISHI, WOLFSBERG

*Associate Professors:* J. ALEXANDER, HAIM, LAUTERBUR, LENOBLE, WISHNIA

*Assistant Professors:* BERNAL, BOIKESS, EMERSON, GOLDFARB,[a] HIROTA, KERBER, KWEI, SCHNEIDER, SOLO

*Director of Chemical Laboratories and Lecturer:* CROFT

### Admission to Graduate Study

For admission to graduate study in chemistry the following are required:

A. Baccalaureate degree in chemistry earned in a curriculum approved by the American Chemical Society, or an equivalent course of study.

B. A minimum grade-point average of 2.75 (B–) in all undergraduate course work, and 3.00 (B) in all courses in the sciences and in mathematics.

C. Acceptance by the Department of Chemistry and by the Graduate School.

In exceptional cases, a student not meeting the requirements (A) and (B) may be admitted on a provisional basis.

### Qualifying Examination

Before classes begin in the fall semester a series of three qualifying examinations in the fields of physical, inorganic, and organic chemistry will be administered to all incoming graduate students. These examinations will be based largely upon final examinations given in the junior and senior years of the undergraduate program of the State University at Stony Brook. The examinations will be based largely upon final examinations given in the junior and senior years of the undergraduate program of the State University at Stony Brook. The examinations will also be given between the fall and spring semesters and at the end of the spring semester. Any of the three parts not passed must be repeated. The purpose of the qualifying examinations is to aid in the advising of incoming

[a]Not in residence, Fall 1966.

graduate students concerning their first year programs and to ensure that the students are qualified for candidacy for an advanced degree.

#### Seminars

All graduate students will register for a chemistry seminar. In the course of his first year each student shall present a topic of his own selection. All first year graduate students will attend a pre-research seminar in which the faculty members of the Department of Chemistry will present talks on their research programs. The objective of these seminars is to provide information which will allow the student to make an intelligent selection of a research advisor.

In addition to the above, all graduate students are expected to attend the Department's regularly scheduled colloquia. These colloquia are presented by outstanding chemists invited from outside the University.

#### Research Advisor

At the beginning of the second semester, each first year student shall request a faculty member of his choice to become his research advisor and shall then apply to the Chairman of the Department of Chemistry for final approval.

The research advisor becomes the academic advisor for the student, and his subsequent program of study must meet with the approval of the research advisor.

Faculty research programs currently in progress include synthetic and physicochemical studies of molecular inorganic hydrides; organophosphorus compounds and organic synsthesis; stable free radicals and diradicals, aryldimides, molecular biochemistry and medicine; experimental and theoretical studies of electrolyte solutions, including calorimetry and statistical mechanics of equilibrium and transport processes; isotopic reaction studies and isotope geochemistry; molecular quantum chemistry and theory of isotope effects; nuclear reactions and fission, stopping of recoil atoms; kinetics and mechanisms of inorganic reactions in aqueous systems; nuclear magnetic resonance; organic systems under high pressure; physical biochemistry; structural inorganic chemistry of transition elements; low temperature photochemical valency tautomerism, nonbenzenoid aromatics, strained bicyclics; organometallics; high resolution infrared and far infrared spectroscopy; electron paramagnetic resonance and optical studies of triplet state; ion pairs; small ring heterocycles; chemical reaction studies by molecular beam technique; nuclear quadrupole resonance and Raman spectroscopy; flash photolysis in gaseous systems.

With the permission of the chairmen of the Departments of Chemistry and of Earth and Space Sciences, research may also be conducted in the area of Earth and Space Science.

**Courses of Study**

Students will be advised concerning courses of study appropriate to their backgrounds. The objective of the course of study in the first year is the development of breadth in chemistry. The following courses or their equivalent are required of all graduate students and will normally be taken during their first year.

*First Semester*

| | | |
|---|---|---|
| Organic Chemistry I | (CHE 501) | 3 credits |
| Inorganic Chemistry I | (CHE 511) | 3 credits |
| Quantum Chemistry I | (CHE 521) | 3 credits |
| Chemical Thermodynamics | (CHE 523) | 3 credits |
| Seminar | (CHE 531) | 0 credit |

*Second Semester*

| | | |
|---|---|---|
| Seminar | (CHE 532) | 1 credit |
| Research | (CHE 599) | 1-2 credits |
| —and at least two of the following: | | |
| Organic Chemistry II | (CHE 502) | 3 credits |
| Inorganic Chemistry II | (CHE 512) | 3 credits |
| Quantum Chemistry II | (CHE 522) | 3 credits |
| Chemical Kinetics | (CHE 526) | 3 credits |
| Statistical Mechanics | (CHE 528) | 3 credits |
| Nuclear Chemistry | (CHE 529) | 3 credits |

Students entering with advanced standing and desiring placement out of any first year course must obtain the approval of the faculty member in charge of the course and of the appropriate graduate committee. Such approvals must be filed in the Departmental Office.

**Qualification to Candidacy**

The qualifications of each first year graduate student will be reviewed by the faculty of the Department of Chemistry at the end of the spring semester, and students will be either accepted or rejected for qualification to candidacy for a graduate degree. Qualification requires successful completion of Qualifying Examinations and achievement of the grade point average in first year graduate courses indicated below.

**Requirements for the M.S. Degree**

A. Residence: one year minimum.

B. Qualification to candidacy (3.0 grade-point average).[a]

C. Language: reading proficiency in German or Russian.

D. Formal Course Requirement: successful completion (3.0 average or above) of an approved course of study comprising at least twenty-four graduate credits.

E. Thesis.

F. Oral Defense of Thesis: Upon acceptance of an M.S. thesis by a reading committee, the student is admitted to oral defense of his thesis. Upon recommendation of the oral defense committee, the Chairman of the Department recommends acceptance or rejection of the thesis to the Dean of the Graduate School.

**Requirements for the Ph.D. Degree**

A. Residence: two years minimum.

B. Qualification to candidacy (3.5 grade point average).[a]

C. Language: reading proficiency in German, and in a second foreign language in which there exists a substantial body of chemical literature.

D. Formal Course Requirement: successful completion (3.5 average) of an approved course of study.

E. Cumulative Examinations: The cumulative examination is intended to provide a means by which the student's depth of knowledge in a specialized area can be demonstrated. These examinations will be offered at eight stated dates each year in the three major areas of physical, inorganic, and organic chemistry. A student must pass six examinations in a major area within the first two years after qualification to candidacy. At least two of these must be passed in the first year following qualification. At the end of each semester the Department will review the performance of graduate students and determine the appropriate

[a]Based on the system A = 4.5, A— = 4.0, B = 3.5, B— = 3.0, C = 2.0, F = 0, for Chemistry Graduate Courses.

action, whether remedial or punitive, for each student who has not successfully met cumulative requirements to date. The action will be determined after reviewing the student's entire record of performance.

F. Advancement to candidacy: In order to be advanced to candidacy for the Ph.D. degree the student must satisfy the formal course requirement, the language requirement, demonstrate satisfactory progress in research, and satisfy the cumulative examination requirement.

G. Thesis.

H. Oral Defense of Thesis: Upon acceptance of a Ph.D. thesis by a reading committee, the student is admitted to oral defense of his thesis. Upon recommendation of the oral defense committee, the Chairman of the Department recommends acceptance or rejection of the thesis to the Dean of the Graduate School.

**Courses**

**CHE 501 Organic Chemistry I**

Useful and modern reactions used to construct organic molecules will be surveyed. These will include condensation reactions, benzyne chemistry, organophosphorus and organoboron chemistry, metal carbonyl reactions and acetylene chemistry.

*Fall, 3 credits*

**CHE 502 Organic Chemistry II**

The use of substituent effects and medium effects to evaluate the mechanisms of reactions proceeding through heteropolar, free radical and isopolar transition states is considered in detail. Unstable intermediates and unusual molecules are also discussed.

*Spring, 3 credits*

**CHE 511 Inorganic Chemistry I**

The crystal and molecular structure of inorganic compounds including complex hydrides, halides, chalconides, organo-metallic compounds and transition metal complexes will be surveyed. Chemical properties of and reactions leading to these compounds will be discussed.

*Fall, 3 credits*

**CHE 512 Inorganic Chemistry II**

Topics presented include physical properties of inorganic substances, structural effects in chemical equilibria, mechanisms of inorganic reactions and interpretation in terms of electronic structure.

*Spring, 3 credits*

**CHE 521 Quantum Chemistry I**

Elementary quantum and statistical mechanics will be applied to problems of chemical interest, including chemical bonding and molecular structure. The interpretation of ultraviolet, visible, infrared and radio-frequency spectroscopic data will be emphasized.

*Fall, 3 credits*

### CHE 522 Quantum Chemistry II

An introduction to matrix methods in quantum mechanics, and the behavior of systems in the presence of electric and magnetic fields. The application of symmetry properties and group theory will be made to atomic and molecular systems.

*Spring, 3 credits*

### CHE 523 Chemical Thermodynamics

A rigorous development of the fundamentals of thermodynamics and their application to a number of systems of interest to chemists. These systems include electrolytic and non-electrolytic solutions, electrochemical cells, gases, homogeneous and heterogeneous equilibrium systems. An introduction to statistical mechanics will also be included in order to relate the microscopic properties of molecules to the classical thermodynamic functions.

*Fall, 3 credits*

### CHE 526 Chemical Kinetics

An intensive study of rates of chemical reactions and in particular the relationship of kinetic studies to the determination of reaction mechanisms. Experimental methods will be discussed with emphasis on the determination of rate laws. The theoretical treatment will include discussions of the kinetic theory and the transition-state theory approaches to chemical kinetics. Topics will include gas reactions, chain reactions, and the new approaches to the study of very rapid chemical reactions.

*Spring, 3 credits*

### CHE 528 Statistical Mechanics

Techniques will be discussed which permit the calculation of microscopic properties for a variety of chemical systems, given the detailed nature of the microscopic substructure of the system. The above techniques, which lead to results paralleling those of thermodynamics, will be applied to ideal and real gases, crystals and liquids. In addition, some kinetic properties of systems will be examined.

*Spring, 3 credits*

### CHE 529 Nuclear Chemistry

Topics include the properties of radioactive substances and their use in the study of chemical problems; nuclear structure; a study of nuclear reactions; radioactive decay and growth; interactions of radiation with matter; detection and measurement of radiation, including a discussion of statistics; application of radioactivity to chemical problems such as kinetics, structure and analysis; artificially produced elements; and nuclear reactions.

*Fall, 3 credits*

### CHE 531 Seminar

*Fall, No credit*

### CHE 532 Seminar

*Spring 1 credit*

### CHE 599 Research

*Variable and repetitive credit*

### CHE 602 Intermediates in Organic Chemistry

The most important intermediates in organic reactions (free-radicals, carbonium ions, carbanions, benzynes, carbenes, etc.) are discussed on the basis of evidence as the products of reaction, kinetics, spectral observation, etc.

*Spring, 2 credits*

### CHE 603 Theoretical Organic Chemistry

The methods of chemical physics are applied to complex organic systems. Simplifying assumptions and empirical parameters for the linear combination of atomic orbital-molecular orbitals, self consistent field, free electron, and split-p-orbital treatments are considered. These methods are then used for spectral interpretation and correlation function determination. Reactivity indices, localization energies, free valence, bond order, and polarizabilities are discussed.

*Fall, 2 credits*

### CHE 604 Molecular Biochemistry

The application of physical-organic chemistry to biochemical reactions, including a survey

of intermediary metabolism and mechanistic analysis of such reactions as decarboxylations, hydration, hydrolysis, electron-transfer reactions, hydrogen-transfer reactions and reactions of phosphates.

*Spring, 2 credits*

### CHE 623 Molecular Spectroscopy

A detailed description of the theory and practice of rotational, vibrational, and electronic absorption spectroscopy. Topics to be covered will include energy levels, force fields, and selection rules for polyatomic molecules. Emphasis will be on the application of spectroscopic data to molecular structure and other problems of chemical interest.

*Fall, 2 credits*

### CHE 624 Magnetic Resonance

A study of the theory of magnetic and electrostatic interactions among nuclei and electrons, and of the experimental techniques used to observe them. Applications of magnetic resonance spectroscopy to a number of topics of chemical interest, including rate processes, the electronic structures, conformations, and motions of molecules, and the structures and electronic properties of solids will be discussed.

*Spring, 2 credits*

### CHE 625 Molecular Structure and Crystallography

Experimental methods in the determination of molecular structure. The relationship of structure to chemistry. The emphasis will be on the determination of structure in the solid state, particularly by x-ray crystallography.

*Fall, 2 credits*

### CHE 681 Special Topics in Organic Chemistry

A one-semester course dealing with certain specialized aspects of organic chemistry such as organophosphorus compounds, nitrogen heterocyclics (purines, pyrimidines, etc.) chemistry of the nucleotides organosulfur compounds.

*2 credits*

### CHE 682 Special Topics in Inorganic Chemistry

Subject matter varies, depending on interests of students and staff but will cover recent developments in inorganic chemistry.

*2 credits*

### CHE 683 Special Topics in Physical Chemistry

Subject matter varies, depending on interests of students and staff but will cover recent developments and advanced topics in physical chemistry.

*2 credits*

### CHE 699 Research

*Variable and repetitive credit*

# EARTH AND SPACE SCIENCES

*Professors:* GOLDICH, PALMER, SCHAEFFER (*Chairman*), STROMGREN (*Adjunct*), WEYL

*Associate Professor:* CHIU (*Adjunct*)

*Assistant Professors:* DODD, HANSON, R. SMITH

### Admission to Graduate Studies

For admission to graduate studies in the Department of Earth and Space Sciences, the following are required:

A. Baccalaureate degree in chemistry, physics, biology or one of the earth or space sciences from a department whose course requirements are equivalent to those at the State University of New York at Stony Brook.

B. A minimum grade point average of 3.00 (B) for undergraduate course work and a 3.00 (B) average in courses in the sciences and mathematics.

C. Acceptance by the Department of Earth and Space Sciences and by the Graduate School.

In exceptional cases a student not meeting requirements A. or B. may be admitted on a provisional basis.

### Requirements for the M.S. Degree

A. Residence: one year

B. Language: reading proficiency in French, German or Russian.

C. Graduate Courses: Successful completion (B average or above) of an approved course of study comprising at least 24 graduate credit hours. It is expected that at least six of these credit hours will be taken in one of the following: biology, chemistry, mathematics or physics.

D. Final Examination: A final written examination will be given. It will cover material studied in courses and information which the student is expected to obtain through supplementary reading and attendance at colloquia.

E. Thesis: A Master's thesis representing original research under the direction of a thesis advisor.

F. Oral defense of thesis: Upon acceptance of an M.S. thesis and passing of the final written examination, a committee will be appointed by the Department Chairman and the student will be admitted to an oral examination on his thesis.

G. Granting of the degree: A student who has passed his oral examination and has met the requirements of the Graduate School may apply to the Dean of the Graduate School for the degree.

**The Ph.D. Program**

The Department will inaugurate a Ph.D. program in the near future. Qualified students who have the permission of the Department will then be able to transfer from the M.A. to the Ph.D. program without loss of credit for residence.

**Courses**

*Advanced undergraduate courses carrying graduate credit*

Optical and X-ray Mineralogy

Igneous Petrology

Metamorphic Petrology

Sedimentary Petrology

Field Geology

Paleobiology

Systematic Paleontology

Evolution of the Earth

*Graduate Courses*

**ESS 501 Precambrian Geology**

The succession of Precambrian rocks as exemplified in the Lake Superior district. Precambrian history, as interpreted with the aid of radiometric age determinations.

