



State University of New York

at Stony Brook

*Graduate School Bulletin*

1965-1966

# State University of New York

THE STATE UNIVERSITY OF NEW YORK was established by the State Legislature in 1948. It comprises 58 units: four university centers, two medical centers, ten colleges of arts and science, eight specialized colleges, six two-year agricultural and technical colleges and 28 locally-sponsored two-year community colleges. Although separated geographically, all are united in the purpose to improve and extend opportunities for youth to continue their education beyond high school.

State University offers programs in the liberal arts and sciences; engineering; home economics; industrial and labor relations; veterinary medicine; ceramics; agriculture; forestry; maritime service; teacher education; law; pharmacy; medicine; dentistry; social work; business administration; public administration and librarianship. The University's two-year programs also include liberal arts study and a wide variety of technical courses in such areas as agriculture, business and the industrial and medical technologies.

Advanced graduate study at the doctoral level is offered by the University at 13 of its units, including the university centers and the Graduate School of Public Affairs. While graduate work can be pursued at 24 of the colleges, the programs at the majority of these units are now limited to the master's level. The University, however, is continuing to broaden and expand overall 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. Students should write directly to the institution in which they are interested for admission forms.

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

*For further information write:*

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



STATE UNIVERSITY OF  
NEW YORK  
AT STONY BROOK

*The Graduate School*

**Bulletin**  
*1965-1966*



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★ ★ ★ ★ ★ **CALENDAR for 1965** ★ ★ ★ ★ ★

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# Academic Calendar

## 1965-1966

### *Fall Semester 1965*

Registration .....	September 20-21
Classes Begin .....	September 22
Thanksgiving Holiday .....	November 25-28
Classes Resume .....	November 29
Christmas Holiday .....	December 19-January 2
Classes Resume .....	January 3
Last Day of Classes .....	January 15
Semester Examinations .....	January 17-27

### *Spring Semester 1966*

Registration .....	February 7-8
Classes Begin .....	February 9
Spring Recess .....	April 3-10
Classes Resume .....	April 11
Last Day of Classes .....	May 21
Semester Examinations .....	May 23-June 2
Commencement .....	June 5

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\* On leave Academic Year 1965/66.

† Visiting, Academic Year 1965/66.

‡ Visiting, Fall Semester, 1965.

\*\* On leave Spring Semester 1966.

# Initial appointment (Spring Semester, 1966) supported by the New York State Science and Technology Foundation.

## General Information

The State University of New York 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 the major fields of the humanities, social sciences, natural sciences and engineering by 1970.

During the 1965-66 academic year, graduate programs leading to the Master's and Ph.D. degrees are offered by the Departments of *Biological Sciences*, *Chemistry*, *History* and *Physics* in the College of Arts and Sciences and by the Departments of *Applied Analysis* and *Mechanics* in the College of Engineering. Master's degree programs are offered by the Departments of *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.

### Stony Brook in Brief

Founded in 1957, the State University at Stony Brook moved in 1962 to its permanent campus in the Stony Brook-Setauket area of Long Island, a region of woods, hills and small historic villages on the north shore about 50 miles northeast of New York City. The 640-acre campus is linked with Manhattan by a pattern of four- and six-lane highways and by the Long Island Railroad.

As a relatively new University and in the context of the vigorously expanding State University system, Stony Brook is experiencing dramatic growth. By 1970, the number of students will have increased fivefold over the 1964 enrollment of 1,800, with the number of graduate students expected to double each year. Over 200 graduate students are numbered among the 2,850 students expected in 1965-66. To meet the needs of the burgeoning enrollment, campus facilities will be more than doubled over the next two years, with some two dozen buildings to be constructed at a cost of about \$35 million. Further expansion is planned, including development of a comprehensive medical center.

## Buildings and Research Facilities

During 1965-66, the following academic buildings are in use: Biological Sciences, Chemistry, Engineering, Humanities, Physics, and the Library. In addition, the campus has dormitories and dining halls, a Physical Education building and service buildings. In various stages of planning or construction are: a Social Sciences building, a Fine Arts center, a second Biological Sciences building, a second Chemistry building, several Engineering buildings, an Earth and Space Sciences building, an extension to the Physics building, a Nuclear Structure Laboratory, a Library extension, an Administration building, and a student center, auditorium, infirmary, and additional dormitories.

The *Biological Sciences 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, a greenhouse with five individually controllable compartments and a potting room, an X-ray room, engineering shop, electron microscope room, photographic dark room, isotope counting room, herbarium, a museum, three constant temperature rooms, and environmental chambers. An air-conditioned animal wing contains sea water and fresh water aquaria, animal rooms, and research laboratories.

The Biological Sciences Department has its own boat for use in marine research, and is in the process of acquiring a shore station on Long Island Sound, near the campus, for instruction and research in marine biology.

A second Biological Sciences building, planned for occupancy in 1968, will add greatly to the physical facilities for graduate instruction and research in the biological sciences.

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, ultra-

violet, infrared, and far infrared spectrometers. Also available is a wide range of instruments for nuclear and radio chemistry, an amino acid analyzer, preparative gas chromatographs, and a dichrograph. Instruments specially constructed for the Chemistry Department's research facilities include a flash-photolysis apparatus, a stop-flow apparatus, cryogenic infracells, and a high pressure apparatus. Among the equipment currently being added is an X-ray diffractometer. 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 1968.

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.

A HVEC FN "King" tandem Van de Graaff accelerator is being installed in the Physics Department 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, to provide 110,000 sq. ft. of space mainly for faculty and graduate research, is now planned for completion in 1968.

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

equipped research laboratories 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 total additional floor space will be in the neighborhood of 100,000 sq. ft.

## Libraries

The Frank Melville, Jr. Memorial Library, the main library at Stony Brook, is designed to house 350,000 volumes and to seat 700 students in the present building. This building is intended as the first part of a large structure that ultimately will contain a million volumes. Other libraries on campus are the scientific and technical collections housed in each science building and in the College of Engineering.

Each of the campus libraries operates as an open-stack library. In the Melville Library, seminar rooms are provided on the first floor and soundproof typing rooms on the second and third floors. A maximum of free access to the collections and a maximum of privacy are provided by distributing seating areas throughout the

stacks. There are special facilities for the housing and use of microform materials, including reading machines for microfilm, microcard, microprint, and microfiche. Microprint reader-printer and photocopy equipment is also available.

The university library is a depository for publications of the U.S. government and the Organization of American States. Over 2,000 periodicals, ranging broadly over the arts and sciences and engineering, are currently subscribed to.

### **Computing Center**

The services of the Computing Center are available to faculty members and their graduate students. Present equipment consists of an IBM 7040/1401 computing system, with 32,768 words of main storage in the 7040 computer; eleven magnetic tape units, one connected to a high speed automatic plotter; and associated peripheral equipment. With the rapidly expanding requirements for computer facilities at Stony Brook, it is expected that the Computing Center will acquire larger and faster equipment in the very near future.

### **Housing Accommodations**

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.

## Financial Information

### Tuition

The tuition rate for graduate students is \$20 per semester-hour. There is no tuition charge for university graduate assistants, but they must pay certain 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 (optional).

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 \$865 per academic year, of which \$365 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.

### 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, covering the academic year, are available with stipends of \$2,575 for half-time duties and with tuition exemption.

Research assistantships for advanced graduate students and fellowships are also available.

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 Federal fellowships and traineeship programs as: NSF Co-operative Graduate Fellowships, NDEA Fellowships, NSF Traineeships, and NASA Traineeships.

