# STATE UNIVERSITY OF NEW YORK

AT STONY BROOK

STONY BROOK L. I., NEW YORK

# GRADUATE SCHOOL BULLETIN

1962 — 1963

STATE UNIVERSITY OF NEW YORK

AT STONY BROOK

# GRADUATE SCHOOL
# *TEMPORARY BULLETIN

1962-63

*Final printed Bulletin will be issued at a later date.

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| Robert Haberman | Assistant Librarian |
| Robert Birnbaum | Assistant Dean of Students |
| Thomas A. Post | Assistant Director of Admissions |
| I. Andre Edwards | Assistant Dean of Students (Residence Hall) |

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# Calendar

## Fall Semester 1962

| | |
|---|---|
| Classes Begin | September 25 |
| Last day of registration for graduate students | October 2 |
| Thanksgiving Holidays | November 22, 23 |
| Classes Resume | November 26 |
| Christmas Holidays | December 21-January 1 |
| Classes Resume | January 2 |
| Semester Examinations Begin | January 14 |
| Last Day of Semester | January 25 |

## Spring Semester 1963

| | |
|---|---|
| Classes Begin | February 4 |
| Last day of registration for graduate students | February 11 |
| Washington's Birthday (Holiday) | February 22 |
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| Spring Holiday | April 1-5 |
| Classes Resume | April 8 |
| Final Examinations Begin | May 20 |
| Memorial Day (Holiday) | May 30 |
| Last Day of Semester | May 31 |
| Commencement | June 2 |

FACULTY

Nandor Balazs
Professor of Physics
M.A., Scientific University of Budapest, 1948
Ph.D., University of Amsterdam, 1951

Francis T. Bonner
Professor of Chemistry
Chairman, Department of Chemistry
B.A., University of Utah, 1942
M.S., Yale University, 1944
Ph.D., Yale University, 1945

Walter S. Bradfield
Professor of Engineering
Chairman, Department of Thermal Sciences
B.S., Purdue University, 1941
M.S., California Institute of Technology, 1945
A.E., University of Michigan, 1949
Ph.D., University of Minnesota, 1957

Robert D. Cess
Associate Professor of Engineering
B.S., Oregon State College, 1955
M.S., Purdue University, 1956
Ph.D., University of Pittsburgh, 1959

Robert Lee de Zafra
Assistant Professor of Physics
A.B., Princeton University, 1954
Ph.D., University of Maryland, 1958

**Daniel Dicker
Assistant Professor of Engineering
B.C.E., City College of New York, 1951
M.C.E., New York University, 1955
Eng.Sc.D., Columbia University, 1961

Leonard Eisenbud
Professor of Physics
B.S., Union College, 1935
Ph.D., Princeton University, 1948

Arnold M. Feingold
Professor of Physics
B.A., Brooklyn College, 1941
M.A., Princeton University, 1948; Ph.D., 1952

David Fox
Professor of Physics
B.A., University of California at Berkeley, 1942;
M.A., 1950; Ph.D., 1952

**Irving Gerst
Professor of Engineering
Chairman, Department of Engineering Analysis
B.S., City College of New York, 1931
M.A., Columbia University, 1932; Ph.D., 1947

Theodore D. Goldfarb
Assistant Professor of Chemistry
A.B., Cornell University, 1956
Ph.D., University of California at Berkeley, 1959

Barry M. Gordon
Assistant Professor of Chemistry
B.S., University of California at Los Angeles, 1951
Ph.D., Washington University, 1955

Thomas F. Irvine, Jr.
Professor of Engineering
Dean, College of Engineering
B.S., Penn State University, 1946
M.S., University of Minnesota, 1951; Ph.D., 1956

Peter B. Kahn
Assistant Professor of Physics
B.S., Union College, 1956
Ph.D., Northwestern University, 1960

Edward M. Kosower
Associate Professor of Chemistry
S.B., Massachusetts Institute of Technology, 1948
Ph.D., University of California, 1952

*Edward D. Lambe
Associate Professor of Physics
B.A. Sc., University of British Columbia, 1948;
M.A. Sc., 1949
Ph.D., Princeton University, 1959