*Spring 1968, 3 credits*

**ESS 502 Isotope Geology**

Radioactive decay schemes useful for determining the age of rocks and minerals. Evaluation of the various methods and consideration of problems of interpreting data. Application of radioactive and stable isotopes to the study of geologic processes, as for example, metamorphic and magmatic activity, ore deposition, and crustal evolution.

*Spring, 3 credits*

### ESS 503 Advanced Field Geology

Advanced problems in field geology.
*Fall and Spring, variable credit*
To be offered 1967-68.

### ESS 504 Seminar on Meteoritics

A study of the solid materials which strike the earth and their relation to earth and solar system history.
*Spring, 2 credits*

### ESS 505 Geochemistry

The study of the distribution and chemical combinations of the earth including the atmosphere and the oceans.
*Spring, 2 credits*

### ESS 506 Paleoecology

Methods and procedures for evaluating environments of the past using paleontologic and sedimentologic data.
*Spring 1968, 4 credits*

### ESS 507 Biostratigraphy

The uses of paleontologic data in problems involving dating and correlation of rocks and interpretations of geologic history.
*Spring 1968, 3 credits*

### ESS 553 Astrophysics-Stellar Theory

Introduction to the study of stellar structure, physics of stellar interiors and related current research topics.
*Fall, 3 credits*

### ESS 598 Seminar in Earth Sciences

A series of seminars discussing problems of current interest.
*Fall, 2 credits*

### ESS 599 Research

*Fall and Spring, Variable and repetitive credit*

## ENGLISH

*Professors:* P. ALEXANDER, JORDAN, KAZIN, LEVIN, LUDWIG, WEISINGER (*Chairman*)

*Associate Professors:* CREED, FIESS, GOLDBERG, PEQUIGNEY,[a] ROGERS, STAMPFER, THOMPSON

### Admission to Graduate Study

1. Applications for admission to graduate study in English shall be accompanied by an official transcript of undergraduate record, letters of recommendation from *three* previous instructors, the results of the Graduate Record Examination, and, wherever possible, an interview with a graduate advisor in the Department. When an applicant has been accepted by the Department, the Chairman of the Department will recommend his admission to the Dean of the Graduate School.

2. Undergraduate requirements for admission shall normally include:
   a) A Bachelor's degree from a recognized institution.
   b) An average of at least B in undergraduate literature courses.
   c) Proficiency in a foreign language equivalent to two years of college work.

*Note.* Any deficiencies in these requirements shall not automatically bar admission; but it is understood that inadequacies in undergraduate preparation will normally require the student to take additional work, the amount to be determined by the Graduate Committee, and not to be used to fulfill any specific M.A. degree requirements.

### Requirements for the Degree

Satisfying the minimum requirements, as set forth below, will not guarantee a degree. The final departmental decision as to the awarding of the degree will be made by the Graduate Committee.

1. *Course Requirements:* eight one-semester courses, normally amounting to twenty-four credit hours, including the following:

   a) (1) One graduate English course in the literature of a period.

[a]Not in residence, academic year 1966-67.

(2) One graduate English course devoted to one or two authors.

b) English 599. Independent Studies.

c) Five additional courses, at least four of which are to be in English. One may be a graduate or advanced undergraduate (200- or 300-level) course in a field related to English. No more than two 200- or 300-level courses will be counted toward the degree. Graduate students admitted to 200- or 300-level courses in English shall be required by the instructor to do additional reading and to submit at least two papers, one of which shall be a research paper.

*Note 1.* Before his Master's degree is granted the student will be required to have taken one course in Shakespeare and one course in Chaucer or Milton. Such a course on the graduate level will fulfill the requirement of 1, a), (2) above.

*Note 2. Performance.* An average grade of B in all course work is the minimum required, but no more than two C's will be permitted.

2. *M.A. Paper.* Each student must write a substantial (twenty-five to thirty-five page) scholarly or critical study on an approved topic, normally as part of his work in English 599.

3. *The Departmental Examination.* The written departmental M.A. examination will be designed to test the student's mastery of scholarly and analytic techniques.

4. *Foreign Language Proficiency.* The student must demonstrate as early as possible his ability to read literary texts of moderate difficulty in one approved foreign language.

**General Procedures and Regulations**

1. *Departmental Graduate Committee.* Members of the Department assigned to teach graduate courses will constitute a departmental Graduate Committee: (a) to evaluate the qualifications of prospective students, (b) to supervise the departmental examination, and (c) to make final departmental recommendations to the Dean of the Graduate School for the granting of the degree.

2. *The Advisor.* Each prospective M.A. candidate will be assigned an advisor who will supervise his work in the program.

3. *Residence Requirements and Time Limitations.* All the requirements for the degree must be completed within a period of two years from the initial admission to graduate study in the Department, except where in the opinion of the Department Graduate Committee extraordinary circumstances warrant exceptions to this rule.

## Courses

*Advanced Undergraduate Courses*

### EGL 306 Middle English Literature

Study of major works of prose, poetry, and drama of the fourteenth and fifteenth centuries, exclusive of Chaucer, in Middle English.

Prerequisite: EGL 207 or consent of instructor.

Mr. Jordan

*Spring, 3 credits*

### EGL 313 Tudor and Stuart Drama

Study of representative plays of the major dramatists (excluding Shakespeare) and genres from the beginnings of English secular drama to the closing of the theaters in 1642.

Prerequisite: Senior standing or consent of instructor.

Mr. Levin

*Fall, 3 credits*

### EGL 315 Elizabethan Poetry

Readings in Raleigh, Spenser, Sidney, Daniel, Davies, Marlowe, and Shakespeare.

Prerequisite: Senior standing or consent of instructor.

Messrs. Pequigney, Stampfer, Thompson

*Fall, 3 credits*

### EGL 333 English Drama, 1660-1780

Comparative analysis of representative works of the major dramatists from Dryden to Sheridan, with emphasis on the diverse forms of serious drama and the changing conception of comedy.

Prerequisite: EGL 211 or consent of instructor.

Mr. Goldberg

*3 credits*

### EGL 344 Romantic Revival I

The French Revolution; its influence on Wordsworth and Coleridge; their development as poets; the relation of Keats and Shelley to the Romantic movements; the criticism associated with the period; its prose.

Prerequisite: Senior standing or consent of instructor.

Mr. Alexander

*Fall, 3 credits*

### EGL 345 Romantic Revival II

The Romantic Movement continued; the prose criticism of the period (Lamb, Hazlitt, etc.) and its development in Victorian criticism; the Victorian poets—insofar as they are reacting to the work of their immediate predecessors. May be taken independently of EGL 344.

Prerequisite: Senior standing or consent of instructor.

Mr. Alexander

*Spring, 3 credits*

### EGL 365 James Joyce

The poetry and fiction of James Joyce will be read, including passages from *Finnegans Wake*. Selected works will be carefully analyzed, with *Ulysses* the major emphasis.

Prerequisite: Senior standing or consent of instructor.

Mr. Ludwig

*Fall, 3 credits*

### EGL 366 William Butler Yeats

Readings in the poetry, plays, autobiographies, and letters.

Prerequisite: Senior standing or consent of instructor.

Mr. Ludwig

*Fall, 3 credits*

### EGL 367 Modern British and American Poetry

Study of the achievement of twentieth century poetry in English, concentrating on Yeats, Eliot, Auden, Stevens, Thomas, and Frost.

Prerequisite: Senior standing or consent of instructor.

Messrs. Ludwig, Stampfer

*Spring, 3 credits*

### EGL 371 Major American Authors I

Intensive study of major American writers of the earlier nineteenth century.

Prerequisite: Senior standing or consent of instructor.

Mr. Kazin

*Fall, 3 credits*

### EGL 372 Major American Authors II

Intensive study of major American writers of the later nineteenth and twentieth centuries. May be taken independently of EGL 371.

Prerequisite: Senior standing or consent of instructor.

Mr. Kazin

*Spring, 3 credits*

### EGL 375 Major American Poets

Studies in American poetry from Emerson to Robert Frost.

Prerequisite: EGL 271 or 272, or consent of instructor.

Mr. Kazin

*Spring, 3 credits*

### EGL 381 History of Literary Criticism I

Analytic survey of major texts in the history of European literary theory and criticism from ancient times through the middle ages.

Prerequisite: EGL 281, senior standing, or consent of instructor.

Messrs. Jordan, Goldberg

*Fall, 3 credits*

### EGL 382 History of Literary Criticism II

Analytic survey of major texts in the history of European literary theory and criticism from the early Renaissance to the present. May be taken independently of EGL 381.

Prerequisite: EGL 281, senior standing, or consent of instructor.

Messrs. Jordan, Goldberg

*Spring, 3 credits*

### EGL 384 The History of English Poetry I

The study of the development of form, theme, and language in English verse from the fourteenth century to the end of the Renaissance.

Prerequisite: Senior standing or consent of instructor.

Mr. Thompson

*Fall, 3 credits*

### EGL 385 The History of English Poetry II

The study of the development of form, theme, and language in English verse from the end of the Renaissance to the present.

Prerequisite: EGL 384 or consent of instructor.

Mr. Thompson

*Spring, 3 credits*

### EGL 394 Satire and the Satiric Spirit

Critical analysis of satire and the satiric spirit from Aristophanes through Horace, Juvenal, and Persius, to writers such as Chaucer, Rabelais, Ben Jonson, Moliere, Dryden, Swift, Voltaire, Pope, Byron, Stendhal, and Flaubert.

Prerequisite: Senior standing or consent of instructor.

Mr. Ludwig

*Spring, 3 credits*

## *Interdepartmental Course in World Literature*

### WL 395 The European Novel

Selected masterpieces of European fiction, such as the novels of Stendhal, Balzac, Dostoevsky, and Tolstoy.

Mr. Kazin

*Fall, 3 credits*

## *Graduate Courses*

### EGL 500 Introduction to Graduate Study

Introduction to the major resources, techniques, and approaches involved in literary scholarship and criticism, with illustrative practical applications.

Mr. Stampfer and Staff

*Fall, 3 credits*

### EGL 501 Introduction to Old English Language and Literature

After a brief introduction to the language, the student will read in Old English and discuss a number of shorter Old English poems from *Caedmon's Hymn* to *The Battle of Maldon.*

Mr. Creed

*Fall, 3 credits*

### EGL 502 Beowulf

An intensive study, largely from a literary point of view, of the Old English original of this earliest recorded English epic.

Mr. Creed

*Spring, 3 credits*

### EGL 506 Studies in the Medieval Period

A study of major works of the Middle English period (exclusive of Chaucer) in relation to the traditions of chivalry and Christianity. Readings will include *Pearl, Sir Gawayne and the Green Knight,* Malory's *Death of Arthur,* and selected lyrics.

Messrs. Jordan, Creed

*3 credits*

### EGL 507 Special Topics in Chaucer

A study of the principles of unity in the *Canterbury Tales.* Chaucer's works will be examined in the light of modern and medieval conceptions of poetic unity.

Prerequisite: An undergraduate course in Chaucer or consent of instructor.

Mr. Jordan

*Spring, 3 credits*

### EGL 512 Special Topics in Shakespeare I

The development of the Elizabethan theater; the London companies; Shakespeare's early theatrical connections; his development as a dramatist with special reference to selected plays.

Messrs. Alexander, Levin, Stampfer

*Fall, 3 credits*

### EGL 513 Special Topics in Tudor and Stuart Drama

This course each year will focus upon some specific topic in the field of Tudor and Stuart drama exclusive of Shakespeare.

Mr. Levin

*Spring, 3 credits*

### EGL 515 Shakespeare's Roman Tragedies

This course will focus on one area of Shakespeare's genre writing, its sources, its plots, and its sense of political legitimacy: Shakespeare's evolving sense of Rome as a civilization.

Mr. Stampfer

*3 credits*

### EGL 517 Special Topics in Shakespeare II

This course is a continuation of EGL 512 but may be taken independently.

Messrs. Alexander, Levin, Stampfer

*Spring, 3 credits*

### EGL 528 Andrew Marvell

Marvell's poetry will be studied, analytically and in the contexts of history and his biography, of literary traditions and critical commentaries.

Mr. Pequigney

*3 credits*

### EGL 535 Alexander Pope

Study of Pope's major poems, translations, and miscellaneous prose, in the context of his life and times.

Mr. Rogers

*3 credits*

### EGL 536 Studies in the Later Eighteenth Century

This course each year will focus upon some specific topic in the field. The topic for 1966-67 will be the works of Samuel Johnson and James Boswell.

Mr. Rogers

*Fall, 3 credits*

### EGL 537 Studies in Eighteenth Century Fiction

Critical investigation of the four major mid-century novelists (Richardson, Fielding, Smollett, and Sterne) and the current state of scholarship in the field, with emphasis on relationships and distinctions among the latter three.

Mr. Goldberg

*3 credits*

### EGL 541 Studies in Romantic Poetry

An examination of the major poems of Blake, Wordsworth, and Keats, stressing the revolutions in poetry and philosophy which marked this period.

Mr. Kazin

*3 credits*

### EGL 542 Wordsworth and Coleridge

An intensive study of the works of Wordsworth and Coleridge centering on Wordsworth's *The Prelude.*

Mr. Abrams

*3 credits*

### EGL 558 Matthew Arnold

An analysis of Arnold as a critic of Victorian culture, a literary critic, and poet, emphasizing his place in scientific, religious, literary and educational controversy.

Mr. Ludwig

*3 credits*

### EGL 565 James Joyce

An intensive study of *Ulysses* with all of joyce's other works brought into the discussion.

Mr. Ludwig

*Fall, 3 credits*

### EGL 573 Mark Twain and the Tradition of American Humor

Some acquaintance with the work of Mark Twain, particularly *Huckleberry Finn,* will be assumed. The course will give attention to the predecessors of Twain, especially the humorists of the Old Southwest, but it will concentrate on the chronology of Twain's career.

Mr. Fiess

*Fall, 3 credits*

### EGL 575 Selected American Writers

The seminar will be devoted to a parallel examination of the works and characters of Hawthorne and Melville with special attention to their methods and literary invention. Their relationships with other literary contemporaries will be thoroughly explored.

Messrs. Kazin, Fiess

*3 credits*

### EGL 576 Melville

The seminar will concern itself with all of Melville's work; prior acquaintance with Mel-

ville's more familiar works like *Moby Dick* will be assumed. Textual, biographical and critical approaches will be used.

Mr. Fiess

*Spring, 3 credits*

### EGL 578 Henry James

A study of the major novels, critical essays, and biographical and bibliographical problems of Henry James.

Mr. Thompson

*Fall, 3 credits*

### EGL 579 Twentieth Century American Poetry

An intensive study of selected major American poets of the twentieth century.

Mr. Kazin

*Fall, 3 credits*

### EGL 583 The Structure and History of the English Language

A study, employing the techniques of modern linguistics, of the structure of present-day American English, with some attention to selected earlier periods for comparison.

Mr. Creed

*3 credits*

### EGL 599 Independent Studies

Work with one or more instructors designed to strengthen a weakness or intensify an area of study leading to advanced work.