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 February 28 for those wishing to start their studies in the fall, and August 31 for those who wish to enter the University in the spring semester.

## 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.

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

Admission application blanks may be obtained from:

*The Office of the Graduate School  
State University of New York  
Stony Brook, L.I., New York 11790*

## 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.

### 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 a proficiency examination in each of two 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, Long Island, New York). Graduate courses are numbered 501 and above. Odd-numbered courses are ordinarily given in the Fall, even-numbered courses in the Spring.

The following symbols are used for departmental names:

- BIO – Biological Sciences
- CHE – Chemistry
- EGL – English
- HIS – History
- MAT – Mathematics
- PHY – Physics
- ESA – Applied Analysis
- ESM – Material Sciences
- ESC – Mechanics

# College of Arts and Sciences

## Biological Sciences

*Professors* Erk (Chairman), Glass, Kramer; *Associate Professors* Battley, Cirillo, Jones, Merriam, Smolker, Tunik, Williams; *Assistant Professors* Carlson, Edmunds, Fowler, Gaudet, Hechtel, Howland, Kernaghan, Obrebski, M. Rosenberg, Wurster.

### Admission to Graduate Study

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

A. A baccalaureate degree, with at least the following undergraduate preparation: four laboratory courses in biology totaling at least 16 semester credits, and including work in genetics and evolution, development, cytology, general physiology, and ecology; chemistry, including at least one semester of organic chemistry; one year of college physics; mathematics through 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. Provisional students must act immediately to fulfill deficiencies in basic courses, the credits for which do not count toward graduate degree requirements.

### 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, including **Interarea Seminar**; at least 24

semester credits, of which 18 credits shall be in graduate level courses, and of which 4 credits may be for research.

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 accepted, 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; the examination may include a defense of the thesis.

### 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, the student may apply for the preliminary examination. The examination will usually be both written and oral.

D. Language requirement: A reading knowledge of two foreign languages selected from German, French and Russian, in consultation with the student's advisor.

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. Research and thesis.

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

H. Residence requirements: A student who has devoted two years to full time graduate study is rated as meeting the minimum residential requirements for the Ph.D. degree.

## Courses

A. The following advanced undergraduate courses carry graduate credit.

BIO 301 *Biometry*. Fall semester. 3 credits.

BIO 311 *Aquatic Botany*. Summer. 6 credits.

BIO 331 *Microbiology*. Fall semester. 4 credits.

BIO 336 *Marine Biology*. Spring semester. 4 credits.

BIO 341 *Integrative Mechanisms*. Fall semester. 4 credits.

BIO 342 *Ethology*. Spring semester. 4 credits.

### B. Graduate courses.

BIO 501 *Biochemistry I*. Fall semester. 3 credits.

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, and reaction mechanisms, including the role of coenzymes. Two evening lectures per week.

BIO 502 *Biochemistry II*. Spring semester. 3 credits.

A study of metabolic pathways of biosynthesis and degradation involved in cellular activity. Special emphasis will be placed upon mechanisms of nitrogen and sulfur metabolism, CO<sub>2</sub> fixation, photosynthesis, formation and utilization of high-energy phosphate compounds, and the regulation of enzyme activity. Two evening lectures per week.

BIO 505 *Experimental Biochemistry I*. Fall semester. 2 credits.

An introduction to the application of biochemical methods to the isolation and characterization of representative cell constituents including carbohydrates, lipids, proteins, and nucleic acids. Six laboratory hours per week.

BIO 506 *Experimental Biochemistry II*. Spring semester.  
2 credits.

The application of biochemical methods to the study of intermediary metabolism. The experimental methods will include chromatography, manometry, use of radioactive isotopes, and the isolation and characterization of enzymes in cell-free preparations. Six laboratory hours per week.

**BIO 512 *Cellular Biology*.** Spring semester. 4 credits.

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.

**BIO 522 *Physiological Genetics*.** Spring Semester. 4 credits.

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. One lecture, two discussions, three hours of laboratory per week.

**BIO 531 *Plant Morphogenesis*.** Fall semester. 4 credits.

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.

**BIO 534 *Experimental Embryology*.** Spring semester. 3 credits.

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.

**BIO 545 *Comparative Animal Physiology*.** Fall semester.  
4 credits.

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.



**BIO 552** *Population and Community Ecology*. Spring semester. 5 credits.

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. Three hours of discussion with six hours of laboratory to be arranged each week.

**BIO 571, 572** *Interarea Seminar*. Each semester. 2 credits.

Each semester, two of the staff combine their interests to develop a series of topics and review of the literature which touches on both fields of interest.

**BIO 599** *Research*. Each semester. Credit to be arranged.

Original investigation undertaken with the supervision of a member of the staff.

**BIO 624** *Genetics of Microorganisms*. Spring semester. 3 credits.

A presentation of methods and principles involved in studies of heredity in bacteria, bacterial viruses, fungi, and protozoa. Emphasis will be placed upon the special features of these organisms which permit unique contributions to be made to our understanding of the nature of the genetic material and the fundamental mechanisms concerned in its mutation, replication, recombination, interaction with cytoplasmic components and metabolic functioning. Three hours of lecture or discussion per week.

**BIO 636** *Comparative Physiology and Biochemistry of Lower Plants*. Spring semester. 3 credits.

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. The general areas of genetic control of protein synthesis and enzyme regulation will be taken up with particular reference and emphasis on their relation to aspects of growth and differentiation. Three hours of lecture and discussion per week.

**BIO 646** *The Invertebrata I*. Spring semester. 4 credits.

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 alternative years. Three hours lecture and discussion with three hours of laboratory.

BIO 648 *The Invertebrata II*. Spring semester. 4 credits.

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.

BIO 692 *Seminar in Marine Biology*. Spring semester. 2 credits.

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.

BIO 696 *Seminar on Molecular Biology*. Spring semester.  
3 credits.

A presentation and discussion of current literature on molecular biology. Topics to be included are the molecular organization of DNA and RNA and the molecular basis of: mutation, DNA replication, genetic recombination, transcription of genetic information and its transfer to the protein-synthesizing machinery of the cell, and genetic elements in the regulation of cellular metabolism. The discussion will be designed to make clear the essential simplicity of the conceptual approaches which have utilized biophysical and biochemical techniques in studying such problems, as well as revealing the current status of our knowledge. Three hours of discussion a week.

BIO 697, 698 *Current Problems in Animal Behavior*. Each semester. 1 credit.

A weekly seminar devoted to reviews and discussion of investigations, methods, and literature in comparative behavior.

BIO 699 *Research*. Each semester. Credits to be arranged.

Original investigation undertaken as part of Ph.D. program under supervision of a research committee.

*Departmental colloquium*. Each semester.

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.

## Chemistry

*Professors* Bonner (Chairman), Friedman, Kosower, Ramirez, Sujishi; *Associate Professors* J. Alexander, Lauterbur, Ie Noble; *Assistant Professors* Bernal, Boikess, Emerson, Goldfarb, Hirota, Kerber, Kern, Schneider, Solo.

### 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.

### Orientation Examination

Within the two-week period preceding opening of classes for the fall semester, a series of three orientation 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 purpose of the orientation examination is primarily to aid in the advising of incoming graduate students concerning their first-year programs.

### 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 physiochemical studies of molecular inorganic hydrides, organophosphorus compounds, enzymatic systems, organic  $\pi$  complexes, nonbenzenoid aromatics, organic systems under high pressure; studies of nuclear reactions, cosmic-ray induced radioactivity and isotope geochemistry, nuclear magnetic resonance, electron paramagnetic resonance, direct quadrupole resonance, high resolution infrared and far infrared, flash photolysis in gaseous systems, and theoretical chemistry.