William J. le Noble
Assistant Professor of Chemistry
B.S., Equiv. Advanced Technical School at
Dordrecht, Holland, 1949
Ph.D., University of Chicago, 1957

Arthur R. Lepley
Assistant Professor of Chemistry
A.B., Bradley University, 1954
S.M., University of Chicago, 1956; Ph.D., 1958

**Sumner N. Levine
Professor of Engineering
Chairman, Department of Material Sciences
B.S., Brown University, 1946
Ph.D., University of Wisconsin, 1949

Richard A. Mould
Assistant Professor of Physics
B.S., Lehigh University, 1951
M.S., Yale University, 1954; Ph.D., 1957

Herbert Muether
Professor of Physics
B.S., Queens College (N.Y.), 1942
A.M., Princeton University, 1947; Ph.D., 1951

Edward O'Brien
Assistant Professor of Engineering
B.E., University of Queensland, Australia, 1955
M.S.M.E., Purdue University, 1957
Ph.D., Johns Hopkins University, 1960

Thomas A. Pond
Professor of Physics
Chairman, Department of Physics
A.B., Princeton University, 1947; A.M., 1949;
Ph.D., 1953

Fausto Ramirez
Professor of Chemistry
B.S., University of Michigan, 1946; M.S., 1947;
Ph.D., 1949

B. James Raz
Associate Professor of Physics
B.S., University of Rochester, 1950; Ph.D., 1955

Robert Schneider
Assistant Professor of Chemistry
A.B ., Columbia University, 1954; M.A., 1956;
Ph.D., 1959

William T. Snyder
Associate Professor of Engineering
B.S.M.E., University of Tennessee, 1954
M.S.M.E., Northwestern University, 1956;
Ph.D., 1958

Richard Solo
Assistant Professor of Chemistry
B.S., Massachusetts Institute of Technology, 1958
Ph.D., University of California at Berkeley, 1962

Sei Sujishi
Professor of Chemistry
B.S., Wayne State University, 1946; M.S., 1948
Ph.D., Purdue University, 1949

Clifford E. Swartz
Associate Professor of Physics
A.B., University of Rochester, 1945; M.S., 1946;
Ph.D., 1951

**Armen H. Zemanian
Professor of Engineering
B.E.E., City College of New York, 1947
M.E.E., New York University, 1949; Sc.D., 1953

*On leave until September, 1963

**Participating in the graduate program of the Department of Thermal Sciences

# GENERAL INFORMATION

At the beginning of its first year on its permanent campus, the State University of New York at Stony Brook has the mandate to award undergraduate and graduate degrees in all the major fields as facilities permit. Established as the first of the four major university campuses within the State University system, the Stony Brook campus is expected to enroll 10,000 students in 1970.

Graduate programs, leading to the M.A., M.S., and Ph.D. degrees, were initiated in September 1962 by the Department of Chemistry and the Department of Physics of the College of Arts and Sciences and by the Department of Thermal Sciences of the College of Engineering. During the following years, additional departments are expected to develop graduate programs in various areas of the social sciences, humanities, physical sciences, and engineering.

## Stony Brook Campus

The permanent campus is situated in a wooded and hilly region of the north shore, on four hundred and eighty acres of land donated to the State of New York by Ward Melville. The region, which is commonly known as the Three Village area from the associated villages of Stony Brook, Setauket, and Old Field, is rich in historic landmarks and cultural facilities. Churches and stores are conveniently situated in Stony Brook and East Setauket.

Plans for the new campus were first made in 1956 and actual preparation of the site began the next year. As the academic year 1962-63 opens, the following buildings will be available for use: a dormitory and dining hall to accommodate six hundred students, the Humanities building, the Chemistry building, and a group of service buildings. By the beginning of the academic year 1963-64 the Library and the Biology, Physics, Engineering, and Physical Education buildings are expected to be ready.

Designs have been approved for an Administration building, a Student Union building, an infirmary, and two dormitories. In the planning stage are a social science building, a fine arts center, a second Engineering building, and addititional dormitories.