Staff

*Fall and Spring, 3 credits*

## HISTORY

*Professors:* BUARQUE DE HOLLANDA (*Visiting* 1966-67), CESPEDES, MAIN, ROSS, SEMMEL (*Chairman*)

*Associate Professors:* ANGRESS, CLELAND, PRATT, ROSENTHAL, SLAVIN (*Visiting* 1966-67), STAUDENRAUS, TRASK, WELTSCH[a] (*Adjunct*), WILDMAN

*Assistant Professors:* ALIN, BOTTIGHEIMER, LEBOVICS, R. H. G. LEE

### Admission to Graduate Study

1. Applications for admission to graduate study in History shall be accompanied by an official transcript of undergraduate record and letters of recommendation from *three* previous instructors. The results of the Graduate Record Examination, though not mandatory, are desirable to help in the selection process for admission.

2. Requirements for admission shall also include:

   a) A baccalaureate degree in history, or its equivalent.

   b) A minimum grade-point average of 2.75 (B—) in all undergraduate course work, and 3.00 (B) in history courses.

   c) Acceptance by the Department of History and the Graduate School.

In special cases, students not meeting requirements (a) and (b) may be admitted on a provisional basis.

With the approval of the Dean of the Graduate School and the History Department, a student holding an M.A. degree from another accredited institution may be admitted directly to the Ph.D. program at Stony Brook.

### Degree Requirements

*The Master of Arts Degree*

The Master's degree requires at least one year (two semesters) of residence, including a minimum of 24 hours of course work, an oral examination, and any additional work which the student may be required to take. The nature and scope of such additional work will depend on the student's state of preparation

[a]Not in residence, Fall 1966

for graduate studies and will be determined by his graduate advisor. Furthermore, the candidate must prove his proficiency in one foreign language by taking an examination no later than the beginning of the second semester in residence. If he fails the examination, he will have to retake it until he passes it. Under no circumstances can the M.A. degree be awarded to any student who has not yet passed his first language examination. A student entering the program with an M.A. from another institution who has not already passed one language examination must pass such an examination within his first semester of residence at Stony Brook.

The 24 hours of course work must include the following: two research seminars, taken with two different instructors; two reading seminars, taken with two different instructors; and such advanced upper division courses as the student's training will require. Ordinarily, an M.A. candidate will be expected to work in his major field and also to begin course work in a field separate in time or geographic area from his major field of concentration. Such course work will normally contribute to the preparation of one of the minor fields required for the Ph.D. degree.

The M.A. oral examination committee will be composed of at least three members of the faculty appointed by the Graduate Dean of the University in consultation with the Chairman of the Department. The oral examination for the M.A. will be in the student's major field of concentration, to be defined and delimited by his major advisor.

### *The Doctor of Philosophy Degree*

#### PH.D., PRELIMINARY REVIEW

When a student has completed his work for the M.A. degree, his record will be reviewed by the departmental Graduate Committee. Unless the student's record promises success in the more difficult and more independent work for the Ph.D., he will be discouraged from further graduate study in history.

#### PH.D., GENERAL REQUIREMENTS

The Ph.D. is not a degree which can be obtained by satisfying course requirements. The chief specific tasks of the student are to prepare for his qualifying examinations and to write his dissertation. However, to insure adequate preparation for the qualifying examinations, the student will ordinarily take course work in his minor fields as well as in his major thesis field.

The Ph.D. degree requires at least one year (two semesters) of residence beyond the M.A. During each semester of residence the student will ordinarily

take twelve credits per semester (nine if he is a teaching or research assistant). He must prove his proficiency in a second foreign language prior to taking qualifying examinations, and he must write a dissertation. The qualifying examinations will test the student's proficiency in his major field and two minor fields (see below, *Ph.D., Selection of Fields*).

Ph.D. programs will of necessity vary from individual to individual. The normal program, to be worked out between the student and his advisor, will ordinarily include four reading seminars, two each semester. In some instances, a directed reading course may be substituted for a reading seminar, and such other directed reading courses as may be appropriate to the student's program may also be taken. Furthermore, the student may have to take some lecture courses in order to fill gaps in his background. A student who has taken his M.A. degree at another institution may be required by the department to take one research seminar as well. Because the graduate program is designed to prepare the student for a career of teaching and scholarly research, great emphasis will be placed on extensive reading, primarily to enable the student to acquire a solid foundation of historical knowledge and to prepare him properly for his Ph.D. qualifying examinations in his major field and his two minor fields.

All Ph.D. students will be required to take a one-hour non-credit course in Teaching History at the College Level. This will usually be done in connection with section teaching in the History of Western Civilization, U.S., British, or Latin American History.

### PH.D., LANGUAGE REQUIREMENTS

A reading knowledge of two foreign languages is required. One of these will ordinarily be either French or German. However, the department may permit the student to substitute any other foreign language, provided there exists a rich scholarly literature in it, or it is demonstrably necessary for the student's research. Because language proficiency is an essential prerequisite for course work, and especially for graduate seminars, the student is expected to complete his language preparation before commencing the doctoral program. Under no circumstances will a student be permitted to take the qualifying examinations until he has passed the required language examinations.

### PH.D., SELECTION OF FIELDS

The student must choose for special study a major field and two minor fields of history. A major field will generally consist of one of the Divisions, listed below under *Fields of Examination,* or a substantial part of one, its scope and emphasis to be determined by the advisor in consultation with the student. This is the

field in which the student will write his dissertation. A minor field will generally consist of a subdivision of one of the Divisions, and is likewise to be determined by the advisor, in consultation with the student and an instructor in the minor field. In some cases, the major field selected may determine one of the minor fields (e.g., if a student's major field is Late Modern Europe, he should offer a subdivision of Early Modern Europe as one of the minor fields).

One of the two minor fields, moreover, must be clearly removed in either time or space from the student's major field, i.e., the separation may be either geographical or chronological. *Examples:* If a student's major field is U. S. History (and delimited to the National period, at the discretion of the advisor), one of his minor fields should be either in Latin American, East Asian, or European History. If a student's major field is Modern Europe (and delimited to England, France and Germany since 1815, at the discretion of the advisor), one of his minor fields should either be in Ancient, Medieval, or in any period of history on another continent, while his second field should be in one of the Early Modern European subdivisions. The minor fields will be passed by written examinations (3 hours each); the major fields by a two-hour oral examination.

ADMISSION TO DOCTORAL CANDIDACY

A student will be considered a candidate for the doctorate after he has met his language requirements and passed his qualifying examinations. After admission to candidacy, a student will register for dissertation credits in consultation with his advisor.

**M.A. and Ph.D. Fields of Examination**

The Divisions (see below) constitute the major fields (subject to delimitation outlined under *Ph.D., Selection of Fields,* above), whereas the minor fields and the dissertation fields will be chosen from the various subheadings listed below the Divisions. Thus, a student's major field may be Division IV, Modern Europe (1815-Present)—which may be further qualified by giving special emphasis to certain countries, to diplomatic or intellectual history, etc., as outlined under *Ph.D., Selection of Fields,* above. Whatever the qualifications, the student will be held responsible for demonstrating an overall comprehension of his entire major field (Division) outside the area of special emphasis. For the choice of minor fields, see above, *Ph.D., Selection of Fields.*

At present, the department is equipped to offer examinations in all seven Divisions, but can offer dissertation fields only in U.S., Modern European, Latin American and Medieval History. The department anticipates adding Early Modern Europe as a dissertation field by the fall of 1967.

I. The Ancient World

II. The Medieval World, 500-1500

III. Early Modern Europe
   1. Renaissance and Reformation, 1300-1648.
   2. Tudor and Stuart and Early Hanoverian England, 1485-1760.
   3. The Age of Enlightenment and Revolution, 1648-1815.

IV. Modern Europe (1815-Present)
   Subdivisions to be determined by consultation with advisor.
   Guidelines: Approximately 150 years and three major countries or: approximately 100 years for entire area, with emphasis on diplomatic, or intellectual, or social and economic, etc.

V. Latin America
   1. Latin America to 1824.
   2. Latin America since 1824.

VI. East Asia
   1. Traditional China to 1800.
   2. China since 1800.

VII. United States of America
   1. Colonial and Early National Period to 1824.
   2. National Period since 1824.

With the consent of the departmental Graduate Committee, a student may define a field or fields not included in this above list (e.g., Expansion of Europe). In a few cases, where advanced work outside the Department of History is an integral part of the student's preparation for a professional career (e.g., preparation in science for historians of science, or in economics for economic historians), the Committee will consider a request to substitute such advanced work for one of the two minor fields.

#### Courses

Advanced undergraduate history courses, numbered from 201-399, will often be part of a beginning graduate student's program. A list of these courses can be found in the History section of the *Undergraduate Bulletin.*

Graduate courses in the 500 series, unless otherwise indicated, are reading seminars, those in the 600 series are research seminars in the fields listed. Seminars normally carry three credits:

**HIS 501** Reading Seminar in Ancient History

**HIS 502** Reading Seminar in Medieval History

**HIS 503** Reading Seminar in Renaissance and Reformation

**HIS 504** Reading Seminar in Western Europe, 1500-1789

**HIS 505** Reading Seminar in Western Europe since 1789

**HIS 506** Reading Seminar in Central Europe, 1500-1789

**HIS 507** Reading Seminar in Central Europe since 1789

**HIS 508** Reading Seminar in Eastern Europe, 1505-1801

**HIS 509** Reading Seminar in Eastern Europe since 1801

**HIS 510** Reading Seminar in Intellectual European History

**HIS 521** Reading Seminar in American Colonial History

**HIS 522** Reading Seminar in The American Revolution, 1760-1789

**HIS 523** Reading Seminar in American Constitutional Origins and Development

**HIS 524** Reading Seminar in The Age of Jefferson and Jackson

**HIS 525** Reading Seminar in Civil War and Reconstruction

**HIS 526** Reading Seminar in United States History, 1877-1929

**HIS 527** Reading Seminar in United States History 1929—Present

**HIS 528** Reading Seminar in American Industrial Society to 1900

**HIS 529** Reading Seminar in American Industrial Society since 1900

**HIS 530** Reading Seminar in Social and Intellectual U. S. History to 1865

**HIS 531** Reading Seminar in Social and Intellectual U. S. History since 1865

**HIS 532** Reading Seminar in U. S. Diplomatic History

**HIS 541** Reading Seminar in Latin America and the Outside World

**HIS 542** Reading Seminar in Modern Mexico

**HIS 543** Reading Seminar in Colonial Latin America

**HIS 544** Reading Seminar in Latin America since Independence

**HIS 545** Reading Seminar in Brazilian History

**HIS 552** Reading Seminar in Social and Economic History of England, 1785—Present

**HIS 553** Reading Seminar in Tudor and Stuart England

**HIS 554** Reading Seminar in Modern British History

**HIS 555** Reading Seminar in British Empire History

**HIS 561** Reading Seminar in East Asian History

**HIS 581** Supervised Teaching

*One hour, no credit*

**HIS 582** Directed Reading for M.A. Candidates

*Variable and repetitive credit*

**HIS 583** Seminar in Historiography

**HIS 601** Research Seminar in Ancient History

**HIS 602** Research in Medieval History

**HIS 603** Research Seminar in Renaissance and Reformation

**HIS 604** Research Seminar in Western Europe, 1500-1789

**HIS 605** Research Seminar in Western Europe since 1789

**HIS 606** Research Seminar in Central Europe, 1500-1789

**HIS 607** Research Seminar in Central Europe since 1789

**HIS 608** Research Seminar in Eastern Europe, 1505-1801

**HIS 609** Research Seminar in Eastern Europe since 1801

**HIS 610** Research Seminar in Intellectual European History

**HIS 621** Research Seminar in American Colonial History

**HIS 622** Research Seminar in The American Revolution, 1760-1789

**HIS 623** Research Seminar in American Constitutional Origins and Development

**HIS 624** Research Seminar in The Age of Jefferson and Jackson

**HIS 625** Research Seminar in Civil War and Reconstruction

**HIS 626** Research Seminar in United States History, 1877-1929

**HIS 627** Research Seminar in United States History, 1929—Present

**HIS 628** Research Seminar in American Industrial Society to 1900

**HIS 629** Research Seminar in American Industrial Society since 1900

**HIS 630** Research Seminar in Social and Intellectual U. S. History to 1865

**HIS 631** Research Seminar in Social and Intellectual U. S. History since 1865

**HIS 632** Research Seminar in United States Diplomatic History

**HIS 641** Research Seminar in Latin America and the Outside World

**HIS 642** Research Seminar in Modern Mexico

**HIS 643** Research Seminar in Colonial Latin America

**HIS 644** Research Seminar in Latin America since Independence

**HIS 652** Research Seminar in Social and Economic History of England, 1785—Present

**HIS 653** Research Seminar in Tudor and Stuart England

**HIS 654** Research Seminar in Modern British History

**HIS 655** Research Seminar in British Empire History

**HIS 661** Research Seminar in East Asian History

**HIS 682** Directed Reading for Ph.D. Candidates
*Variable and repetitive credit*

**HIS 699** Research for Ph.D. Candidates
*Variable and repetitive credit*

## MATHEMATICS

*Professors:* ADLER (*Visiting*), BARCUS, DOSS, LISTER, SZUSZ

*Associate Professors:* W. FOX (*Acting Chairman*), KRAVETZ, WEHN, ZAUSTINSKY

*Assistant Professors:* BACHELIS, D'ALARCAO, HACHIGIAN (*Visiting*), KUMPEL, OH, SCHROER, SHANTARAM, TRAMER

### Admission to Graduate Study

For admission to graduate study in mathematics, an applicant should have a baccalaureate degree with preparation substantially equivalent to that required of mathematics majors at this institution. He is required to present three letters of recommendation from members of the mathematics faculty under whom he has taken courses. The Departmental recommendation for admission will be based upon signs of exceptional ability in mathematics as indicated by these letters and the student's grades.

In certain cases a student whose background in mathematics contains gaps may be admitted on a provisional basis. Upon admission the student will be informed of the requirements which he must satisfy in order to be admitted to full standing.

### Requirements for the M.A. Degree

Aside from the general requirements of the Graduate School, the single Departmental requirement is the successful completion of a comprehensive examination designed to test general proficiency in the fields of real and complex analysis, algebra, and some branch of geometry or topology. Syllabi and bibliographies indicating the nature and scope of the examination will be provided. Students will prepare for the examination in regularly organized courses and, with the occasional assistance of the staff, through independent study. Students who are admitted to full standing and are studying fulltime will normally take the examination after one calendar year of preparation.

### The Ph.D. Program

The Department will inaugurate a Ph.D. program in the near future. Qualified students who have the permission of the Department will then be able to transfer from the M.A. to the Ph.D. program without loss of credit for residence.

**Courses**

(Prerequisites may be satisfied by equivalent material taken at other universities or by independent study.)

## *Advanced Undergraduate Courses*

### MAT 301 Introduction to Complex Analysis

Holomorphic functions. The Cauchy-Riemann equations, Cauchy's theorem, Taylor series. Maximum modulus theorem. Meromorphic functions. Laurent series, the Cauchy residue theorem.

Prerequisite: Advanced Calculus.

*Fall, 3 credits*

### MAT 302 Introduction to Real Analysis

Functions of bounded variation. Lebesgue and Lebesgue-Stieltjes measures and integrals, and the corresponding theorems of Fubini and Radon-Nikodym. Basic properties of $L_2$.

Prerequisite: Advanced Calculus.

*Spring, 3 credits*

### MAT 312 Introduction to Topology

Basic topological properties; convergence, continuity, compactness, connectedness. Construction of spaces, metrics, local properties, and topics selected from homotopy, covering spaces, simplicial homology.