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**

*Advanced Organic Chemistry* (CHE 501) 2 credits.

*Advanced Inorganic Chemistry* (CHE 511) 2 credits.

*Quantum Chemistry I* (CHE 521) 2 credits.

*Chemical Thermodynamics* (CHE 523) 3 credits.

*Seminar* (CHE 531) 0 credits.

**Second Semester**

*Chemical Kinetics* (CHE 526) 2 credits.

*Seminar* (CHE 532) 1 credit

*Research* (CHE 599) 1-2 credits.

and two of the following:

*Quantum Chemistry II* (CHE 522) 3 credits.

*Introduction to Statistical Mechanics* (CHE 528) 2 credits.

*Physical Organic Chemistry* (CHE 502) 2 credits.

*Physical Inorganic Chemistry* (CHE 512) 2 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 in May, and the students will be either accepted or rejected for qualification to candidacy for a graduate degree.

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

- A. Residence: one year minimum.
- B. Qualification to candidacy.
- C. Language: reading proficiency in German or Russian.
- D. Formal course requirement: successful completion (B 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.
- C. Language: reading proficiency in German, and in second foreign language in which there exists a substantial body of chemical literature.
- D. Formal Course Requirement: successful completion of an approved course of study.
- E. Advancement to candidacy: In order to be advanced to candidacy for the Ph.D. degree the student must satisfy language requirement, demonstrate satisfactory progress in research, and satisfy the cumulative examination requirement. 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. For advancement to candidacy, 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.
- F. Thesis.
- G. 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 Graduate School.

## Courses

CHE 310, 302 *Experimental Methods of Chemistry I and II.*

CHE 305 *Intermediate Inorganic Chemistry.*

CHE 315 *Intermediate Organic Chemistry.*

CHE 325 *Intermediate Physical Chemistry.*

CHE 501 *Advanced Organic Chemistry.* Fall semester. 2 credits.

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.

CHE 502 *Physical Organic Chemistry.* Spring semester.  
2 credits.

A detailed consideration of current topics which may include the following: solvolysis reactions (neighboring group effects, salt effects, allylic and homoallylic compounds, solvent effects); isotope effects on reaction rates; charge-transfer complexes and spectra; aromatic, electrophilic, nucleophilic, and free-radical substitution; photochemistry; and free-radical reactions.

CHE 511 *Advanced Inorganic Chemistry.* Fall semester.  
2 credits.

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

CHE 512 *Physical Inorganic Chemistry.* Spring semester.  
2 credits.

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

CHE 521 *Quantum Chemistry I.* Fall semester. 2 credits.

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.

CHE 522 *Quantum Chemistry II*. Spring semester. 3 credits.

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.

CHE 523 *Chemical Thermodynamics*. Fall semester. 3 credits.

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 nonelectrolytic 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.

CHE 526 *Chemical Kinetics*. Spring semester. 2 credits.

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.

CHE 528 *Introduction to Statistical Mechanics*. Spring semester. 2 credits.

Techniques will be discussed which permit the calculation of macroscopic 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.

CHE 529 *Nuclear Chemistry*. Fall semester. 3 credits.

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.

CHE 531 *Seminar*. Fall semester. No credit.

CHE 532 *Seminar*. Spring semester. 1 credit.



CHE 599 *Research*. (variable and repetitive credit).

CHE 602 *Intermediates in Organic Chemistry*. Spring semester. 2 credits.

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

CHE 603 *Theoretical Organic Chemistry*. Fall semester. 2 credits.

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.

CHE 604 *Molecular Biochemistry*. Spring semester. 2 credits.

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.

CHE 623 *Molecular Spectroscopy*. Fall semester. 2 credits.

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.

CHE 624 *Magnetic Resonance*. Spring semester. 2 credits.

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.

CHE 681 *Special Topics in Organic Chemistry*. 2 credits.

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.

CHE 682 *Special Topics in Inorganic Chemistry*. 2 credits.

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

CHE 683 *Special Topics in Physical Chemistry*. 2 credits.

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

CHE 699 *Research*. (variable and repetitive credit).

## English

### Admission to Graduate Study

*Professors* P. Alexander, Kazin, Levin (Acting Chairman), Ludwig;  
*Associate Professors* Creed, Fiess, Goldberg, Jordan, Marsh,  
Pequigney, Rogers, Stampfer.

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 of the 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.
- (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 (300-level) course in a field related to English. No more than two 300-level courses will be counted toward the degree.

*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 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.* Spring semester. 3 credits.  
Study of major works of prose, poetry, and drama of the fourteenth and fifteenth centuries, exclusive of Chaucer, in Middle English.

*Instructor:* Mr. Jordan.

EGL 313 *Tudor and Stuart Drama.* Fall semester. 3 credits.  
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.

*Instructors:* Mr. Levin, Mr. Stampfer.

EGL 315 *Elizabethan Poetry.* Fall semester. 3 credits.  
Readings in Raleigh, Spenser, Sidney, Daniel, Davies, Marlowe, and Shakespeare.

*Instructors:* Mr. Stampfer, Mr. Pequigney.

EGL 333 *English Drama, 1660-1780.* Spring semester. 3 credits.  
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.

*Instructor:* Mr. Goldberg.

EGL 344 *Romantic Revival.* Fall semester. 3 credits.  
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 movement; its prose.

*Instructor:* Mr. Alexander.

EGL 366 *William Butler Yeates.* 3 credits.  
Readings in the poetry, plays, autobiographies, and letters. To be offered 1966-67.

*Instructor:* Mr. Ludwig.

EGL 371 *Proseminar in Major American Authors I.*

Fall semester. 3 credits.

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

*Instructor:* Mr. Kazin.EGL 372 *Proseminar in Major American Authors II.*

Spring semester. 3 credits.

Intensive study of major American writers of the later nineteenth and twentieth centuries.

*Instructor:* Mr. Kazin.EGL 375 *Major American Poets.* Spring semester. 3 credits.

Studies in American poetry from Emerson to Robert Frost.

*Instructor:* Mr. Kazin.EGL 381 *History of Literary Criticism I.* Fall semester.

3 credits.

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

*Instructors:* Mr. Jordan, Mr. Marsh, Staff.EGL 382 *History of Literary Criticism II.* Spring semester.

3 credits.

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 English 381.

*Instructors:* Mr. Jordan, Mr. Marsh, Staff.EGL 394 *Satire and the Satiric Spirit.* 3 credits.

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, Flaubert. To be offered 1966-67.

*Instructor:* Mr. Ludwig.

Courses primarily for graduate students. In extraordinary cases qualified undergraduates may be admitted to these courses.

EGL 501 *Introduction to Old English Language and Literature.*

Fall semester. 3 credits.

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*.*Instructor:* Mr. Creed.

EGL 502 *Beowulf*. Spring semester. 3 credits.

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

*Instructor:* Mr. Creed.

EGL 506 *Studies in the Medieval Period*. Fall semester.  
3 credits.

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. To be offered 1966-67.

*Instructors:* Mr. Jordan, Mr. Creed.

EGL 507 *Special Topics in Chaucer*. Spring semester.  
3 credits.

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.

*Instructor:* Mr. Jordan.

EGL 512 *Special Topics in Shakespeare*. Fall semester. 3 credits.

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

*Instructors:* Mr. Alexander, Mr. Levin, Mr. Stampfer.