Research Facilities

The new Chemistry Building is a spacious, modern structure (83,000 sq. ft. gross floor area) designed for research and instructional activities covering a broad range of specialization in chemistry. Equipment available for research use will include nuclear magnetic resonance spectrometers, spectrophotometers covering the electromagnetic spectrum from the microwave region to the far ultraviolet, Raman spectrometer, mass spectrometer, nuclear detection apparatus, electron spin resonance spectrometer, x-ray spectrometer, and optical rotatory dispersion equipment. In addition, such accessories as have become routinely essential in modern chemical research (e.g., gas chromatographs, high vacuum equipment, infrared and ultraviolet analytical instruments) are broadly included. Glass blowing and machine shop facilities also will be available.

The Physical Laboratory, to be completed in mid-1963, contains 76,000 square feet, of which more than one-third will be available for graduate instruction and faculty and graduate research. In addition to the usual departmental shop facilities (photographic, electronic, and machine shops) the initial equipping of the Laboratory will include experimental apparatus for research in low-temperature and solid-state physics, magnetic resonance, quantum electronics, beta and gamma-ray spectroscopy. The Physics Department includes faculty members affiliated in research with Brookhaven National Laboratory; a portion of the experimental program will be in instrumentation in nuclear and high energy physics for use at such nearby facilities. The faculty's activities in theoretical physics include nuclear theory, statistical mechanics, field theory, many-body problems, plasma physics, solid state physics and general relativity; research in these areas will be aided by proximity to the University Computing Center.

An Engineering Building (containing 96,000 sq. ft. of gross floor area) is now under construction; it is to be occupied in September, 1963. During the initial period of occupancy, this building will be used for instruction and research, and will house the Computing Center. At a later date, the major research facilities and the Computing Center will be located in a Graduate Research Building, now in the planning stage. The Engineering Buildings will be equipped for the research of the Departments of Electrical Sciences, Engineering Analysis, Material Sciences, and Thermal Sciences; the latter department will have apparatus for research in the areas of heat transfer (including free and forced convection, radiation, film boiling, and heat transfer in chemically reactive systems), turbulence and diffusive processes, combustion, energy conversion, magnetohydrodynamics, and irreversible thermodynamics. Shop facilities will include a precision machine shop, faculty and student shops, and an electronics shop.

## Library Facilities

The library building now under construction will seat 750 readers and house 350,000 volumes; there are plans for an annex that will provide space for an additional 600,000 volumes. The new building is being equipped as an open-stack library, with carrels, study rooms, projection and music rooms, and areas for special materials. It will offer a maximum of free access to the collections, together with a maximum of privacy, by scattering small seating areas throughout the stacks. With its accelerating growth and attractive new quarters the library will be the intellectual as well as the physical center of the new campus.

The number of subscriptions to periodicals in Physics, Chemistry, Engineering, and Mathematics is about 500 and is increasing rapidly. The library purchases most of the current books of interest to research workers in these fields; there is also an extensive program for the acquisition of older books in these areas. Books and photocopies of articles not presently available may be obtained through an efficient interlibrary loan service. Facilities for microfilm and microprint reading are available. For making reproductions, the library has a thermocopying machine and a microfilm reader-printer.

## Computing Center

The services of the Computing Center of the College of Engineering are available to all faculty members and their graduate students. At present, the Center has an IBM 1620, with 40,000 positions of storage, and card input-output; peripheral equipment includes a printer, a sorter, and several key-punch units. The capacity of the 1620 will be increased in the near future.

Since the need for computer facilities is increasing, present plans call for a larger and faster machine to be installed by 1964.

The Computing Center intends to build a staff of full-time professional programmers and graduate students who will furnish programming assistance to faculty members and their graduate students and carry out research in the various areas of the computational sciences.

Housing Accommodations

Single graduate students may live in the university residence halls. In 1963-64 housing for approximately 1200 men and women will be available on the Stony Brook campus. All rooms provide for double occupancy and include a bed, mattress, bureau, study desk and chair, lamp and closet for each student.