Prerequisite: Advanced Calculus, Algebra I (Groups, rings, and fields).

*Fall, 3 credits*

### MAT 323 Introduction to Differential Geometry

Local theory of curves and surfaces in Euclidean space: fundamental forms, curvature, geodesics. Introduction to global differential geometry.

Prerequisite: Advanced Calculus.

*Fall, 3 credits*

### MAT 331 Algebra II

Elementary group theory; composition series, the Sylow theorems, the fundamental theorem of Abelian groups. Field extensions; the splitting field of a polynomial, the fundamental theorem of Galois theory.

Prerequisite: Algebra I.

*Spring, 3 credits*

## *Graduate Courses*

### MAT 501, 502 Real Analysis I, II

Topological preliminaries—compactification, metrization, completion of metric spaces. The Baire category theorem. Abstract measures, their extension and decomposition. Integration. The Radon-Nikodym theorem. Product measures and the theorem of Fubini. Elementary theory of Banach and Hilbert spaces.

Prerequisite: MAT 302 or permission of instructor.

*Fall and Spring, 4 credits each semester.*

### MAT 506 Complex Analysis

Entire functions. Normal families and the Riemann Mapping Theorem. Picard's theorem. The Dirichlet problem, harmonic and subharmonic functions. Analytic continuation and the monodromy theorem, Riemann surfaces of elementary functions.

Prerequisite: MAT 301.

*Spring, 4 credits*

### MAT 512 Algebraic Topology I

Homotopy groups. The Hurewicz theorem. Obstruction theory. Fibre spaces. Spectral sequences.

Prerequisite: MAT 312.

*Spring, 4 credits*

### MAT 513 Algebraic Topology II

Cohomology operations. Application to the computation of the homotopy groups of spheres and other problems.

Prerequisite: MAT 512.

*Fall, 4 credits*

### MAT 521 Riemannian Geometry

Linear connections, Riemannian manifolds, and the Riemannian connection, geodesics, elements of Morse Theory for Riemannian spaces, relations between curvature and the topology of the space.

Prerequisite: MAT 522.

*Fall, 4 credits*

Not offered Fall 1966.

### MAT 522 Differential Manifolds

Differentiable manifolds and submanifolds, tensor bundles, theorems of Stokes, Frobenius and de Rham, connections and curvature.

Prerequisite: Advanced Calculus, and MAT 312 or permission of the instructor.

*Spring, 4 credits*

### MAT 531, 532 Algebraic Systems I, II

Structure of rings—chain conditions, theory of the radical. Modules over rings of various types. Structure of algebras. Cohomology of algebras.

Prerequisite: MAT 331.

*Fall and Spring, 4 credits*

## *Seminars and Independent Study*

In 1966-67 the listed seminars will be taught as formal 4 credit courses with a year of graduate study in that field as prerequisite.

### MAT 581 Analysis Seminar

Fall 1966 topics: Analytic number theory, Diophantine problems, summability.

*Fall and Spring*

### MAT 582 Topology Seminar

Fall 1966 topic: K-theory.

*Fall and Spring*

### MAT 583 Differential Geometry

Fall 1966 topics: Differentiable manifolds and Lie groups.

*Fall and Spring*

### MAT 584 Algebra Seminar

*Fall and Spring*

### MAT 598 Independent Study

A reading course in material not covered in the formal curriculum. Subjects to be arranged by the students and individual members of the staff.

## PHYSICS

*Professors:* BALAZS, DRESDEN,[a] EISENBUD, FEINGOLD,[f] D. FOX, GOLDHABER (*Adjunct*), GOOD, LAMBE, B. LEE,[b] L. LEE,[c] MUETHER, POND (*Chairman*), TOLL, YANG[d]

*Associate Professors:* AMES, CHIU (*Adjunct*), DEZAFRA, KAHN, KAO, LEE-FRANZINI, MOULD, SILSBEE, SWARTZ, THADDEUS (*Adjunct*)

*Curator of the Physical Laboratory:* EKLUND[e]

*Assistant Professors:* EMMONS, FOSSAN, GRANNIS, HWA,[b] KANTOR, KAYSER,[b] KRAMER, PAUL, WEINBERG, ZANELLO (*Visiting*)

### Admission to Graduate Study

For admission to graduate study in physics, the following are required:

A. Baccalaureate degree in physics from an accredited institution, with departmental course requirements in physics equivalent to those at this institution (including courses at the junior and senior level in Electromagnetic Theory, Mechanics, Methods of Theoretical Physics, Quantum Mechanics and Modern Physics, Advanced Laboratory).

B. A minimum grade average of B in all undergraduate course work, and of B in physics, mathematics, and chemistry.

C. Acceptance by the Department of Physics and by the Graduate School.

In special cases, a student not meeting requirements (A) and (B) may be admitted on a provisional basis. Upon entrance, the student will be informed of the requirements he must satisfy for the termination of the provisional status.

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[a] Executive Officer, Institute for Theoretical Physics
[b] Member, Institute for Theoretical Physics
[c] Director, Nuclear Structure Laboratory
[d] Director, Institute for Theoretical Physics
[e] Associate Director, Nuclear Structure Laboratory
[f] Not in residence, Academic Year 1966-67

**First-Year Program**

The student's program for the first year of graduate study will be determined on the basis of past records and an interview and examination (see below), given at the beginning of the first semester.

**Qualifying Examination**

An examination will be given to each graduate student upon entrance in his first year. Covering basic undergraduate physics, this examination is given primarily for guidance purposes. Passing this examination is also required for continued graduate study beyond the first year. An opportunity to repeat this examination, in case of failure, will normally be given early in the Spring semester.

**Requirements for the M.A. Degree**

A. Residence: one year.

B. Advancement to candidacy.

C. Courses: The student must complete a program of courses which is approved by his faculty advisor and which includes PHY 501 (Analytical Mechanics), PHY 502 (Electrodynamics), and PHY 511 (Quantum Mechanics I).

D. Language requirement: Before the candidate receives permission to take the final examination for the M.A. degree he must demonstrate proficiency in reading scientific material in one of the following foreign languages: German, French, Russian.

E. Final examination: A final examination will be given, covering both material studied in the course work and information which the student is expected to attain through supplementary reading and attendance at colloquia and seminars. Part I of the Preliminary Examination (see below) will normally constitute the written part of this examination.

**The Ph.D. Program**

While there are no formal course requirements for advancement to candidacy for the Ph.D., it is expected that most students will be advised to take courses in preparation for the preliminary examination. The following constitutes a sample

program for a student who is admitted with no special conditions to satisfy, and who holds a teaching assistantship:

FIRST SEMESTER

Analytical Mechanics
Quantum Mechanics I
Methods of Mathematical Physics I

SECOND SEMESTER

Methods of Mathematical Physics II
Electrodynamics
Quantum Mechanics II

THIRD SEMESTER

Nuclear and Elementary Particle Physics
Solid-State Physics
Advanced Quantum Mechanics

FOURTH SEMESTER

Statistical Mechanics
Electives

**Requirements for the Ph.D. Degree**

A. Preliminary Examination: The preliminary examination will be given in two parts. Part I will be a written examination, and will cover the following topics: Analytical Mechanics, Electrodynamics, Quantum Mechanics, Methods of Mathematical Physics. Part II will be partly written and partly oral, and will cover Statistical Mechanics, Nuclear Physics, Solid State Physics, Elementary Particle Physics, and an advanced option to be chosen by the student. Part II will also include questions on recent developments, not necessarily discussed in the courses, which the student is expected to learn through independent reading and attendance at colloquia and seminars. The oral part of Part II will also contain a discussion of an Original Proposition to be submitted by the student. A student who is admitted to graduate study with no conditions will ordinarily take Part I in September of his second year and Part II the following September.

B. Language Examinations: The student is expected to have a reading knowledge of two of the following languages: German, Russian, French. Proficiency in one of these languages must be demonstrated before Part I of the preliminary examination is

taken, and in the second language before Part II is taken.

C. Advancement to Candidacy: The department's recommendation with respect to advancement to candidacy will be based primarily on the satisfactory completion of requirements A and B.

D. Research and Thesis: The candidate's thesis committee is appointed by the Graduate School upon recommendation of the department chairman. The chairman of the committee is the candidate's research and thesis advisor. (Although this formal arrangement begins after admission to candidacy, the student is expected to have an informal association with a research group at an earlier stage.)

E. Thesis Examination: An examining committee will read the thesis and give the candidate an oral examination on the research topic and related areas. Upon recommendation of the committee, the department chairman recommends acceptance or rejection of the thesis to the Graduate School.

F. Teaching Requirement: Teaching experience at least equivalent to that obtained in a one-year appointment as a Graduate Teaching Assistant is required.

**Courses**

*Advanced Undergraduate Courses*

**PHY 341, 342 Quantum Mechanics and Modern Physics**

**PHY 343, 344 Methods of Mathematical Physics I and II**

**PHY 345, 346 Senior Laboratory**

*Graduate Courses*

**PHY 501 Analytical Mechanics**

Dynamics of particles and rigid bodies, Lagrange's and Hamilton's equations, variational principles, canonical formulation, Hamilton-Jacobi equation.

*3 credits*

**PHY 502 Electrodynamics**

Maxwell's equations, scalar and vector potential theory, boundary value problems, electromagnetic waves and radiation.

*3 credits*

**PHY 511 Quantum Mechanics I**

Review of basic principles of quantum theory with applications to atomic, molecular, nuclear, and solid state physics; stationary state and time dependent perturbation theory, elementary collision problems.

*3 credits*

**PHY 512 Quantum Mechanics II**

Formal structure of quantum theory, collision problems and formal scattering theory, ele-

mentary quantization of the radiation field, introduction to Dirac electron theory.

*3 credits*

### PHY 531 Advanced Quantum Mechanics

Symmetries and invariance principles, many-body techniques, relativistic electron theory, introduction to field theory.

*3 credits*

### PHY 540 Statistical Mechanics

Boltzmann statistics, H theorem and entropy, quantum statistics, microscopic approach to thermodynamics.

*3 credits*

### PHY 551 Nuclear and Elementary Particle Physics

Basic properties of nuclei, nuclear forces, radioactivity, electromagnetic properties; experimental techniques, accelerators and nuclear detectors; introduction to pion physics; elementary particle systematics, conservation laws in strong and weak interactions.

*3 credits*

### PHY 553 Astrophysics—Stellar Theory

Introduction to the study of stellar structure, physics of stellar interiors, and related current research topics. This course is identical with ESS 553.

*3 credits*

### PHY 555 Solid State Physics

Crystal structure, symmetry and space groups, ionic crystals, band theory of metals and semiconductors, transport phenomena, imperfections, magnetic and dielectric phenomena, low-temperature properties of solids.

*3 credits*

### PHY 562 Solid State Theory

Transport properties of solids, including interactions of electrons with various imperfections; galvomagnetic and thermoelectric effects; optical, spectroscopic and photoelectric properties; dielectric and magnetic properties.

*3 credits*

### PHY 564 Theoretical Nuclear Physics

The two-body problem, theory of nuclear forces and properties of nuclear matter, nuclear models, formal theory of nuclear reactions.

*3 credits*

### PHY 566 Elementary Particle Theory

Fundamental particle systematics, weak and strong interactions, high energy phenomena.

*3 credits*

### PHY 580 Special Research Projects

Research under the direction of a faculty member. Not open to Ph.D. candidates who have passed the preliminary examination.

*Each semester, variable and repetitive credit*

### PHY 585 Special Study

Reading course in selected topics.

*Each semester, variable and repetitive credit*

### PHY 610, 611 Quantum Field Theory I, II

Field quantization; scalar and pseudoscalar meson field; electromagnetic field, Dirac field, interacting fields; Feynman diagrams; charge and mass renormalization; dispersion relations.

*3 credits*

### PHY 620 Relativity

Special and general theories of relativity; cosmology; unified field theories.

*3 credits*

### PHY 680 Special Topics in Theoretical Physics

Subject matter varies from semester to semester, depending on interests of students and staff. Advanced topics such as group theory and applications, modern topics in field theory.

*Each semester, 3 credits per semester, repetitive credit*

### PHY 681 Special Topics in Statistical Mechanics

Subject matter varies from semester to semester, depending on interests of students and staff. Advanced and special topics of current interest such as non-equilibrium theory, theory of phase transitions.

*Each semester, 3 credits per semester, repetitive credit*

### PHY 682 Special Topics in Solid State Physics

Subject matter varies from semester to semester, depending on interests of students and staff. Advanced and special topics of current interest such as theory of superconductivity, resonance phenomena and applications, plasma dynamics; advanced treatment of topics discussed in PHY 555, 562.

*Each semester, 3 credits per semester, repetitive credit*

### PHY 684 Special Topics in Nuclear Physics

Subject matter varies from semester to semester, depending on interests of students and staff. Current advanced topics in nuclear physics such as collective phenomena, nuclear reaction mechanisms.

*Each semester, 3 credits per semester, repetitive credit*

### PHY 686 Special Topics in Elementary Particle Physics

Subject matter varies from semester to semester, depending on interests of students and staff. Advanced and special topics of current interest.

*Each semester, 3 credits per semester, repetitive credit*

### PHY 688 Special Topics in Astrophysics

Subject matter varies from semester to semester, depending on interests of students and staff. Advanced and special topics of current interest.

*Each semester, 3 credits per semester, repetitive credit*

### PHY 699 Thesis Research

Independent research for Ph.D. degree. Open only to candidates for the Ph.D. who have passed preliminary examination.

*Each semester, variable and repetitive credit*

## PSYCHOLOGY

*Professors:* KALISH *(Chairman)*, KRASNER,[a] PETRINOVICH, WYERS

*Associate Professors:* BRAMEL, GOLDFRIED[b], M. LEVINE, SINGER

*Assistant Professors:* DAVISON, D'ZURILLA, EISENSTEIN, KATZEV, POMERANZ, M. SMITH, WEISS, YOUNG

### Admission to Graduate Study

Undergraduate requirements for admission shall normally include:

A. A baccalaureate degree in Psychology.

B. An average of 3.0 in all undergraduate course work.

C. Letters of recommendation from three instructors or academic advisors.

D. Results from the Graduate Record Examination.

E. Acceptance by the Department of Psychology and the Graduate School.

Students who do not meet these requirements may also apply if they feel that special circumstances should be considered.

### Requirements for the Degree

The award of the Ph.D. Degree in Psychology is intended to signify both a scholarly mastery of the field of Psychology and the ability to conduct independent research.

*Residence*

Minimum residence required is two years including at least two consecutive semesters of full-time study. Full-time study is defined as twelve credits per semester, except for teaching or research assistants for whom full-time study is nine credits per semester.

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[a]Director of Clinical Training.
[b]Director of Psychological Services.

*Language Proficiency*

Proficiency in translating one foreign language must be demonstrated before the student is admitted to the Specialty Examination. Ability to translate technical literature in either French, German, or Russian is the criterion for satisfaction of the requirement. Substitution of any other language requires special departmental permission.

*First Year Evaluation*

The progress of each first year graduate student is reviewed at the end of the academic year by the entire faculty. The purpose of this review is to allow the student to withdraw without an unusually heavy investment of time when, in the opinion of the Department, the student would not pass the preliminary examination at the Ph.D. level or produce a suitable dissertation. Any student whose performance is below the standard for the Ph.D. established by the Department of Psychology may be asked to withdraw. Under certain circumstances a student may be permitted to obtain a terminal Master of Arts degree after passing the Preliminary Examination at the M.A. level, satisfactorily completing the quantitative methods course, and the learning course, completing 30 semester hours of study culminating in an M.A. thesis.