EGL 513 *Special Topics in Tudor and Stuart Drama*.  
Fall semester. 3 credits.

This course each year will focus upon some specific topic in the field of Tudor and Stuart drama (exclusive of Shakespeare). The special topic for 1965-66 will be the use of the double plot.

*Instructor:* Mr. Levin.

EGL 515 *Shakespeare's Roman Tragedies*. 3 credits.

This course will focus upon 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. To be offered in 1966-67.

*Instructor:* Mr. Stampfer.

EGL 528 *Andrew Marvell*. Spring semester. 3 credits.

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

*Instructor:* Mr. Pequigney.

EGL 535 *Alexander Pope*. 3 credits.

Study of Pope's major poems, translations, and miscellaneous prose, in the context of his life and times. To be offered in 1966-67.

*Instructor:* Mr. Marsh.

EGL 536 *Studies in the Later Eighteenth Century*. 3 credits.

Extensive examination of the prose and poetry of the second half of the eighteenth century, with special attention to the immediate antecedents of the Romantic movement. To be offered in 1966-67.

*Instructors:* Mr. Rogers, Mr. Marsh.

EGL 537 *Studies in Eighteenth Century Fiction*. Fall semester.  
3 credits.

Critical investigation of the four major midcentury 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.

*Instructor:* Mr. Goldberg.

EGL 541 *Studies in Romantic Poetry*. 3 credits.

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

*Instructors:* Mr. Kazin, Mr. Marsh.

EGL 558. *Matthew Arnold*. 3 credits.

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. To be offered in 1966-67.

*Instructor:* Mr. Ludwig.

EGL 565 *Joyce*. Fall semester. 3 credits.

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

*Instructor:* Mr. Ludwig.

EGL 575 *Selected American Writers*. 3 credits.

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. To be offered in 1966-67.

*Instructors:* Mr. Kazin, Mr. Fiess.



EGL 576 *Melville*. Spring semester. 3 credits.

The seminar will concern itself with all of Melville's work; prior acquaintance with Melville's more familiar works like *Moby Dick* will be assumed. Textual, biographical and critical approaches will be used.

*Instructor:* Mr. Fiess.

EGL 583 *The Structure and History of the English Language*.  
3 credits.

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. To be offered 1966-67.

*Instructor:* Mr. Creed.

EGL 599 *Independent Studies*. Fall and Spring semester.

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

*Instructors:* Staff.

## History

*Professors* Céspedes, Ross, Semmel; *Associate Professors* Angress, Cleland, Staudenraus, Weltsch; *Assistant Professors* Alin, Bottigheimer, R. H. G. Lee, Pratt, Rosenthal, Selinger, Wildman.

### Admission to Graduate Study

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

- 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. It may be obtained either under Plan "A" or Plan "B". Under either plan, the candidate must prove his proficiency in one foreign language by taking an examination no later than the beginning of his second semester in residence.

Plan A, which includes a thesis, is required for students who go on to seek the doctorate and may be elected by other students if they choose. Plan B requires additional hours of course work and a more extensive examination. It leads to a terminal degree. Students may elect Plan B only with the approval of the Graduate Committee of the Department of History.

The department requires graduate students to fulfill the work for the Master's degree under Plan A by taking 30 (thirty) hours of

work, by writing a thesis and by passing an examination in a foreign language and a comprehensive oral examination. The thirty hours of work must include the following:

Research seminars in two different major fields; reading seminars in two different major fields; an historiography course; six hours of thesis credit; and additional course work to make up thirty hours. The student may also be required, at the discretion of the graduate advisor, to audit additional courses (without credit) in history or in a cognate field.

The oral examination for the M.A. will consist of a defense of the thesis and an oral examination in the major field of history in which the thesis falls, with special attention to sources for the thesis. The candidate for a M.A. degree will select his thesis topic as soon as possible after beginning his graduate studies. The topic must be approved by the faculty member under whose supervision the student is writing his thesis.

The department requires graduate students to fulfill the requirements under Plan B by taking thirty-six hours of work and passing an examination in a foreign language, and a comprehensive written examination in one major and one minor field of history. The thirty-six hours of work must include the following: research seminars in two different fields; reading seminars in two different fields; and a historiography course. The M.A. under Plan B is a terminal degree. Students with this degree will not be permitted to enroll in a doctoral program.

#### *The Doctor of Philosophy Degree*

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 his general examinations, and he must write a dissertation. The general examinations will test the student's proficiency in two minor fields by means of written examinations, and his major field by means of an oral examination.

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.

*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.

The normal program will ordinarily include four reading seminars, two per semester. A student who has taken his M.A. degree at another institution may be required by the department to take a research seminar as well.

During the year preceding his general Ph.D. examinations, the student will be expected to do intensive reading in his major field and his two minor fields.

All the 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 or U.S. 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. It is strongly recommended that the student complete his language preparation before commencing the doctoral program. Language proficiency is necessary for course work as well as seminar work. In any event, he should take his language examinations as early in his program as possible. A student will not be permitted to take the general examination 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 consists of the whole of one of the fields in the list which follows, and is usually the field within which the student will write his dissertation. A minor field consists of a subdivision of one of the major fields, as determined by the advisor in consultation with the student and an instructor in the minor field. In some cases, the major field selected will determine one of the minor fields (e.g., if a student's major field is Late Modern Europe, he must offer a segment of Early Modern Europe as one of his minor fields).

One of the two minor fields, moreover, must be taken outside the geographic area of the student's major field (e.g., if his major field is U.S. History, one of his minor fields should be either in Far Eastern, European, or Latin American History). The minor fields will be passed by a written examination, and the major field by an 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 general 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, 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 III (Modern Europe): one of his minor fields may be "The Age of Enlightenment and Revolution, 1648-1815," the other "United States 1850 to the Present," while his dissertation field may be "Modern England since 1760."

At present, the department is equipped to offer examinations in all six divisions, but can offer dissertation fields only in U.S., Modern European and Latin American History.

Division I: *Ancient and Medieval*

- 1) The Ancient World: Western Asia, Greece and Rome.
- 2) The Medieval World, 500-1500.

Division II: *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.

Division III: *Modern Europe*

- 1) Western and Central Europe, 1815-1914.
- 2) Europe since 1870.

- 3) Eastern Europe since 1750.
- 4) Imperial and Soviet Russia, 1700 to the Present.
- 5) Modern England since 1760.

Division IV: *East Asia*

- 1) Traditional East Asia to 1850.
- 2) Modern East Asia after 1850.

Division V: *Latin America*

- 1) Latin America to 1824.
- 2) Latin America since 1824.

Division VI: *United States of America*

- 1) United States to 1877.
- 2) United States 1850 to the Present.

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 551 *Reading Seminar in Social and Economic History of England, 1760-1785.*

- 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 599 *Research for M.A. candidates (variable and repetitive credit).*
- 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 651 *Research Seminar in Social and Economic History of England, 1760-1785.*
- 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* Lister (Acting Chairman), Witt; *Associate Professors* Barcus, S. Böge, W. Böge, W. Fox, Kravetz, Wehn, Zaustinsky; *Assistant Professors* Bell, Cornell, Frampton, Kumpel, Oh.

### 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).

### A. Advanced Undergraduate Courses

MAT 301 *Introduction to Complex Analysis*. Fall semester.

3 credits.

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.

MAT 302 *Introduction to Real Analysis*. Spring semester.

3 credits.

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.

MAT 312 *Introduction to Topology*. Fall semester. 3 credits.

Triangulated spaces and their simplicial homology. Singular homology, its properties and its relationship to simplicial theory. Fixed point theorems. The fundamental group and covering spaces.