Board, consisting of 21 meals per week, is purchased by resident students each semester. Non-resident students may purchase meals in the university dining hall also.

It is very difficult to obtain housing off-campus within walking distance of the University. However, houses, apartments, and rooms are available within a reasonable driving distance.

## 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 some special 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, Long Island, New York.

## FINANCIAL INFORMATION

### Tuition

The tuition rate for graduate students is $20 per semester-hour. There is no tuition charge for teaching assistants, but they pay the other fees listed below:

## Other Fees

State University Fee: $1.75 per semester-hour.
Student Health and Accident Insurance: $22.50 per academic year.
Matriculation Fee: $5.00, paid at the time of admission.
Late Registration Fee: $2.00, paid by students who register after the official registration period.
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 at the Stony Brook campus will be approximately $815-$830 per academic year, payable on a quarterly basis. A $25 advance deposit is required, and this amount is applied to the first quarter payment. The room deposit is not refundable after June 30. Each resident student pays approximately $25 per year for linen service.

## Refunds

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

## Assistantships and Fellowships

Teaching Assistantships are available, each with a stipend of $2,500 for the 1962-63 academic year and with tuition exemption.

Research assistantships and University research fellowships are available for advanced graduate students.

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

Other Financial Aid

Veterans may attend the State University under the benefits of Public Law 894 (disability) or 550 (Korean War).

Other sources of direct financial aid and loans include the Division of Vocational Rehabilitation of the New York State Education Department, the New York State Scholar Incentive Program, the New York Higher Education Assistance Corporation, and the National Defense Education Act program. Information may be obtained from the Dean of Students.

## 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 two to three years of full-time study. (A 12 semester-hour course load in a fall or spring semester is a full-time program. Teaching assistants ordinarily take 9 semester-hours.)

The following degree requirements are common to the three departments now offering graduate programs. (A later section contains a detailed list of requirements for each department, together with the graduate course offerings.)

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

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

## The Ph.D. Degree

1. Residence: two years
2. The passing of a proficiency examination in each of two languages
3. The passing of the departmental preliminary (cumulative) 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 of 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 401 and above. Odd-numbered courses are ordinarily given in the fall, even-numbered courses in the spring.

The following symbols are used for department names:

CHE - Chemistry
PHY - Physics
ESA - Engineering Analysis
ESM - Material Sciences
EST - Thermal Sciences

## CHEMISTRY

Professors Bonner (Chairman), Ramirez, Sujishi; Associate Professor Kosower; Assistant Professors Goldfarb, Gordon, le Noble, Lepley, Schneider, Solo.

## Admission to Graduate Study

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

A. Baccalaureate degree in chemistry from an institution accredited by the American Chemical Society, or an equivalent course of study. The undergraduate background should include completion of five years of college work in chemistry, including one year each of work in general, quantitative, organic and physical chemistry. It should also include at least one year of college physics and two years of college mathematics, including differential and integral calculus.

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.

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

## 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 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 problem.

## Research Advisor

In order to discover and develop ability to do independent and productive scientific research, it is desirable for the student to undertake a research program as soon as possible. Upon conclusion of the pre-research seminar series, each first-year student shall apply to a faculty member of his choice for acceptance as a research student, 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.

## 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, and a typical first-year program is as follows:

First Semester

| | |
|---|---|
| Organic Chemistry ..... | 2 hours |
| Inorganic Chemistry ..... | 2 hours |
| Advanced Physical Chemistry | 3 hours |
| Elective (e.g., Chem. 301, Math. 301, Phys. 220, 340) | 3 hours |
| Seminar | |

Second Semester

| | |
|---|---|
| Chemical Thermodynamics .... | 3 hours |
| Chemical Kinetics ..... | 2 hours |
| Physical Organic and Inorganic Chemistry ..... | 2 hours |
| Research ..... | 3 hours |
| Seminar | |

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 of an approved course of study comprising at least 24 graduate credit hours
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 a 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 the 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 admission 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

A. Advanced undergraduate courses

| | |
|---|---|
| CHE 301, 302 | Experimental Methods of Chemistry I and II |
| CHE 305 | Intermediate Inorganic Chemistry |
| CHE 315 | Intermediate Organic Chemistry |

B. Graduate courses to be offered beginning 1962-63

CHE 401 Advanced Organic Chemistry, 2 hrs. 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 411 Advanced Inorganic Chemistry, 2 hrs. The thermodynamic and structural properties of reacted inorganic systems of current interest will be discussed. These will include elementary and binary systems at high temperatures, simple and complex hydrides, and polynuclear and complex ions.