*Preliminary Examination*

The Preliminary Examination ordinarily must be completed by the end of the third semester of graduate study and consists of two parts: (1) The General, and (2) the Specialty Examination. The General Examination, covering basic knowledge in the principal areas of Psychology, is the same for all students. The Specialty Examination is constructed individually for each student depending upon the area of specialization.

*Degree Candidacy*

Upon successful completion of the Language Requirement and the Preliminary Examination, the student is admitted to candidacy for the Ph.D.

## Courses

### PSY 501 Quantitative Methods I

This course presumes a knowledge of basic statistical methods. Emphasis will be on scaling, measurement, psychophysics, and curve fitting.

*Fall, 3 credits*

### PSY 502 Quantitative Methods II

Inferential statistics, correlation, and advanced statistical techniques which have special usefulness in psychological research including complex analysis of variance, trend analysis, and analysis by orthogonal polynomials.

*Spring, 3 credits*

### PSY 511 Learning

A consideration of the basic principles of learning. Analysis of the leading theories of learning, as well as areas of controversy and dispute.

*Fall, 3 credits*

### PSY 512 Learning

A continuation of Psychology 511 which stresses the application of learning theories and principles.

*Spring, 3 credits*

### PSY 521, 522 The Development of Behavior and Behavior Deviation

A consideration of contemporary theories and research in the area of personality, deviant behavior, and the social labeling process. Techniques of psychological measurement and assessment as they relate to both theoretical formulations and to specific clinical problems involving assessment and modification of behavior. This course will be taught in conjunction with Practicum, PSY 531, 532.

*Fall and Spring, 3 credits each semester*

### PSY 531, 532 Practicum in Testing and Behavioral Observation Techniques

Experience in testing and diagnosis will be provided through the cooperation of clinics, hospitals, and schools outside the University.

*Fall and Spring, 1 credit each semester*

### PSY 535 Theories and Applications of Psychotherapy and Behavior Modification

Thorough delineation of the leading schools of Psychotherapy. Emphasis on therapeutic techniques derived from modern learning theory and social psychological theory. Study of the relationship of theories of psychotherapy to models of deviant behavior and to assessment procedures. PSY 545 will be accompanying Practicum.

*Fall, 3 credits*

### PSY 536 Special Techniques in Behavior Modification

Presentation and discussion of materials on special techniques of modifying human behavior such as behavior therapy, hypnosis, family therapy, non-directive, and other special techniques. Included are films, tape recordings, and demonstrations. Material will be related to case materials available through Practicum, PSY 546.

*Spring, 3 credits*

### PSY 545-546 Behavior Change Laboratory and Practicum

Experience and training will be provided in the area of psychotherapy conceptualized as a method for inducing change in behavior. Emphasis will be placed on practice in modes of behavior change.

*Fall and Spring, 1 credit each semester*

**PSY 550 Social Psychology**

Theories, methods, and data relevant to human behavior and cognition in interpersonal contexts. Consideration will be given to such topics as belief and attitude change, aggression and altruism, development of the self concept.

*Spring, 3 credits*

**PSY 561, 562 Physiological Psychology**

The relationship between behavior and biological processes. Emphasis on the neural and humoral systems and their role in behavior. The laboratory will provide experience in operative electrophysiological and pharmacological procedures.

*Fall and Spring, 3 credits*

**PSY 571 Comparative Psychology**

Behavior differences among species as related to the species' position in the phylogenetic scale. The relation of changes in complexity and plasticity of behavior to changes in the sensory, motor, and neural structures.

*Fall, 3 credits*

**PSY 603, 604 Practicum in Clinical Procedures**

Third and fourth year students will be placed in settings designed to broaden their clinical experience.

*Variable and repetitive credit each semester*

**PSY 610, 620 Seminars in Selected Topics**

Topics will be selected on the basis of the needs of the graduate program and the research interest of the staff. The seminars will consider such topics as The Physiological Bases of Higher Mental Processes, Sensory Processes, Animal Behavior, Psychopharmacology, Theories and Problems of Learning, Social Psychology, and Computer Applications in Psychology.

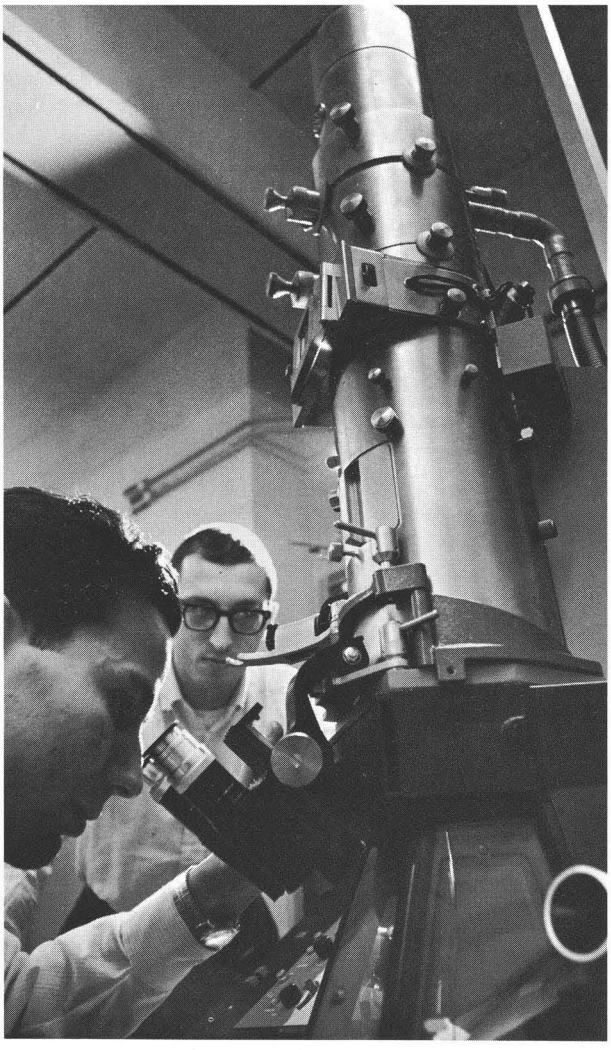
*Variable and repetitive credit each semester*

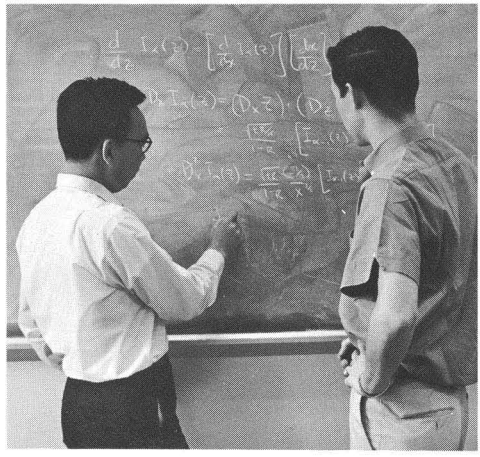
**PSY 698 Research**

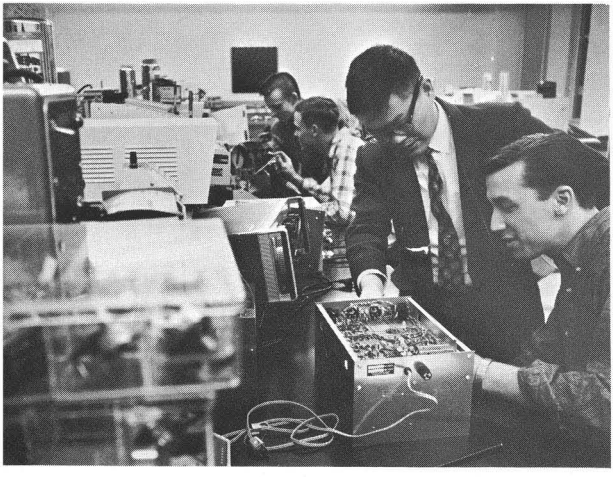
*Variable and repetitive credit each semester*

**PSY 699 Doctoral Research**

*Variable and repetitive credit each semester*







# GRADUATE PROGRAMS IN ENGINEERING

The College of Engineering offers graduate study with degrees leading to the M.S. and Ph.D. The College consists of four academic departments offering graduate programs, each under the direction of a chairman. The graduate program chairmen and the Dean of Engineering comprise the Graduate Executive Committee which reviews all student applications and approves the enrollment of the graduate student in one of the programs best suited to his background and interests.

### Admission to Graduate Study

For admission to graduate study in engineering, the minimum requirements are as follows:

A. A B.S. degree in Engineering or a closely related area from an accredited college or university.

B. A minimum grade average of at least B in all courses in engineering, mathematics and science courses.

C. Acceptance by the Graduate Executive Committee and the Graduate School.

### Requirements for the M.S. Degree

A. Residence: One academic year on a full-time basis.

B. Formal Course Requirements: At least twenty-four credits. The faculties of individual graduate programs may impose additional course requirements. In addition, the grades in courses totaling at least eighteen credits must be B or better and the average grade for all courses taken must also be B or better. Also, the faculties of the various programs may require certain courses to be taken by the candidates.

C. Satisfactory completion of a thesis in the student's area of specialty. An Oral Examination on the thesis may be required by the faculties of any graduate program.

D. Admission to Candidacy: The status of Candidate for the Master of Science degree is conferred upon the student by the Dean of the Graduate School upon the recommendation of the faculty of the graduate program and the Dean of Engineering. The student is eligible for candidacy only after he fulfills his residency requirements. The recommendation will be based upon the records submitted at the time of admission and performance in formal course work.

E. Final recommendation: Upon the fulfillment of the above requirements the faculty of the graduate program will recommend to the Dean of the Graduate School through the Graduate Executive Committee, that the Master of Science degree be conferred or will stipulate further requirements that the student must fulfill.

**Requirements for the Ph.D. Degree**

A. Residence: Two academic years on a full-time basis.

B. Languages: A reading ability in two foreign languages relevant to the student's field of interest is required. The student's choice of languages must be approved by his research advisor.

C. Qualifying examination: Students must satisfactorily pass a qualifying examination to ascertain their ability to study for the Ph.D. degree. This examination shall precede the preliminary examination by a minimum of two semesters.

D. Plan of work: Upon successful completion of the qualifying examination, and one year of full-time residence the student must select a research advisor who agrees to serve in that capacity. The student will then prepare a plan of further course work and a tentative thesis topic. These must receive the approval of the student's advisor and the faculty of the graduate program.

E. Preliminary examination: Upon completion of the course work and language requirements a comprehensive oral examination,

which may be supplemented by a written examination, will be given to the student.

F. Admission to Candidacy: After the student has successfully passed the preliminary examination he is eligible to be recommended for admission to candidacy. This status is conferred by the Dean of the Graduate School upon recommendation of the Chairman of the graduate program.

G. Thesis: The most important requirement of the Doctor of Philosophy degree is the completion of a thesis which must be an original scholarly investigation. The thesis shall represent a significant contribution to the scientific literature and its quality shall be compatible with the publication standards of appropriate and reputable scholarly journals.

H. The student shall defend his thesis before an examining committee. On the basis of the recommendation of this committee, the Graduate Executive Committee will recommend acceptance or rejection of the thesis to the Dean of the Graduate School. All requirements for the degree will have been satisfied upon the successful defense of the thesis.

## APPLIED ANALYSIS

*Professors:* CHANG, FINERMAN, GELERNTER, GERST (*Chairman*), ROSEN, ZEMANIAN

*Associate Professors:* BELTRAMI, DENHAM, DICKER, DOLLARD, LEIBOWITZ, TEWARSON, THAMPURAN

*Assistant Professor:* JOSEPH

Requirements for the M.S. and Ph.D. degrees are listed on pages 75-77.

The graduate program of this department provides a course of study in modern applied mathematical techniques with a view to their utilization in the engineering or scientific disciplines. The course offerings and the research program cover both the theories and principles which are common to the applications as well as the more specialized methods which arise in specific areas. As part of this program, this department has instituted a co-operative project with the Department of Electrical Sciences for the development of specializations in the fields of automatic control theory, network theory, and statistical communication theory.

Faculty research programs currently in progress include studies in network analysis and synthesis, transformation calculus, control theory, information theory, numerical methods, distribution theory, approximation theory, diffusion methods, vibrations, random processes, signal detection, wave propagation, stochastic differential equations, and programming languages and systems.

### Courses

*Advanced Undergraduate Course*

**ESA 316 Special Functions of Applied Analysis**

*3 credits*

*Graduate Courses*

**ESA 501 Analysis of Linear Systems I**

Propagation problems in discrete systems, integral transform techniques, system functions, convolution, applications of complex variables, stability.

*3 credits*

**ESA 502 Analysis of Linear Systems II**

Propagation problems in continuous systems, solution of partial differential equations by transform techniques, asymptotic relations, iterative structures, sampled-data systems, z-transform, systems with memory.

*3 credits*

**ESA 503 Principles of Applied Analysis I**

Equilibrium and characteristic value problems in discrete engineering systems. Development and application of pertinent material from the following subjects: matrix calculus,

linear vector spaces, transformation theory and spectral decomposition, extremum principles, numerical methods.

*3 credits*

### ESA 504 Principles of Applied Analysis II

Equilibrium and characteristic value problems in continuous engineering systems. Development and application of pertinent techniques from the following subjects: Sturm-Liouville theory, orthogonal functions, special functions, variational principles, integral equations, Green's function, conformal mapping, theory of characteristics, analytical and numerical methods of solution.

*3 credits*

### ESA 505 Probability Theory and Applications

Measure-theoretic basis of probability. Fourier transforms. Generating functions. Sums of independent random variables. Limit theorems. Martingales. Markov processes and their connection with differential and integral equations, potentials. Applications to random walk and ruin problems, information theory and coding, statistical mechanics, problems of strategy and decision-making, queueing problems, extinction of populations.

Prerequisite: ESA 320 and a knowledge of Measure Theory and Integration, or the equivalent.

*3 credits*

### ESA 506 Statistics

Probability theory. Probability distributions and generating functions. Statistical inference. Small sample theory. Tests of hypotheses. Distribution-free methods. Applications to processing and interpretations of engineering and industrial data, design of experiments, quality control, sequential analysis, decision functions, reliability studies, curve fitting, estimation of response relationships, time series, optimization techniques, factor analysis.

Prerequisite: ESA 321 and a knowledge of Lebesgue Integration, or the equivalent.

*3 credits*

### ESA 510 Introduction to Applied Analysis

An introductory course for the purpose of developing certain concepts and techniques which are fundamental in modern approaches to the solution of applied problems. Topics germane to the applications are selected from the fields of topology, real variables, integration theory, Hilbert and Banach spaces. Students intending to take ESA 505, 623 or 628 are advised to take this course first.

*3 credits*

### ESA 511 Complex Variable Theory with Applications

A study of those concepts and techniques in complex variable theory which are of interest for their engineering applications. Pertinent material is selected from the following topics: complex algebra, analytic functions, harmonic functions, integration in the complex plane, Taylor and Laurent expansions, singularities, calculus of residues, entire and meromorphic functions, conformal mapping. Application is made to problems in heat conduction, potential theory and fluid mechanics.