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

MAT 323 *Introduction to Differential Geometry*.

Spring Semester. 3 credits.

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

*Prerequisite:* Advanced Calculus.

MAT 331 *Algebra II*. Spring semester. 3 credits.

Elementary group theory: composition series, the Sylow theorems, the fundamental theorem of Abelian groups. Galois theory.

*Prerequisite:* Algebra I.

### B. Graduate Courses

MAT 501, 502 *Analysis I, II*. Fall, Spring semesters.

4 credits per semester.

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.

**MAT 506** *Complex Analysis*. Spring semester. 4 credits.

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.

**MAT 512** *Algebraic Topology I*. Spring semester. 4 credits.

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

*Prerequisite:* MAT 312.

**MAT 513** *Algebraic Topology II*. Fall semester. 4 credits.

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

*Prerequisite:* MAT 512.

**MAT 521** *Differential Geometry*. Fall semester. 4 credits.

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.

**MAT 522** *Riemannian Geometry*. Spring semester. 4 credits.

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 521.

**MAT 531, 532** *Algebraic Systems I, II*. Fall, Spring semesters.  
4 credits.

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

*Prerequisite:* MAT 331.

### C. Seminars and Independent Study.

Credit for seminars is usually two hours per semester. Seminars may be repeated for credit when topics change.

*Prerequisite:* Graduate Status.

MAT 581 *Analysis Seminar*. Fall, Spring semesters.  
Topics for 1964-65 was Introduction to Differential Topology.

MAT 582 *Topology Seminar*. Fall, Spring semesters.  
Topic for 1964-65 was K-Theory.

MAT 583 *Differential Geometry Seminar*. Fall, Spring semesters.  
Topic for 1964-65 was Symmetric Spaces.

MAT 584 *Algebra Seminar*. Fall, Spring semesters.  
Topic for 1964-65 was Homological Algebra.

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, Eisenbud, Feingold, D. Fox, Lambe, L. Lee, Muether, Pond (Chairman), Toll, Yang; *Associate Professors* Chiu, de Zafra, Emery, Kahn, Lee-Franzini, Mould, Raz, Silsbee, Swartz; *Assistant Professors* Fossan, Kantor, Kao.

### 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.

### 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, to determine whether he may continue his graduate studies. Covering basic undergraduate physics, this exami-

nation is given primarily for guidance purposes. Passing this examination is also required for continued graduate study beyond the first year.

## 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 include 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.



## Courses

### A. 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.*

### B. Graduate courses:

PHY 501 *Analytical Mechanics.* 3 credits.

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

PHY 502 *Electrodynamics.* 3 credits.

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

PHY 511 *Quantum Mechanics I.* 3 credits.

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.

PHY 512 *Quantum Mechanics II.* 3 credits.

Formal structure of quantum theory, collision problems and formal scattering theory, elementary quantization of the radiation field, introduction to Dirac electron theory.

PHY 531 *Advanced Quantum Mechanics.* 3 credits.

Symmetries and invariance principles, relativistic electron theory, introduction to field theory.

PHY 540 *Statistical Mechanics.* 3 credits.

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

PHY 551 *Nuclear and Elementary Particle Physics.* 3 credits.

Basic properties of nuclei, nuclear forces, radioactivity, fission, electromagnetic properties; experimental techniques, accelerators and nuclear detectors.

- PHY 555 *Solid State Physics*. 3 credits.  
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.
- PHY 562 *Solid State Theory*. 3 credits.  
Transport properties of solids, including interactions of electrons with various imperfections; galvomagnetic and thermoelectric effects; optical, spectroscopic and photoelectric properties; dielectric and magnetic properties.
- PHY 564 *Theoretical Nuclear Physics*. 3 credits.  
The two-body problem, theory of nuclear forces and properties of nuclear matter, nuclear models, formal theory of nuclear reactions.
- PHY 566 *Elementary Particle Theory*. 3 credits.  
Fundamental particle systematics, weak and strong interactions, high energy phenomena.
- PHY 580 *Special Research Projects*. Each semester. Variable and repetitive credit.  
Research under the direction of a faculty member. Not open to Ph.D. candidates who have passed the preliminary examination.
- PHY 585 *Special Study*. Each semester (variable and repetitive credit.)  
Reading course in selected topics.
- PHY 610, 611 *Quantum Field Theory I, II*. 3 credits.  
Field quantization; scalar and pseudoscalar meson field; electromagnetic field, Dirac field, interacting fields; Feynman diagrams; charge and mass renormalization; dispersion relations.
- PHY 620 *Relativity*. 3 credits.  
Special and general theories of relativity; cosmology; unified field theories.
- PHY 680 *Special Topics in Theoretical Physics*. Both semesters, 3 credits per semester, repetitive credit.  
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.
- PHY 682 *Special Topics in Solid State Physics*. Both semesters, 3 credits per semester, repetitive credit.  
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 super-conductivity, resonance phenomena and applications, plasma dynamics; advanced treatment of topics discussed in Physics 555, 562.

PHY 684 *Special Topics in Nuclear Physics*. Both semesters, 3 credits per semester, repetitive credit.

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.

PHY 686 *Special Topics in Elementary Particle Physics*. Both semesters, 3 credits per semester, repetitive credit.

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

PHY 688 *Special Topics in Astrophysics*. Both semesters, 3 credits per semester, repetitive credit.

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

PHY 699 *Thesis Research*. Both semesters (variable and repetitive credit).

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



## College of 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 which participate at present in three separate 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 totalling 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's 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 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.

## Graduate Program in Applied Analysis

(M.S. and Ph.D. degrees)

*Professors* Gerst (Chairman), Chang, Finerman (Director, Computing Center), Zemanian; *Associate Professors* Dicker, Kieburz, Marsocci, Thampuran; *Assistant Professors* Dolezal, Dollard, Rohrer, Tewarson, Tuan.

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, antenna theory, wave propagation, and radiation theory in plasma.

### Advanced Undergraduate Course

ESA 316 *Special Functions of Applied Analysis*. 3 credits.

### Graduate Courses

ESA 501 *Analysis of Linear Systems I*. 3 credits.

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

ESA 502 *Analysis of Linear Systems II*. 3 credits.

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.



ESA 503 *Principles of Applied Analysis I.* 3 credits.

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.

ESA 504 *Principles of Applied Analysis II.* 3 credits.

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.

ESA 505 *Probability Theory and Applications.* 3 credits.

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.

ESA 506 *Statistics.* 3 credits.

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.

ESA 511 *Complex Variable Theory with Applications.*

3 credits.

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.

ESA 515 *Non-Linear Systems*. 3 credits.

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.

ESA 524 *Theory of Approximation*. 3 credits.

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.

ESA 526 *Numerical Analysis I*. 3 credits.

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

ESA 527 *Numerical Analysis II*. 3 credits.

Ordinary differential equations, integral equations, partial differential equations of Elliptic, Parabolic and Hyperbolic type.

ESA 531 *Tensor and Group Methods in Applied Analysis*.  
3 credits.

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.

ESA 541, 542 *Network Theory*. 3 credits per semester.

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 Bochner-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 nondecreasing step functions are also analyzed.

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

ESA 543, 544 *Network Synthesis*. 3 credits per semester.

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.

ESA 551 *Feedback Control Systems I*. 3 credits.

Analysis and synthesis of automatic control systems, Nyquist and Bode plots, root locus method, multiple loop systems, synthesis through pole-zero configurations, compensating networks.