CHE 421 Advanced Physical Chemistry, 3 hrs. 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 424 Chemical Thermodynamics, 3 hrs. 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 426 Chemical Kinetics, 2 hrs. 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, reactions in solution, electron-transfer reactions, chain reactions, and the new approaches to the study of very rapid chemical reactions.

CHE 404 Physical Organic and Physical Inorganic Chemistry, 2 hrs. A concise and intensive survey of the mechanisms of chemical transformation, including $Sn1$ and $Sn2$ reactions, allylic and other rearrangements, Diels-Alder reaction, carbonyl addition reactions, substitution and electron-transfer reactions in coordination complexes, substitution on elements other than carbon, transition metal complexes.

CHE 416 Nuclear Chemistry, 3 hrs. 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 chemical phenomena accompanying nuclear reactions.

CHE 431, 432 Graduate Seminar, 1½ hrs. for each of two semesters

CHE 499 Thesis Research, variable and repetitive credit

C. Graduate courses to be offered beginning 1963-64

CHE 441 Special Topics in Organic Chemistry, 2 hrs. A one semester course dealing with methods of synthesis of organic compounds or with certain specialized aspects of organic chemistry such as organophosphorus compounds, nitrogen heterocyclics (purines, pyrimidines, etc.), chemistry of the nucleotides.

CHE 444 Physical Organic Chemistry (II), 2 hrs. 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 of reaction rates; charge-transfer complexes and spectra; aromatic electrophilic, nucleophilic, and free-radical substitution; photochemistry; and free radical reactions.

CHE 447 Molecular Biochemistry, 2 hrs. 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 443 Polymer Chemistry, 2 hrs. A survey of the most important polymers, both industrial and biological. The structure and physical properties of polymers, initiation and inhibition, kinetics of chain transfer and stereo-specific polymerization are discussed to provide a basic foundation in the field for students preparing for a career in industrial laboratories.

CHE 445 Intermediates in Organic Chemistry, 2 hrs. The most important intermediates in organic reactions (free radicals, carbonium ions, carbonions, benzynes, carbenes, etc.) are discussed on the basis of evidence such as the products of reaction, kinetics, spectral observation, etc. Emphasis is on recent work not yet digested by the text-books.

CHE 449 Theoretical Organic Chemistry, 2 hrs. 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 polarizability are discussed.

CHE 464 Infrared Spectroscopy, 2 hrs. A detailed description of the theory and practice of infrared spectroscopy. Topics to be covered will include energy levels, normal coordinate analysis and selection rules for polyatomic molecules, infrared spectra of solids, and advanced applications of spectroscopic techniques to problems of chemical interest such as analysis and molecular structure.

CHE 456 Applications of Nuclear Chemistry, 2 hrs. The application of radioactive and stable nuclides to selected fields of chemical research, including chemical kinetics, structural chemistry, self-diffusion, chemical analysis, hot-atom chemistry, and geochemistry. Strong emphasis will be placed upon student participation in the presentation of specialized topics.

CHE 461 Topics in Chemical Physics, 2 hrs. Advanced topics in quantum mechanics will be treated including applications of group theory to chemical problems, perturbation theory, collision theory and certain aspects of the theory of spectroscopy of molecules.

## PHYSICS

Professors Balazs, Eisenbud, Feingold, Fox, Muether, Pond (Chairman); Associate Professors Lambe, Raz, Swartz; Assistant Professors deZafra, Kahn, Mould

### 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.

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 or examination, given at the beginning of the first semester.

## Qualifying Examination

An examination will be given to each graduate student in February of his first year, to determine whether he may continue his graduate studies.