*3 credits*

### ESA 515 Non-Linear Systems

Basic non-linear differential equation theory. Analytical, graphical and approximation techniques for studying the behavior of non-linear engineering systems. Application of phase plane and describing function techniques.

*3 credits*

### ESA 524 Theory of Approximation

A survey of various engineering situations which present special problems in approximation theory, followed by an extensive development of methods for treating these problems. Topics covered include: smoothing of data, least-squares methods, Chebyshev approximation, approximation by rational functions, orthogonal functions, Hilbert space methods, general aspects of approximation in normed linear spaces.

*3 credits*

### ESA 526 Numerical Analysis I

Simultaneous linear equations, matrix inversion, eigenvalues, linear programming, error analysis.

*3 credits*

### ESA 527 Numerical Analysis II

Ordinary differential equations, integral equations, partial differential equations of elliptic, parabolic and hyperbolic type.

*3 credits*

### ESA 531 Tensor and Group Methods in Applied Analysis

This course provides an introduction to the powerful methods of tensor and group theory with applications to engineering and physics. Commencing with a review of linear vector spaces, the course then proceeds to tensor algebra, tensor calculus with applications to dynamics, elasticity, electromagnetic theory and relativity, group properties of transformations and group representation with physical applications.

Prerequisite: Elementary Matrix Algebra.

*3 credits*

### ESA 535 Principles of Dynamic Optimization

The course is concerned with the derivation and the application of the principles of dynamic optimization. The major portion of the course is devoted to a thorough exposition of the calculus of variations. Following this introduction the modern system theoretic approaches to optimization, Pontryagin's maximum principle, and dynamic programming and the principle of optimality, are discussed in the context of being extensions of the classical theory. Finally, the underlying theory is applied to system theoretic problems of current interest: system synthesis; optimal control theory; system identification; filtering and prediction; mechanics. No previous knowledge of the calculus of variations is required; however, a working familiarity with matrices and ordinary differential equations is desirable.

*3 credits*

### ESA 541, 542 Network Theory

Fundamental properties of electrical networks are examined, such as linearity, time-invariance, passivity, causality, and stability. Their relationship to the concept of positive-reality and its generalizations is developed. Quadratic forms, energy functions, and Lagrange's equations are discussed.

The time-domain implications of these results are next considered. The Boehner-Schwartz theorem on positive-definiteness and Bernstein's theorem on complete-monotonicity are derived and applied to obtain realizability criteria for impulse response matrices. The transfer functions corresponding to non-decreasing step functions are also analyzed.

Finally, the scattering matrix is developed and applied to an analysis of various types of degenerate networks.

*3 credits per semester*

### ESA 543, 544 Network Synthesis

General properties of network functions in the complex frequency plane and at real frequencies, Hurwitz polynomials and positive-real functions. Equivalent and reciprocal networks. Synthesis of passive one-ports; two-element kind networks, RLC networks. Realizability criteria for passive two-ports. Synthesis of transfer immittances. Transfer function synthesis. Image-parameter techniques. Lattice, ladder and other unbalanced configurations. N-port realizability theory. Realization techniques using active elements.

*3 credits per semester*

### ESA 551 Feedback Control Systems I

This course is identical with ESE 541.

*3 credits*

### ESA 552 Feedback Control Systems II

This course is identical with ESE 542

*3 credits*

### ESA 554 Information Theory

A systematic development of the concepts and facts of information theory. Definition of a measure of information and study of its properties. Optimum coding and the noiseless coding theorem. Transmission in the presence of random disturbances. Theorem on capacity and reliable transmission. Error correcting codes. The binary symmetric channel. Applications to communication and thermodynamics.

*3 credits*

### ESA 555 Introduction to Communications Principles

This course is identical with ESE 530.

*3 credits*

### ESA 561 Vibrations

Principal modes and natural frequencies of discrete and continuous systems. Forced vibrations, dissipative continua. Stability analysis. Introduction to non-linear vibrations.

*3 credits*

### ESA 563 Hydrodynamics

The mathematical theory of inviscid fluid motions. Irrotational motion, flow nets, conformal mapping, Schwarz-Christoffel transformation. Applications to subterranean flow and surface waves, aerodynamics, hydrodynamic stability.

*3 credits*

### ESA 564 Cavity Flows

A brief review of the hydrodynamics of free-streamline flows. The Helmholtz and Riabouchinsky cavity flow models are studied and applied to physical problems. Unsteady cavity flows are solved by means of perturbation methods. Existence and uniqueness of solutions are discussed.

Prerequisites: ESA 563—ESA 505 or their equivalent.

*3 credits*

### ESA 565 Wave Propagation I

This course is identical with ESE 520.

*3 credits*

### ESA 566 Wave Propagation II

This course is identical with ESE 521.

Prerequisite: ESA 565.

*3 credits*

### ESA 567 Wave Propagation in Plasma

This course is identical with ESE 522.

*3 credits*

### ESA 580 Algorithmic Languages and Compilers

FORTRAN, PL-1, and ALGOL and the techniques used in their compilation. Study of syntax, semantics, ambiguities, procedures, replication, iteration and recursion in these languages.

*3 credits*

### ESA 599 Research

*Variable and repetitive credit*

### ESA 607 Stochastic Processes

Processes with mutually independent, uncorrelated or orthogonal random variables. Markov processes. Martingales. Processes with independent or orthogonal increments. Stationary processes. Prediction. Applications to biology, quantum theory, numerical analysis, statistical physics, nuclear fission, astronomy and astrophysics, chemical reactions.

Prerequisite: ESA 320 and a knowledge of Measure Theory and Integration, or the equivalent.

*3 credits*

### ESA 621 Advanced Operational Methods in Engineering Systems

An advanced course in the application of operator techniques to the analysis of engineering systems. Topics covered include: the general integral transform, Hilbert, Hankel and Mellin transforms, finite transforms, Wiener-Hopf technique, generating functions, asymptotics, Mikusinski operational calculus.

*3 credits*

### ESA 623 Distribution Theory and Its Applications I

Spaces of testing functions and distribution. The calculus of distributions. Distributions as derivatives of continuous functions. Direct product, convolution, and convolution algebras. The distributional Fourier and Laplace transformations. Applications to the analysis of linear systems.

*3 credits*

### ESA 624 Distribution Theory and Its Applications II

Heaviside operators defined on the system of distributions vanishing on the negative semi-axis. Systems of integro-differential equations with constant coefficients; the classical and distributional solution. Generalized Volterra's

operators. Systems of integro-differential equations with variable coefficients; properties of the solutions.
*3 credits*

**ESA 625 Advanced Boundary Value Problems in Engineering Systems**

Linear operators on a Hilbert space and their spectra; applications to self-adjoint boundary value problems and Fredholm theory. The boundary behavior of Cauchy integrals in the usual and distributional sense is studied to provide a unified approach to certain problems in engineering analysis: Plemelj formulas, singular integral equations, and the Wiener-Hopf and Hilbert problems; Hilbert transforms.
*3 credits*

**ESA 628 Functional Analysis I**

Metric and Banach spaces and their applications to engineering problems. Completeness, contraction mappings, compactness and Arzela's theorem. Linear spaces and manifolds, norms, continuous linear functionals, dual spaces, Hahn-Banach theorem, reflexivity, weak convergence. Applications to linear engineering systems are given.

Prerequisite or Corequisite: ESA 503.
*3 credits*

**ESA 629 Functional Analysis II**

Hilbert space, orthogonality, orthonormal expansions, Riesz-Fischer theorem, self-adjoint operators. Topological linear spaces, seminorms, continuous linear functionals, dual spaces, weak and strong topology. Applications to the foundations of physical system theory and generalized networks.

Prerequisite: ESA 628.
*3 credits*

**ESA 657 Optimum Design of Feedback Control Systems I**

This course is identical with ESE 543.
*3 credits*

**ESA 658 Optimum Design of Feedback Control Systems II**

This course is identical with ESE 544.
*3 credits*

**ESA 659, 660 Non-Linear Systems and Optimal Control I and II**

Stability analysis and design of non-linear systems by describing function method. Perturbation analysis. State equation of non-linear systems. Phase plane and phase space methods. Stability theorems and Liapunov functions. Pontryagin's maximum principle and applications. Bang-Bang and Pang-Bang systems. Dynamic programming and digitized maximum principle.
*3 credits per semester*

**ESA 691 Seminar in Applied Analysis**

Supervised reading and discussion of current journal publications in applied analysis.
*3 credits*

**ESA 699 Research**

*Variable and repetitive credit*

In addition to the courses listed above, it is expected that the following graduate courses will be offered in the near future:

Methods of Operations Research
Variational Methods
Theory of Elasticity
Approximate Methods in Engineering Boundary Value Problems
Graph Theory
Sampled-Data Engineering Systems
Electronics and Active Circuits, I and II
Logic and Switching Circuits
Analogue Computers
Topics of Applied Analysis

## ELECTRICAL SCIENCES

*Professor:* CHANG *(Chairman)*

*Associate Professors:* DOLLARD, KIEBURTZ, MARSOCCI, D. SMITH

*Assistant Professor:* TUAN

Requirements for the M.S. and Ph.D. degrees are listed on pages 75-77.

The Department of Electrical Sciences offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. These programs are designed to provide the student with a firm background in fundamental principles of analysis and synthesis on which to base further independent study. Ample opportunities exist for students to become involved in both experimental and theoretical research.

Some of the research areas currently being investigated by faculty members and graduate students include: optimal control theory, digital communications techniques, pattern recognition by computers, synthesis of logic networks, electronic transport phenomena in solids, frequency-independent antennas, wave propagation in random media, and electromagnetic waves in gaseous plasmas.

### Graduate Courses

#### ESE 510 Physical Electronics

The theory of electronic processes and devices. Electron ballistics. Statistics. Emission of electrons. Gaseous conduction. Vacuum electronics. Solid-state electronics, conduction in solids, solid-state devices, transistors, microelectronic circuits, energy converters; magnetism; dielectrics, ferroelectrics, introduction to superconductivity and cryotrons. Elementary theory of masers and lasers.

*3 credits*

#### ESE 511 Solid-State Electronics I

A study of the transport processes in metals and in semiconductors leading to the analysis and design of solid-state devices. Electronic energy-band structure, the Fermi surface, electrical and thermal conductivities, scattering mechanisms, diffusion, galvanomagnetic, thermoelectric and thermomagnetic effects; conduction mechanisms in semiconductors, the continuity equation, p-n junction theory, theory of the junction transistor, transistor characterization.

*3 credits*

#### ESE 512 Solid-State Electronics II

Surface phenomena, conductivity of thin films, microelectronic devices and related circuits. Hall-effect and magnetoresistance devices; theory of magnetism and magnetic devices. Tunnelling phenomena and tunnel devices. Elements of superconductivity and applications. Optical properties of materials and photoelectric devices.

*3 credits*

### ESE 520 Wave Propagation I

Theory of propagation of vector and scalar waves in bounded and unbounded regions. Equivalence theorems of field theory. Development of methods of geometrical optics. Propagation in inhomogeneous and in anisotropic media. Green's function for boundary-value problems.

*3 credits*

### ESE 521 Wave Propagation II

Mode theory of guided waves. Expansion of wave functions in eigen-function series. Applications to propagation of electromagnetic waves in waveguides and around the earth. Propagation on periodic structures, and consequences of higher order symmetries. Operators with a continuous spectrum. Evaluation of radiation integrals by the method of steepest descent.

Prerequisite: ESE 520.

*3 credits*

### ESE 522 Wave Propagation in Plasma

The course includes the following topics: introduction to the magnetoionic theory and plasma kinetic theory, wave propagation in unbounded plasma, guided waves at a plane plasma interface and its application to terrestrial propagation, radiation from antennas in plasma.

*3 credits*

### ESE 530 Introduction to Communications Principles

The basic model of communications systems. Modulation and detection. AM, FM, PM; DSB, SSB and vestigial sideband modulation. FM with feedback. Gaussian noise, signal to noise ratio, and threshold effects in continuous wave systems. The sampling theorem. PAM, PPM, and PCM systems. Quantization noise. Statistical properties of signals. Compandors, vocoders and TASI. Space-, time-, and frequency-division multiplexing. Interference. Distortion. Subjective versus objective criteria of quality. The course emphasizes the underlying theory of the various communications techniques, rather than specific implementation. A major objective is to establish the relative importance of digital techniques in current communications practice, and to indicate some of the reasons why direct application of the more sophisticated theory has been most successful in digital systems.

*3 credits*

### ESE 531 Theory of Digital Communications I

This is the first course of a two-course sequence. It begins with a brief review of probability theory leading to derivation of the Chernoff bound and the Central Limit Theorem. There follows a review of random variables, random processes, and vector (multivariate) random variables and processes. The concepts of entropy and the measure of information, and the basic theorem of noiseless coding are introduced to justify the restriction of subsequent development of the theory to the case of independent equiprobable sources. Further topics include the vector model of digital communications systems, waveforms as vectors, time-bandwidth and dimensionality, the correlation receiver, matched filtering, probability of error and bounds thereon, and efficient signalling schemes. A course in basic probability theory or demonstration of familiarity with the basic concepts of probability is required. Introduction to Communications Principles and/or Random Processes are desirable but not prerequisite.

*3 credits*

### ESE 532 Theory of Digital Communications II

The course is a direct continuation of Theory of Digital Communications I. It begins with a proof of the Theorem of Channel Capacity. The concept of encoding for error protection is introduced as a special case of vector signals. Further topics include the basic algebraic structure of linear codes, block and sequential codes, random linear codes, cyclic codes and their implementation, the fading channel, unidirectional versus feedback communication, and the tradeoffs of rate for reliability. The course concludes with some further theorems of information theory and a discussion of the information theoretic versus the communication theoretic approach to the general problem of digital communications.

Prerequisite: ESE 531 Theory of Digital Communications I.

*3 credits*

### ESE 540 Introduction to System Theory

State variable representation of continuous and discrete systems, feedback and stability, linear system and superposition, impulse response and integral representation, autonomous systems and transfer functions. Routh, Nyquist, and Lyapunov stability.

*3 credits*

### ESE 541 Feedback Control Systems I

Analysis and synthesis of continuous and discrete systems, Nyquist and Bode plots, root locus method, multiple loop systems, synthesis through pole-zero configurations, compensation of continuous and sampled systems.

*3 credits*

### ESE 542 Feedback Control Systems II

Stability analysis and design of non-linear systems by describing function method. Perturbation analysis. State equation of nonlinear systems. Phase plane and phase space methods. Stability theorems and Lyapunov functions.

*3 credits*

### ESE 543, 544 Optimum Design of Feedback Control Systems I and II

System design by minimization of integral square error with constraint. Root square locus method. Analysis of random processes including power spectrum, correlation functions and Weiner's theorem. Statistical design theory of continuous and sample systems. Interpolation, extrapolation, filtering and prediction of continuous and sample data. Optimum filtering and control of nonstationary systems. Pontryagin's maximum principle and applications. Bang-Bang and Pang-Bang systems. Dynamic programming and generalized maximum principle.

*3 credits each semester*

### ESE 550 Theory of Switching Circuits

This course introduces the theory of switching circuits and their application in design of digital computers. Included are a review of switching devices, algebra of switching circuits, methods of reduction of switching functions, and an introduction to combinational and sequential switching circuits.