ESA 552 *Feedback Control Systems II*. 3 credits.

Statistical design theory, minimization of integral-square error, sampled data systems, adaptive control systems.

ESA 554 *Information Theory*. 3 credits.

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.

ESA 555 *Communication in Noise*. 3 credits.

This course is intended to complement the Information Theory course so that both together present various areas of general communication theory as a coherent unit. Topics to be covered include the Gaussian process, multivariate distributions, spectral analysis, generalized sampling, Karhunen-Loeve expansion, "optimum" and "perfect" detection, geometric (vector) representation of finite signal sets and signal spaces, signal sets concentrated in time-bandwidth, theoretical bounds on communication over the Gaussian channel, and comparison of binary "algebraic" codes versus M-nary "geometric" codes and combined codes in terms of their relative approach to the theoretical bounds. Although some familiarity with information theory is desirable, the Information Theory course will not be prerequisite.

ESA 561 *Vibrations*. 3 credits.

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

ESA 563 *Hydrodynamics*. 3 credits.

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.

ESA 565 *Wave Propagation I*. 3 credits.

Theory of propagation of electromagnetic, acoustic and elastic waves. Hamilton's equations and wave equations. One-dimensional elastic waves—the vibrating string. One dimensional acoustic and electromagnetic waves. The meanings of wave velocity; phase progression and energy transport. Boundary conditions—reflection and refraction. Resonance conditions and their interpretation. Wave propagation in anisotropic media. Wave propagation in non-uniform media. Relation between geometrical and physical optics. Fermat's principle. Generalization of Snell's law. WKB method and its generalization.

ESA 566 *Wave Propagation II*. 3 credits.

Theory of waveguiding structures. Closed wave guides; wave guide transmission lines; transverse resonance. Modal theory. Open wave guides, surface waves, beam waveguides, surface waves. Introduction to the theory of scattering; transmission line analogies; variational principle. Reciprocity theorems and field equivalence theorems. Symmetry relations. Propagation in a randomly varying medium. Transverse diffusion of bounded beams; scattering; scintillation.

*Prerequisite:* ESA 565.

ESA 571 *Solid-State Electronics I*. 3 credits.

A study of the transport processes in metals and 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; Hall-effect and magnetoresistance devices; theory of magnetism and magnetic devices; introduction to superconductivity and cryotrons, optical properties and related devices.

ESA 572 *Solid-State Electronics II*. 3 credits.

Development of equivalent circuits for transistors and for microelectronic devices. Conduction mechanisms in semiconductors, the continuity equation, p-n junction theory, theory of the junction transistor, transistor characterization. Description of various transistor types. Surface phenomena, conductivity of thin films, microelectronic devices and related circuits theory. Tunnelling phenomena and tunnel devices.

ESA 599 *Research* (variable and repetitive credit).

ESA 607 *Stochastic Processes*. 3 credits.

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.

ESA 621 *Advanced Operational Methods in Engineering Systems*.  
3 credits.

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.

ESA 623 *Distribution Theory and its Applications*. 3 credits.

Spaces of testing functions and distributions. The calculus of distributions. Distributions as derivatives of continuous functions; their direct product, convolution, and Fourier and Laplace transforms. The relationship between distribution theory and other theories of generalized functions, such as Lighthill's and Sauer's. The algebra of convolution and its relationship to Mikusinski's operational calculus. Applications to the analysis of linear systems. The Schmieden-Laugwitz extension to calculus. The use of distribution theory in applied analysis is emphasized throughout.

ESA 628 *Functional Analysis I*. 3 credits.

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.

ESA 629 *Functional Analysis II*. 3 credits.

Elements of Lebesgue integration, the class  $L_2$ , Riesz-Fischer theorem. Hilbert space, orthogonality, orthonormal expansions, self-adjoint operators, spectral analysis. 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

ESA 657, 658 *Optimum Design of Feedback Control Systems I and II.* 3 credits per semester.

System design by minimization of integral square error with constraint. Root square locus method. Analysis of random processes including power spectrum, correlation functions and Wiener's theorem. Statistical design theory of continuous and sample systems. Interpolation, extrapolation, filtering and prediction of continuous and sample data. State variable and Hilbert space concepts. Optimum filtering and prediction of nonstationary systems.

ESA 659, 660 *Non-Linear Systems and Optimal Control I and II.* 3 credits per semester.

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.

ESA 691 *Seminar in Applied Analysis.* 3 credits.

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

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.

Advanced Boundary Value Problems in Engineering Systems.

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.

## Graduate Program in Material Sciences

(M.S. degree)

*Professors Levine (Chairman), Seigle; Associate Professor Jach; Assistant Professors Jain, Mukherjee, R. Rosenberg.*

The motivating philosophy of the Master's degree program offered by the Department of Material Sciences is that of providing a broad and fundamentally oriented research training applicable to all classes of materials. Consequently, students are ordinarily required to take courses in the basic fields of solid state physics, dislocation theory with applications to continuum mechanics, physical chemistry of materials, and quantum theory of matter. In addition, basic courses providing training in advanced experimental techniques are also encouraged. The thesis may be theoretical or experimental and shall demonstrate a mastery of the subject.

Current research interests of the staff lie in the areas of semiconductors and thin films, phase transformations in solids, influence of point defects and dislocations in mechanical properties of materials, polymer-interface interactions, chemical reactivity at defects, and semi-metals.

### Advanced Undergraduate Courses

ESM 325 *X-ray Diffraction and Structure of Matter.*

ESM 326 *Quantum Theory of Matter.*

ESM 327 *Semiconductor Theory and Technology.*

ESM 328 *Nuclear Technology and Materials.*

### Graduate Courses

ESM 501 *Physical Chemistry of Engineering Materials I.*  
3 credits.

This course provides an advanced survey of the basic physical and chemical principles underlying the behavior of engineering materials: principles of quantum theory, theory of atomic and simple molecular spectra, intermolecular forces, covalent bonding, principles of statistical mechanics,

partition functions and their relationship to thermodynamics, theory of nonideal gases and liquids. Emphasis will be placed on the engineering applications of the theory.

ESM 502 *Physical Chemistry of Engineering Materials II.*  
3 credits.

Extensions of ESM 501 to the theory of solutions of electro-chemistry, homogeneous and heterogeneous equilibria, phase transformations, theory of transport phenomena, rate equations, chemical kinetics, surface phenomena and principles of nuclear structure and decay. Applications to metallurgy, materials processing and other branches of engineering will be emphasized.

ESM 510 *Phase Transformations.* 3 credits.

Thermodynamics of phase transformations, diffusion mechanisms, nucleation, mechanisms of phase transformation, solidification and melting, application to engineering materials.

ESM 511 *Dislocations and the Mechanical Properties of Matter.*  
3 credits.

Stress-strain tensors, principles of elasticity and plasticity, advanced dislocation theory, deformation of single crystals, deformation of polycrystalline materials, applications to creep, fracture fatigue.

ESM 520 *Physics of Engineering Solids I.* 3 credits.

This course will emphasize such topics as structure of solids, symmetry principle, and elementary group theory, bonding in solids, X-ray diffraction theory, solid state thermodynamics, point defects, dislocations, grain boundaries, elastic and plastic deformation, lattice vibrations and the thermal properties of solids.

ESM 521 *Physics of Engineering Solids II.* 3 credits.

Quantum theory of solids, Brillouin Zones, theory of conductors, insulators, phonon-electron interactions, magnetism. Applications to electronic devices, solid state energy converters, lasers, magnetic devices.

ESM 530 *Physical Properties of Polymers I.* 3 credits.