## Requirements for the M.A. Degree

A. Residence: one year

B. Advancement to candidacy

C. Courses: The student must complete a program of courses which is approved by his faculty advisor and which includes PHY 401 (Analytical Mechanics), PHY 402 (Electrodynamics) and PHY 411 (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.

## 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 | Second Semester |
|---|---|
| Analytical Mechanics | Electrodynamics |
| Quantum Mechanics | Quantum Mechanics |
| Statistical Mechanics | Nuclear Physics |
| **Third Semester** | **Fourth Semester** |
| Theoretical Nuclear Physics | Solid State Theory |
| Solid State Physics | Electives |
| Elective | |

## Requirements for the Ph.D. Degree

A. Preliminary examination: The preliminary examination will be given in two parts. Part A will be a written examination, and will cover the following topics: Analytical Mechanics, Electrodynamics, Statistical Mechanics, Methods of Theoretical Physics. Part B will be partly written and partly oral, and will cover Quantum Mechanics, Nuclear Physics, Solid State Physics. Part B 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. A student who is admitted to graduate study with no conditions will ordinarily take Part A in September of his second year and Part B 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 A of the preliminary examination is taken, and in the second language before Part B.

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 - Modern Physics
PHY 220, 340 - Methods of Mathematical Physics I and II
PHY 345, 346 - Senior Laboratory
PHY 343 - Statistical Physics

B. Graduate courses to be offered beginning 1962-63

PHY 401 Analytical Mechanics, 3 hrs. Dynamics of particles and rigid bodies, Lagrange's and Hamilton's equations, variational principles, cononical formulation, Hamilton-Jacobi equation.

PHY 402 Electrodynamics, 3 hrs. Maxwell's equations, scalar and vector potential theory, boundary value problems, electromagnetic waves and radiation.

PHY 411 Quantum Mechanics I, 3 hrs. 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 412 Quantum Mechanics II, 3 hrs. Formal structure of quantum theory, collision problems and formal scattering theory, elementary quantization of the radiation field, introduction to Dirac electron theory.

PHY 415 Statistical Mechanics, 3 hrs. Boltzmann statistics, H theorem and entropy, quantum statistics, microscopic approach to thermodynamics.

PHY 420 Nuclear Physics, 3 hrs. Basic properties of nuclei, nuclear forces, radioactivity, fission, electromagnetic properties; experimental techniques, accelerators and nuclear detectors; introduction to high energy physics and elementary particles.

PHY 440 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.

C. Graduate courses to be offered beginning 1963-64

PHY 445 Solid State Physics, 3 hrs. 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 446 Solid State Theory, 3 hrs. Transport properties of solids, including interactions of electrons with various imperfections, galvanomagnetic and thermoelectric effects, and limitations of the band theory of solids; optical, spectroscopic and photoelectric properties.

PHY 451 Theoretical Nuclear Physics, 3 hrs. The two-body problem, theory of nuclear forces and properties of nuclear matter, nuclear models, formal theory of nuclear reactions.

PHY 456 Advanced Quantum Mechanics, 3 hrs. Group theory and other techniques useful in treating many body-systems; applications to atomic spectra, nuclear structure, properties of nuclear matter, theory of superconductivity.

PHY 460 High Energy Physics, 3 hrs. Experimental techniques, cascade theory, meson interactions, fundamental particle systematics, weak and strong interactions, ultra-high energy phenomena.

PHY 465, 466 Quantum Field Theory I, II, 3 hrs. each term. Field quantization; scalar and pseudoscalar meson field; electromagnetic field, Dirac field, interacting fields; Feynman diagrams; charge and mass renormalization; dispersion relations.

PHY 470 Relativity, 3 hrs. Special and general theories of relativity; cosmology; unified field theories.

PHY 481 Special Topics in Theoretical Physics, Both semesters, 3 hrs. 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 483 Special Topics in Nuclear Physics, Both semesters, 3 hrs. 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 theory of angular correlations, photonuclear reactions, 3-decay theory, collective vibrations.

PHY 485 Special Topics in Solid State Physics, Both semesters, 3 hrs. 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 610, 611.