*3 credits*

### ESE 551 Advanced Switching Theory

This course provides an introduction to modern techniques for analysis and synthesis of switching networks. Among topics included are a summary of classical combinational synthesis, theories of functional decomposition, threshold logic, adaptive logic, linear sequential switching circuits and general sequential circuits.

*3 credits*

### ESE 599 Research

*Variable and repetitive credit*

### ESE 610 Seminar in Solid-State Electronics

A course designed primarily for the student who is, or expects to be, involved in solid-state research. The subject matter presented is designed in any given semester to support the research interests of the staff and the students involved.

*3 credits*

### ESE 620 Seminar in Electromagnetic Theory

Current research problems in electromagnetic wave propagation and antennas.

*3 credits*

### ESE 630 Seminar in Communications Theory

*3 credits*

### ESE 640 Seminar on Systems Theory

Recent and current research work in systems theory.

*3 credits*

### ESE 650 Seminar in Computer Sciences

Current research topics in logical design, machine learning, and self-organization.

*3 credits*

### ESE 699 Research

*Variable and repetitive credit*

## MATERIAL SCIENCES

*Professors:* S. LEVINE *(Chairman)*, SEIGLE

*Associate Professors:* JACH, F. WANG

*Assistant Professors:* JAIN, MUKHERJEE, R. ROSENBERG, SIEGEL

Requirements for the M.S. degree are listed on pages 75-77.

The motivating philosophy of the graduate program offered by the Department of Material Sciences is that of providing the student with a broad synthesis of the theoretical and experimental techniques required for work with all classes of materials. Emphasis is placed on courses which unify the field in terms of fundamentals treated with sufficient depth to prepare the student for work in diverse areas of materials science and technology. Current research interests of the faculty lie in the areas of polymer-interface interaction, chemical reactivity at lattice imperfections, point defects in metals, mechanism of crack propagation in solids, band theory of metals and semimetals, thermodynamics of solids, and mechanisms of solid-state reactions. Both theoretical and experimental research are conducted.

### Courses

*Advanced Undergraduate Courses*

**ESM 325 Diffraction Techniques and the Structure of Solids**

**ESM 326 Quantum Theory of Matter**

**ESM 327 Semiconductor Theory and Technology**

**ESM 328 Nuclear Technology and Materials**

*Graduate Courses*

**ESM 501 Advanced Survey of Materials Sciences I**

This course provides an advanced survey of the principles underlying the behavior of engineering materials to serve as preparation for further study in materials sciences. Topics include structure of solids, solid solutions, liquids, review of thermodynamic principles, phase relationships, heterogeneous equilibria, electrochemical principles, with applications to corrosion.

*3 credits*

### ESM 502 Advanced Survey of Materials Sciences II

This course is a continuation of the above and includes an introduction to diffusion and reaction kinetics in solids with practical applications, principles of classical and quantum statistical thermodynamics, partition functions, relationship between partition functions and thermodynamic properties of solids, equation of state of solids order-disorder transitions, theory of irreversible processes with applications.

*3 credits*

### ESM 509 Thermodynamics of Solids

The thermodynamic functions for various types of engineering solids are considered in relation to structure and atomic interaction. Current knowledge regarding the thermodynamic properties of solids is reviewed. This knowledge is applied to the thermodynamic analysis of phase equilibria, phase transitions, oxidation, and other reactions of practical importance in engineering solids.

*3 credits*

### ESM 511 Imperfections in Crystals

Characteristics of point defects, equilibrium concentrations, generation processes, mobility, effects on physical properties. Introduction to dislocation theory and grain boundary structures. Irradiation damage and annealing processes.

*3 credits*

### ESM 512 Strength and Plasticity of Solids

Advanced dislocation theory, anisotropy of deformation, theories of yielding, flow, and fracture of materials. Application to relaxation processes, embrittlement, and mechanical testing procedures.

*3 credits*

### ESM 515 Reactions in Engineering Solids I

This course provides an advanced treatment of the important reactions in engineering solids: diffusion phenomena and mechanisms in solid elements and compounds; influence of structure and composition, Kirkendall effect and vacancy condensation. Kinetics and mechanisms of oxidation and analogous layer growth reactions. Sintering of metals, ceramics and other solids. Application to high temperature materials, powder metallurgy, ceramics, and polymers.

*3 credits*

### ESM 516 Reactions in Engineering Solids II

Continuation of ESM 515 to the theory of phase transformations in condensed phases: interface energy, heterophase fluctuations, theory of nucleation, phenomenological analysis of nucleation and growth, first and second order phase changes, diffusionless transformations. Application to melting and solidification, crystal growth, grain growth, precipitation, order-disorder phenomena, and other transformations in solids.

*3 credits*

### ESM 530 Physical Properties of Polymers I

This course provides an advanced study of the physical and physical chemical principles underlying the behavior of polymers. Topics include an introduction to the statistical thermodynamics of polymers, X-ray and spectroscopic techniques and their use in structural studies, thermodynamics of polymer solutions, light scattering techniques, theory of viscosimetry and osmometry. Practical applications are emphasized.

*3 credits*

### ESM 531 Physical Properties of Polymers II

Continuation of ESM 530 to such topics as viscoelasticity, flow, and diffusion of polymers; sedimentation theory and ultraconfiguration, electrostatic free energy and the statistical mechanics of poly-electrolytes, electrophoresis theory and techniques, configuration of polymers in solution, catalysis by macromolecules.

*3 credits*

### ESM 533 Radioisotopes in Materials Studies

This course is primarily a laboratory one which stresses the utilization of radioactive isotopes in the study of a variety of materials problems such as wear testing, thickness gauging, electrodeposition, chemical reactivity of solids, etc.

*3 credits*

### ESM 535 Physical Properties of Crystals

The anisotropic properties of crystals treated by tensor and matrix methods with applications to paramagnetism, conduction, diffusion, thermoelectricity, deformation and elastic constants, piezoelectricity, optical properties. The effects of crystal symmetry and the properties of aggregates are discussed.

*3 credits*

### ESM 540 Advanced Techniques of Materials Research I

Theory and laboratory demonstrations of modern techniques for the preparation and characterization of engineering materials such as high vacuum and high temperature techniques, cryogenic procedures, crystal growth and zone melting techniques.

*3 credits*

### ESM 541 Advanced Techniques of Materials Research II

Continuation of ESM 540 to the theory and demonstration of spectroscopic methods, diffraction techniques, electron microscopy, and other methods for the examination of materials.

*3 credits*

### ESM 550 Statistical Theory of Matter

The principles of statistical mechanics are systematically developed and applied to analysis of the properties and behavior of engineering materials. Topics include a discussion of Fermi-Dirac and Bose-Einstein distributions, ideal and real gases, theory of electrolytes and non-electrolytic solutions, rate processes and transport phenomena.

*3 credits*

### ESM 599 Research

*Variable and repetitive credit*

### ESM 603 Surfaces and Interfaces I

A large part of technology depends on the properties of surfaces and interfaces. This course explores the application of physical and chemical principles to the study of surface behavior. The following topics are included: thermodynamics of surfaces, surface bonds, interfacial tension, properties of monolayers, surface potentials, surface conductance, electrokinetic phenomena, adsorption at liquid interfaces and solids, reactivity at interfaces, theory of corrosion and oxidation, structural defects and interfacial behavior.

*3 credits*

### ESM 604 Surfaces and Interfaces II

This course is the second half of ESM 603 and includes the physics of semiconductor surfaces and thin films with applications, chemadsorption and catalysis, membrane phenomena, mass transport through surfaces, applications to adhesion, friction, lubrication, wear, wetting and detergency; stability of colloids, emulsions, foams, smog and pollution, ion exchange, chromatography.

*3 credits*

### ESM 614 Quantum Theory of Atoms and Molecules

This course introduces the modern theory of engineering materials covering such topics as principles of quantum mechanics, linear operators and their matrix representation, perturbation theory, Thomas-Fermi approximation and the Hartree Foch method. Applications to atomic and molecular structure, optical spectra and intermolecular forces are emphasized.

*3 credits*

### ESM 615 Electron Theory of Solids

Band theory of solids, Brillouin zones, Fermi surface in metals, alloys and semiconductors, galvanomagnetic effects, optical properties, magnetism, lattice vibrations and thermal

properties of solids. Applications to magnetoresistance, Hall effect and thermoelectric devices, photoconductors and luminiscent materials, metal-semiconductor contacts and the photovoltaic effect.

*3 credits*

### ESM 616 Advanced Topics in Solids

Selection is made from topics such as: shape of the Fermi surface in metals, theory of de Haas van Alphen effect, cyclotron resonance, anomalous skin effect, magnetoplasma wave propagation, acoustic attenuation. Energy bands in semiconductors and spin resonance; impurity states, optical absorption and excitons. Theory of alloys, neutron diffraction by crystals, Mossbauer effect.

*3 credits*

# MECHANICS

*Professors:* BERLAD *(Chairman)*, BRADFIELD, CESS, IRVINE

*Associate Professors:* KRAUS, R. S. LEE, O'BRIEN, TASI

*Assistant Professors:* HARRIS, L. WANG

Requirements for the M.S. and Ph.D. degrees are listed on pages 75-77.

The Department of Mechanics offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. The Department offers a broad program emphasizing fundamental knowledge in the basic academic areas of heat transfer, thermodynamics, and fluid mechanics. Faculty research interests include convective and radiative heat transfer, magnetohydrodynamics, statistical mechanics, gas dynamics, turbulence and experimental techniques. In each area students are encouraged to participate in research.

## Graduate Courses

### ESC 501, 502 Advanced Heat Transfer

Thermal boundary layers in forced and free convection, heat transfer in internal flows, two-phase boundary layer flows. Thermal radiation, formulation of radiation problems in terms of integral equations, radiant transfer with absorbing-emitting gases.

*3 credits per semester*

### ESC 511, 512 Advanced Fluid Mechanics I and II

Lagrangian and Eulerian frames, Rayleigh transport theorem and kinematic surface conditions, elementary kinetic theory, dynamical equations of motion, energy and momentum transfer, classes of constitutive relations. Fluid statics, including self-gravitation stability of floating bodies, surface tension effects and statics of the earth's atmosphere. Significant features of fluid dynamics of incompressible and barotropic perfect fluids and of the compressible perfect gas. Characteristic surfaces and shock waves. Internal and surface waves. Constitutive equations of viscous fluids. Some exact solutions of the Navier-Stokes equations. The nature of laminar instabilities.

*3 credits per semester*

### ESC 514 Homogeneous Turbulence

Probability functions and generalized Fourier transforms. Kinematics. Invariance theory. Isotropic turbulence. Statistical theories. Local isotrophy. Scalar transport.

*3 credits*

### ESC 515 Compressible Fluid Mechanics

The general conservation equations of gas dynamics from a differential and integral point of view. Hyperbolic compressible flow equations, unsteady one-dimensional flows, the non-linear problem of shock wave formation, isentropic plane flow, small perturbation theory, method of characteristics, hodograph method.

*3 credits*

### ESC 516 Viscous Fluids

Constitutive equation of a viscous fluid. The Stokesian fluid in simple shear Navier-Stokes equation. Exact solutions. Low Reynolds number behavior, lubrication theory, flow through porous media. Asymptotic behavior at large Reynolds numbers, boundary layers, wakes and jets. Instability of laminar flows.

*3 credits*

### ESC 524 Boundary Layer Theory

Navier-Stokes equations and their subsequent reduction to the boundary layer equations. General properties of the boundary layer equations, conditions for similarity, exact solutions, approximate methods, compressible boundary layers. Introduction to the fundamentals of turbulent flow, mixing length theories and their application to turbulent boundary layers.

*3 credits*

### ESC 599 Research

*Variable and repetitive credit*

### ESC 611 Reactive Media I

Thermodynamics, rate processes, flow, and stability of reactive media. Fundamentals of theory and experiment for combustion, condensation, crystallization and selected other transport phenomena. Nonadiabatic theory of reaction wave structure, initiation, propagation, and extinction. Deflagration and detonation. Interaction of intense radiation with gaseous flows.

*3 credits*

### ESC 612 Reactive Media II

Continuation of theory of reactive flows. Fundamental aspects of chemical, nuclear, and electric jet propulsion systems for aircraft and spacecraft.

*3 credits*

### ESC 613 Kinetic Theory and Non-Equilibrium Statistical Fluid Mechanics

Elementary free path theory and Brownian motion. The Boltzmann equation; Hilbert and Chapman-Enskog solution and the transition to fluid dynamics. Determination of transport coefficients. Generalized kinetic equations; rigorous derivation of the Boltzmann equation and other recent developments. Kinetic theory of polyatomic and ionized gases.

*3 credits*

### ESC 614 Equilibrium Statistical Fluid Mechanics

Determination of observable properties of macroscopic atomic and molecular systems in equilibrium from microscopic models. Microcannonical, Cannonical, and Grand Cannonical ensembles are considered for classical quantum systems. Applications for both perfect and imperfect gases.

*3 credits*

### ESC 615 Radiative Energy Transfer

The physics of absorption, emission and scattering of thermal radiation in gaseous media. Basic equations relating to energy transfer in absorbing, emitting and scattering media. Formulation and solution of the integro-differential equations describing conservation of energy for radiative equilibrium, combined conduction and convection, and convective phenomena involving radiating media.

*3 credits*

### ESC 618 Time Dependent Phenomena in Two-Phase Flows

Introduction to regimes of two-phase internal and external flow with time dependent momentum, heat, and mass transport; study of self excited oscillations at the stagnation point of two-phase flows involving heat and mass transport; time dependent flows of thin liquid films in a gaseous atmosphere; shear wave instabilities in laminar film boiling; instabilities of accelerated liquid interfaces; study of selected papers from the open literature.

Prerequisite: permission of instructor.

*3 credits*

### ESC 622 Magnetohydrodynamics

General concept of ionized gases, the Maxwell equations, electrodynamics of moving media, electromagnetic boundary conditions, the conservation equations derived from the Boltzmann equation, generalized Ohm's law, plasma oscillations and plasma wave phenomena, selected problems illustrating the physical features of plasma dynamics and magnetohydrodynamics.

*3 credits*

### ESC 623 Statistical Fluid Mechanics

Statistical mechanical concepts, phase space, ensembles, distribution functions, relationship between microscopic and macroscopic properties of a continuum, the Boltzmann integro-differential equation, approximate solutions to the Boltzmann equation including derivation of the macroscopic conservation equations, relationships between transport properties and molecular interaction models.

*3 credits*

### ESC 625 Kinetic Theory of Radiating Media

Spectral line profiles, Lambert's law of extinction, band models, infrared gas emissivities. Equation of radiative transfer, radiative equilibrium problems and Milne's integral equation, integral equation of radiative equilibrium in infrared radiating gases. Introduction to methods of solutions, eigenvalues and eigenfunctions and their determination by approximate methods, thermal radiation diffusivities, luminescence radiation diffusivities. Singular perturbation methods and the radiation predominant problems.

*3 credits*

### ESC 626 Shear Flow Turbulence

The fundamental equations of turbulent shear flow, boundary conditions, analytical and experimental results on boundary layers, jets, wakes, etc. Scalar transport in shear flows. Current problems in turbulent shear flows.

*3 credits*

### ESC 627 Theories of Transition

Classical laminar stability under infinitesimal perturbations. Finite instabilities. Squares' theorem. Relevance to transition to turbulence. Experimental information on physics of transition. Turbulent spot model. Three dimensional effects. Current research.