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 also emphasized.



ESM 531 *Physical Properties of Polymers II.* 3 credits.

This course is a continuation of ESM 530 and includes such topics as viscoelasticity, flow, and diffusion of polymers; sedimentation theory and ultraconfiguration, electrostatic free energy and the statistical mechanics of polyelectrolytes, electrophoresis theory and techniques, configuration of polymers in solution, catalysis by macromolecules.

ESM 540 *Advanced Techniques of Materials Research I.*  
3 credits.

Theory and laboratory demonstrations of high vacuum technique, high temperature technique, cryogenic procedures, single crystal and zone refining techniques.

ESM 541 *Advanced Techniques of Materials Research II.*  
3 credits.

Theory and demonstrations of spectroscopic methods, electron and X-ray diffraction.

ESM 599 *Research* (variable and repetitive credit).

ESM 603 *Surfaces and Interfaces I.* 3 credits.

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.

ESM 604 *Surfaces and Interfaces II.* 3 credits.

This course is the second half of ESM 603 and includes the physics of semi-conductor 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.

ESM 614 *Quantum Theory of Matter I.* 3 credits.

A formal introduction to quantum mechanics covering such topics as linear operators, matrix representatives of operators, inverse operators and Green's Functions, perturbation theory, electron spin of many electron systems, Hartree-Fock method, free electron approximations, band theory, Bloch functions, Brillouin Zones, Wigner-Seitz method, application to alloys, chemical bonding and other relevant areas.

**ESM 615 *Quantum Theory of Matter II.* 3 credits.**

Lattice vibrations in three dimensions, energy distribution of electrons, Boltzmann transport equation, electron motion in perfect three dimensional crystals, electron phonon interactions, magnetic properties, crystal field theory. Applications to thermoelectric devices, photoelectricity, stimulated emission amplifiers.

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

Chemical Transformations I.

Chemical Transformations II.

Statistical Theory of Matter I.

Statistical Theory of Matter II.

Topics in Materials Research.

Principles of Industrial Chemistry I.

Principles of Industrial Chemistry II.

Nuclear Theory and Technology.

Magnetic Materials.

Materials and Techniques of Modern Energy Conversion.

## Graduate Program in Mechanics

(M.S. and Ph.D. degrees)

*Professors Bradfield, Irvine; Associate Professors Cess (Acting Chairman), R. S. Lee, O'Brien; Assistant Professor Wang.*

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.

ESC 501, 502 *Advanced Heat Transfer.* 3 credits per semester.

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.

ESC 511, 512 *Advanced Fluid Mechanics I and II.*

3 credits per semester.

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.

ESC 514 *Homogeneous Turbulence.* 3 credits.

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

ESC 515 *Compressible Fluid Mechanics.* 3 credits.

The general conservation equations of gas dynamics from a differential and integral point of view. Hyperbolic compressible flow equations, un-

steady one-dimensional flows, the non-linear problem of shock wave formation, isentropic plane flow, small perturbation theory, method of characteristics, hodograph method.

ESC 516 *Viscous Fluids*. 3 credits.

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.

ESC 524 *Boundary Layer Theory*. 3 credits.

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.

ESC 599 *Research* (variable and repetitive credit).

ESC 622 *Magnetohydrodynamics*. 3 credits.

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.

ESC 623 *Statistical Fluid Mechanics*. 3 credits.

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

ESC 626 *Shear Flow Turbulence*. 3 credits.

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.

ESC 627 *Theories of Transition*. 3 credits.

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.

ESC 644 *Aerothermochemistry*. 3 credits.

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.

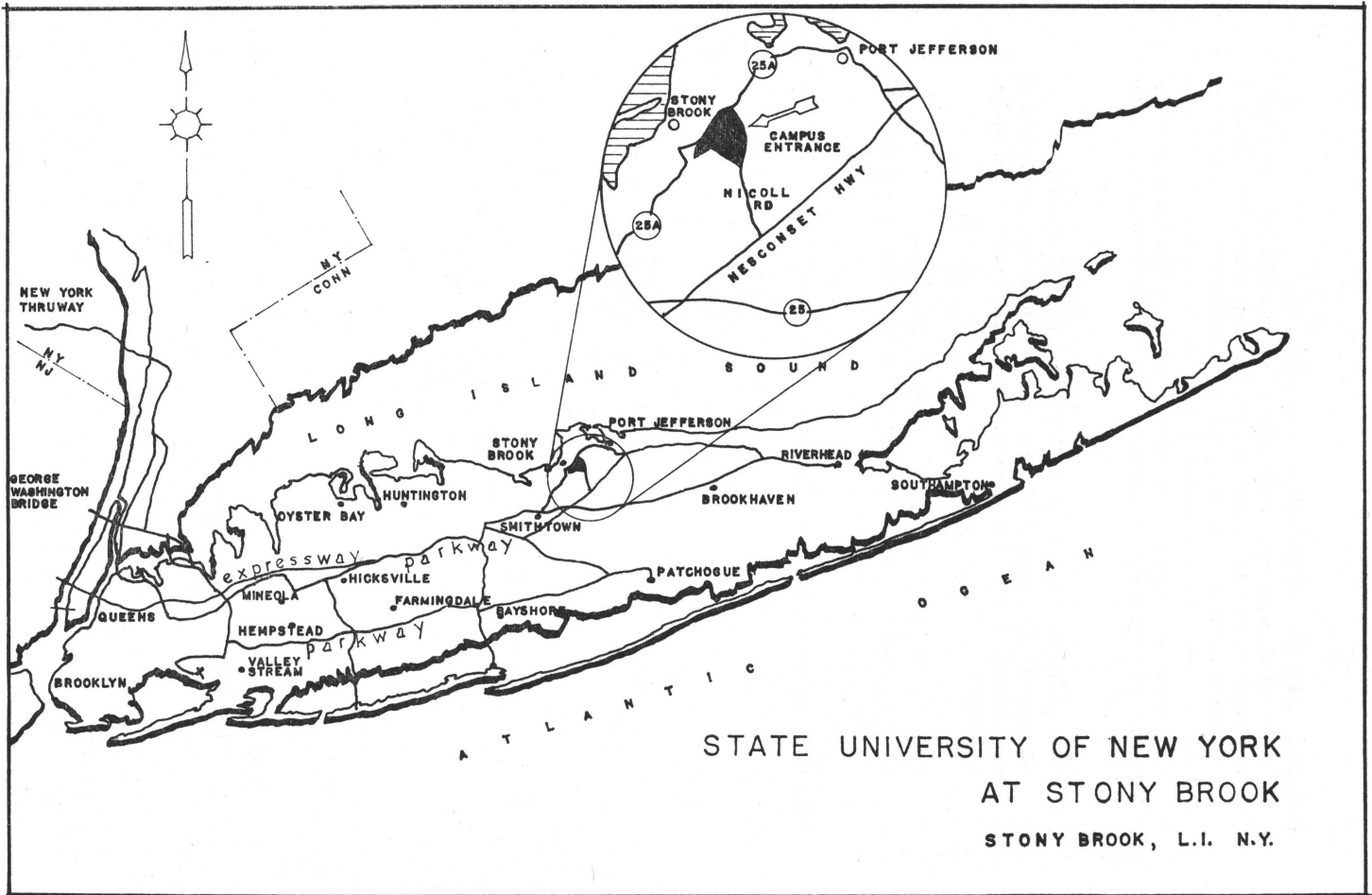
ESC 651 *Advanced Experimental Techniques*. 3 credits.