*3 credits*

### ESC 644 Aerothermochemistry

A generalized treatment of combustion thermodynamics including a systematic derivation of thermodynamic equations, Bridgman tables, criteria of thermodynamic equilibrium, computation of equilibrium composition and adiabatic flame temperature. Introduction to classical chemical kinetics. Conservation equations for a reacting system, detonation and deflagration, theories of flame propagation, dynamics of a dissociating gas, flame stabilization.

*3 credits*

### ESC 651 Advanced Experimental Techniques

Measure of information. Basic properties of instruments. Attainment of required experimental environment. Mechanical, electrical, and optical techniques.

*3 credits*

### ESC 652 Measurements System Design

Design of research instrumentation in the context of the research problem. Selection of appropriate transducers for response to a given phenomenon and design of appropriate intermediate and readout components. Specific problems may be selected, depending upon the students' interest.

*3 credits*

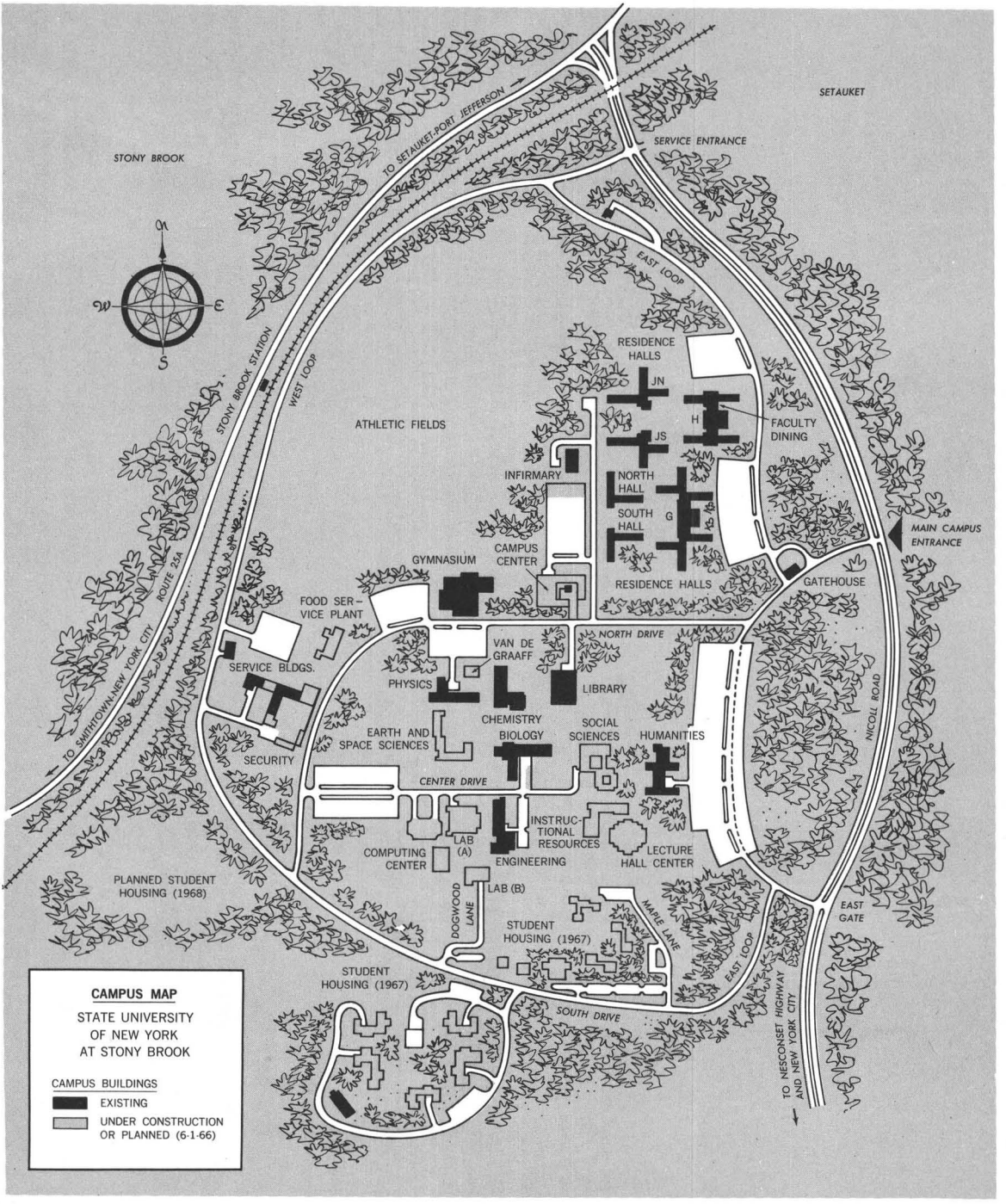
### ESC 696 Special Problems in Mechanics

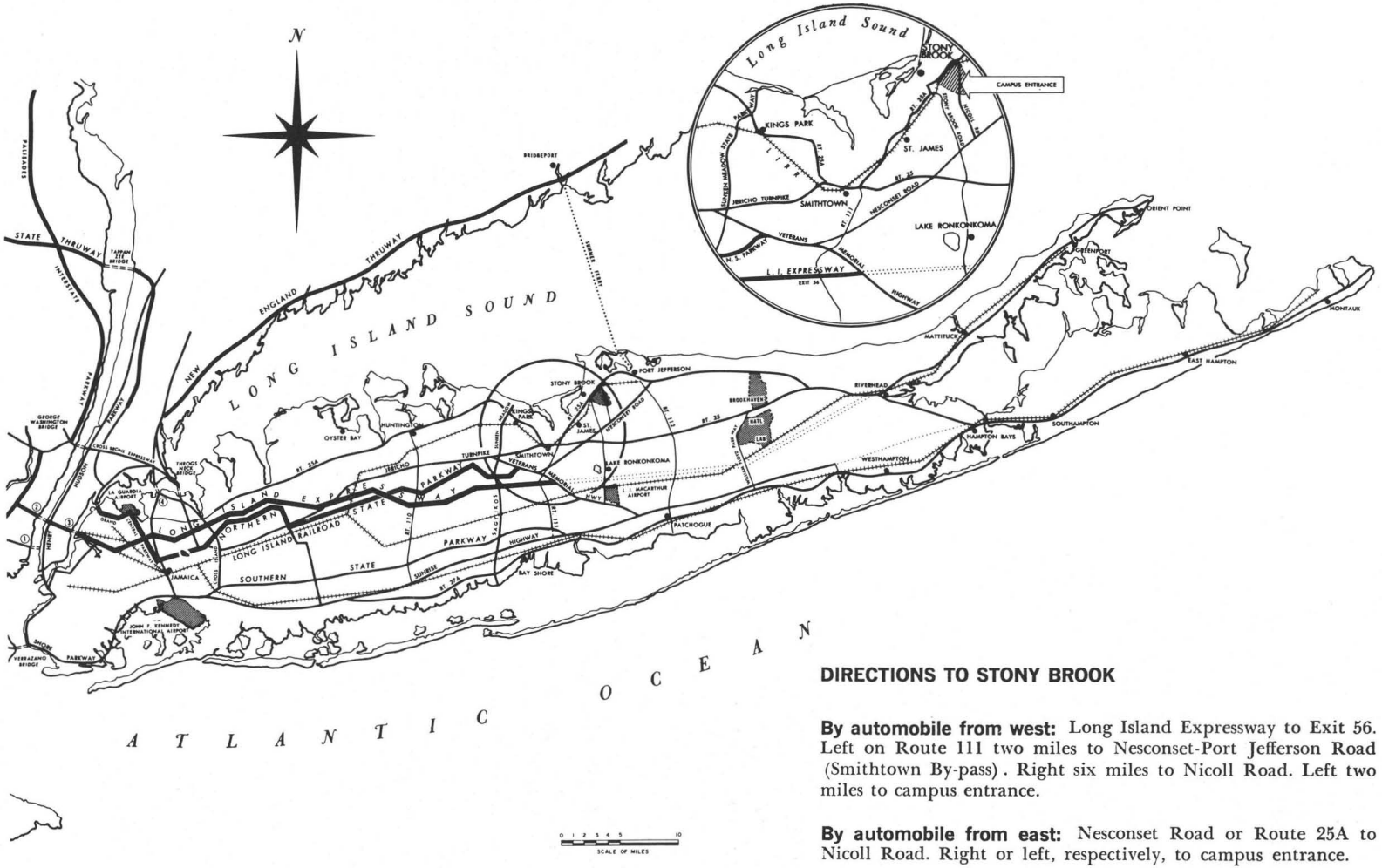
Conducted jointly by graduate students and one or more members of the faculty.

*3 credits*

### ESC 699 Research

*Variable and repetitive credit*


STONY BROOK
TO SETAUKET-PORT JEFFERSON
SETAUKET
SERVICE ENTRANCE
EAST LOOP
RESIDENCE HALLS
JN
H
FACULTY DINING
JS
INFIRMARY
NORTH HALL
SOUTH HALL
G
MAIN CAMPUS ENTRANCE
ATHLETIC FIELDS
STONY BROOK STATION
WEST LOOP
CAMPUS CENTER
GYMNASIUM
RESIDENCE HALLS
GATEHOUSE
FOOD SERVICE PLANT
NORTH DRIVE
VAN DE GRAAFF
SERVICE BLDGS.
PHYSICS
LIBRARY
TO SMITHTOWN-NEW YORK CITY
ROUTE 25A
CHEMISTRY
BIOLOGY
SOCIAL SCIENCES
HUMANITIES
NICOLL ROAD
EARTH AND SPACE SCIENCES
SECURITY
CENTER DRIVE
INSTRUCTIONAL RESOURCES
LAB (A)
COMPUTING CENTER
ENGINEERING
LECTURE HALL CENTER
PLANNED STUDENT HOUSING (1968)
LAB (B)
DOGWOOD LANE
EAST GATE
STUDENT HOUSING (1967)
MAPLE LANE
EAST LOOP
STUDENT HOUSING (1967)
SOUTH DRIVE
TO NESCONSET HIGHWAY AND NEW YORK CITY
CAMPUS MAP
STATE UNIVERSITY OF NEW YORK AT STONY BROOK
CAMPUS BUILDINGS
EXISTING
UNDER CONSTRUCTION OR PLANNED (6-1-66)




## DIRECTIONS TO STONY BROOK

**By automobile from west:** Long Island Expressway to Exit 56. Left on Route 111 two miles to Nesconset-Port Jefferson Road (Smithtown By-pass). Right six miles to Nicoll Road. Left two miles to campus entrance.

**By automobile from east:** Nesconset Road or Route 25A to Nicoll Road. Right or left, respectively, to campus entrance.

**By Long Island Railroad:** Take Port Jefferson line from Pennsylvania Station (Manhattan) or Flatbush Avenue Station (Brooklyn). Change at Jamaica for remainder of trip to Stony Brook Station.

## STATE UNIVERSITY OF NEW YORK

The State University of New York, established by the State Legislature in 1948, comprises 65 colleges and centers. At present, 57 conduct classes: four University Centers, two Medical Centers, ten Colleges of Arts and Science, seven Specialized Colleges, six two-year Agricultural and Technical Colleges and 28 locally-sponsored, two-year Community Colleges.

Three additional Colleges of Arts and Science are in varying stages of development. Two four-year campuses, in Nassau and Westchester Counties, are now in early planning. The third campus, as proposed in an amendment to the University's 1964 Master Plan, would be upper-divisional (junior-senior years) in concept and located in the Utica-Rome-Herkimer Area. Master's level programs will be offered at all three campuses.

The Trustees also have approved establishment of five additional community colleges. Two, in Genesee and Herkimer Counties, are in early stages of organization. Three others, in Clinton, Essex-Franklin and Ontario Counties, are subject to approval of another Master Plan amendment.

State University further comprises the Ranger School, a division of the College of Forestry which offers a 43-week technical forestry program at Wanakena, and the Center for International Studies and World Affairs located at Oyster Bay.

The University offers four-year programs in many fields, including agriculture, business administration, ceramics, dentistry, engineering, forestry, home economics, industrial and labor relations, law, liberal arts and sciences, maritime service, medicine, nursing, pharmacy, professional museum work, public administration, social work, teacher education and veterinary medicine.

Its two-year programs include nursing and liberal arts transfer programs and a wide variety of technical courses in such areas as agriculture, business, and the industrial and medical technologies.

Graduate study at the doctoral level is offered by the University at 12 of its campuses, and graduate work at the Master's level at 24 campuses. The University is continuing to broaden and expand over-all opportunities for advanced degree study.

Governed by a Board of Trustees appointed by the Governor, State University of New York comprises all State-supported institutions of higher education, with the exception of the four-year colleges of City University of New York. Each college and center of State University is locally administered. Although separated geographically, all are united in the purpose to improve and extend opportunities for youth to continue their education beyond high school.

The State University motto is: "Let Each Become All He Is Capable of Being."

# STATE UNIVERSITY OF NEW YORK

Office of the President, 8 Thurlow Terrace, Albany, N. Y. 12201

UNIVERSITY CENTERS

State University at Albany
State University at Binghamton
State University at Buffalo
State University at Stony Brook

MEDICAL CENTERS

Downstate Medical Center at Brooklyn (New York City)
Upstate Medical Center at Syracuse

COLLEGES OF ARTS AND SCIENCE

College at Brockport
College at Buffalo
College at Cortland
College at Fredonia
College at Geneseo
College at New Paltz
College at Oneonta
College at Oswego
College at Plattsburgh
College at Potsdam

(Three additional Colleges of Arts and Science are under development. Two four-year campuses, in Westchester and Nassau Counties, are in early planning. A third, upper-divisional in nature, has been proposed for the Utica-Rome-Herkimer Area.)

SPECIALIZED COLLEGES

College of Forestry at Syracuse University
Maritime College at Fort Schuyler (Bronx)
College of Ceramics at Alfred University
College of Agriculture at Cornell University
College of Home Economics at Cornell University
School of Industrial and Labor Relations at Cornell University
Veterinary College at Cornell University

AGRICULTURAL AND TECHNICAL COLLEGES (Two-year)

Agricultural and Technical Colleges at:

Alfred
Canton
Cobleskill
Delhi
Farmingdale
Morrisville

COMMUNITY COLLEGES

(Locally-sponsored two-year colleges under the program of State University)

Adirondack Community College at Hudson Falls
Auburn Community College at Auburn
Borough of Manhattan Community College at New York City
Bronx Community College at New York City
Broome Technical Community College at Binghamton
Corning Community College at Corning
Dutchess Community College at Poughkeepsie
Erie County Technical Institute at Buffalo
Fashion Institute of Technology at New York City
Fulton-Montgomery Community College at Johnstown
Hudson Valley Community College at Troy
Jamestown Community College at Jamestown
Jefferson Community College at Watertown
Kingsborough Community College at Brooklyn
Mohawk Valley Community College at Utica
Monroe Community College at Rochester
Nassau Community College at Garden City
New York City Community College of Applied Arts and Sciences at Brooklyn
Niagara County Community College at Niagara Falls
Onondaga Community College at Syracuse
Orange County Community College at Middletown
Queensborough Community College at New York City
Rockland Community College at Suffern
Staten Island Community College at New York City
Suffolk County Community College at Selden
Sullivan County Community College at South Fallsburg
Ulster County Community College at Kingston
Westchester Community College at Valhalla

(Five additional community colleges, to be located in Clinton, Essex-Franklin, Genesee, Herkimer and Ontario Counties, have been approved by the Board of Trustees.)