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

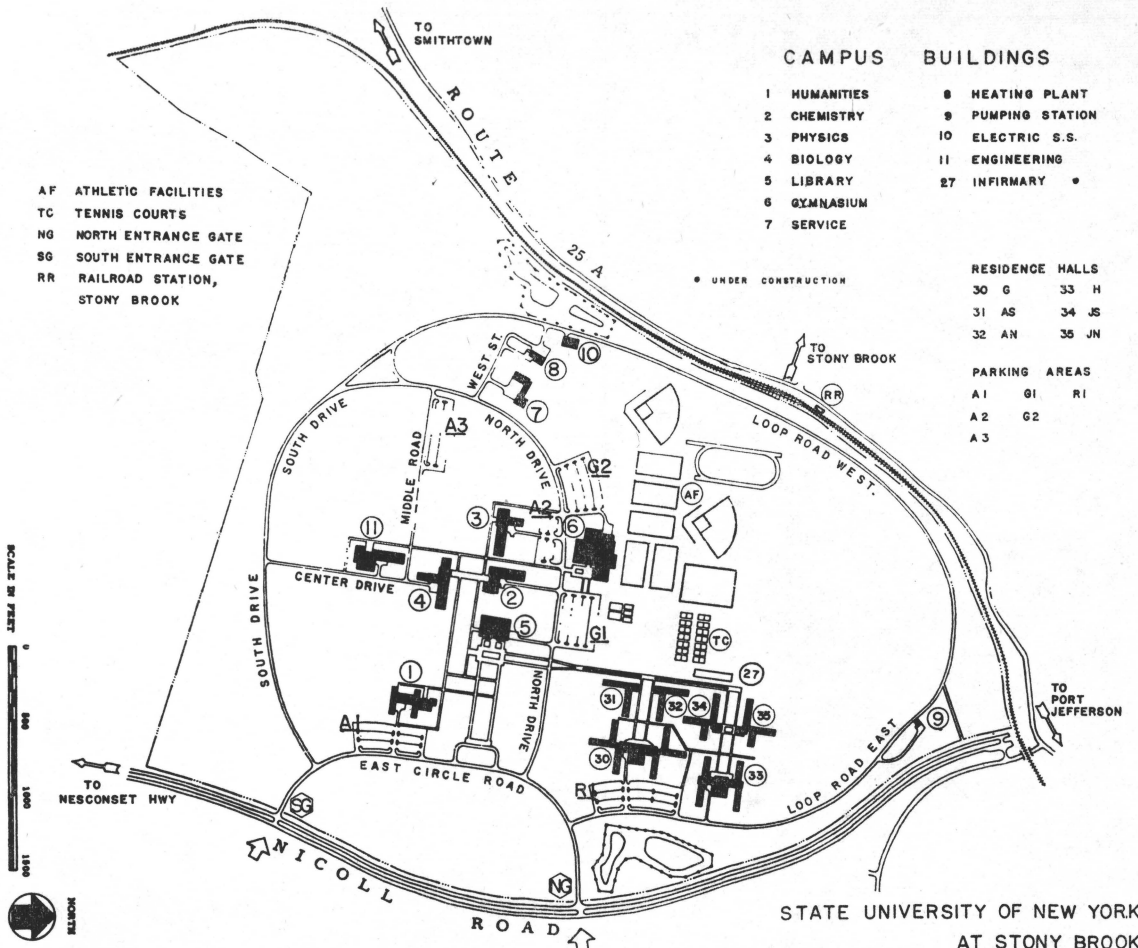
ESC 696 *Special Problems in Mechanics*. 3 credits.

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

ESC 699 *Research* (variable and repetitive credit).



STATE UNIVERSITY OF NEW YORK  
AT STONY BROOK  
STONY BROOK, L.I. N.Y.



AF ATHLETIC FACILITIES  
 TC TENNIS COURTS  
 NG NORTH ENTRANCE GATE  
 SG SOUTH ENTRANCE GATE  
 RR RAILROAD STATION,  
 STONY BROOK

**CAMPUS BUILDINGS**

- |              |                   |
|--------------|-------------------|
| 1 HUMANITIES | 8 HEATING PLANT   |
| 2 CHEMISTRY  | 9 PUMPING STATION |
| 3 PHYSICS    | 10 ELECTRIC S.S.  |
| 4 BIOLOGY    | 11 ENGINEERING    |
| 5 LIBRARY    | 27 INFIRMARY *    |
| 6 GYMNASIUM  |                   |
| 7 SERVICE    |                   |

\* UNDER CONSTRUCTION

**RESIDENCE HALLS**

- |       |       |
|-------|-------|
| 30 G  | 33 H  |
| 31 AS | 34 JS |
| 32 AN | 35 JN |

**PARKING AREAS**

- |    |    |    |
|----|----|----|
| A1 | G1 | R1 |
| A2 | G2 |    |
| A3 |    |    |

STATE UNIVERSITY OF NEW YORK  
 AT STONY BROOK  
 STONY BROOK LONG ISLAND





- D. Admission to Candidacy: The status of Candidate for the Master's 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 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.

REQUIREMENTS FOR THE BACHELOR OF ENGINEERING DEGREE

Effective as of September 1965

A student will be recommended by the Faculty for the degree upon completion of the requirements listed in sections 1, 2, and 3 below.

1. Required courses: Credit for, or exemption from, each of the following is required of all candidates:

Chemistry 103, 104	8 credits
English 101, 102	6 credits
Humanities	6 credits
Mathematics 102, 103, 155, 156	12 credits
Physics 101, 102, 151	12 credits
Social Science	6 credits
Physical Education	2 semesters

(Courses in Physical Education are to be completed  
after the Freshman Year.)

2. Elective requirement: 6 credits are normally required in the sophomore year in the areas of the humanities, (including foreign language courses numbered 150 and above), and the social sciences. An additional 6 credits are required in the senior year and can be taken in any area of study. With the approval of his academic advisor, a student may substitute the 7th-semester Open Elective for the 4th-semester Non-Technical Elective. In this case the Non-Technical Elective must be taken in the 7th semester.
3. Concentration requirement: Every student must meet the requirements of a program of concentration in Engineering Science approved by the Curriculum Committee of the College of Engineering.



4. Unless an alternate program is approved by the College of Engineering Curriculum Committee, every student admitted without advanced standing is required during the freshman year to register for:

ESG 100, 101

English 101, 102

Two semesters of Humanities

Mathematics 102, 103

Physics 101, 102

Two semesters of Social Science

Courses to meet the Humanities requirement are to be chosen from the following:

Humanities 103, 104, 105, 106, 112, 113, 114, 115, 116, 121, 122, 123.

There is no prescribed sequence nor prerequisite for any of the Humanities courses except for Humanities 112.

Courses to meet the Social Science requirement are to be chosen from the following:

Anthropology 101, 102

Economics 101, 102

History 101, 102

Political Science 101, 102

Psychology 101, and any Psychology course for which the prerequisites have been fulfilled.

Sociology 101, 102

5. Exemptions: On the recommendation of the Chairman of the appropriate Department, a student is exempted without credit from any of the course requirements specified in sections 1 or 4 above.



# STATE UNIVERSITY OF NEW YORK

Central Administrative Office: Albany 1, N. Y.

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

## SPECIALIZED COLLEGES

College of Forestry at Syracuse University  
Graduate School of Public Affairs at Albany  
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

## TWO-YEAR COLLEGES

Agricultural and Technical Colleges at:   Alfred                   Delhi  
  Canton                   Farmingdale  
  Cobleskill               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