PHY 499 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.

# THERMAL SCIENCES

Professors Bradfield (Chairman), Irvine (Dean, College of Engineering). Associate Professors Cess, Snyder; Assistant Professor O'Brien.

Members of other departments participating in the Thermal Sciences Graduate Program:

Department of Engineering Analysis: Professors Gerst (Chairman), Zemanian; Assistant Professor Dicker.
Department of Material Sciences: Professor Levine (Chairman)

## Admission to Graduate Study

For admission to graduate study in Thermal Sciences and Fluid Mechanics, the following are required:

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

B. A minimum grade average of B in all courses in engineering, natural sciences, and mathematics.

C. Acceptance by the department.

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 to terminate his provisional standing.

## Requirements for the M.S. Degree

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

B. Formal course requirements: 30 credit hours of formal courses in which a grade of A or B has been achieved.

C. Qualification to candidacy (see below).

D. Thesis

E. Oral defense of thesis: Upon acceptance of the 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.

## Qualification to Candidacy

The qualification of each graduate student shall be reviewed by the faculty of the Department of Thermal Sciences and Fluid Mechanics after one semester's residence. This review is for the purpose of recommending the graduate student for candidacy. Decisions will be based upon records submitted at the time of admission, performance in formal course work, and the opinion of the student's research advisor.

## Requirements for the Ph.D. Degree

A. Residence: two years

B. Languages: either German or Russian, and one additional language approved by the department.

C. Qualifying examination: The department will satisfy itself by written qualifying examination that students who signify intent to undertake study for the Ph.D. degree are qualified to do so. This examination shall precede the comprehensive preliminary examination by a minimum of approximately two semesters. Students must make arrangements with the department to take the examination.

D. Preliminary examination: Upon completion of course work, a comprehensive written preliminary examination will be given. A comprehensive oral preliminary examination will follow the successful completion of the written examination.

E. Advancement to candidacy: The department will recommend to Graduate School that the student be advanced to candidacy after his successful completion of the language and preliminary examinations.

F. Research and thesis: By the end of the second semester of residence, the Department Chairman, after consultation with the student, shall request the appointment by the Graduate School of a Graduate Advisory Committee. The student will present for approval to this Committee a plan for future course work, the name of a proposed thesis advisor, and a tentative thesis topic. The research and the writing of the thesis will be carried out under the direction of the thesis advisor.

G. Oral defense of thesis: The student will defend his thesis before an examining committee. On the basis of the recommendation of this committee, the Chairman of the Department will recommend acceptance or rejection of the thesis to the Graduate School.

## Sample Programs

The following is a sample program, leading to the M.S. degree, for a full-time student who is well prepared on admission to graduate study:

Semester I

| | |
|---|---|
| Advanced Heat Transfer I | 3 |
| Advanced Fluid Mechanics I* | 3 |
| Advanced Engineering Analysis I | 3 |
| Theoretical Physics I | 3 |

Semester II

| | |
|---|---|
| Advanced Heat Transfer II | 3 |
| Advanced Fluid Mechanics II* | 3 |
| Advanced Engineering Analysis II | 3 |
| Theoretical Physics II | 3 |
| Thesis (Summer) | 6 |

*More specialized courses will be substituted for students intending to continue through doctoral program.

The following sample program, for a full-time student concentrating n Fluid Mechanics, leads from the Master's degree to the Doctorate:

Semester III

| | |
|---|---|
| Perfect Fluid Theory | 3 |
| Homogeneous Turbulence | 3 |
| Elective in Physics | 3 |
| Elective in Mathematics | 3 |

Semester IV

| | |
|---|---|
| Magnetohydrodynamics | 3 |
| Seminar in Thermal Sciences | 3 |
| Physical Gas Dynamics* | 3 |
| Elective in Mathematics | 3 |

Comprehensive examinations for candidacy
Dissertation
Final oral defense of dissertation

*Equivalent courses at predoctoral level in the Mathematics or Physics Department may be substituted, with consent of the student's committee (e.g., quantum mechanics, statistical mechanics, field theory, partial differential equations, calculus of variations).

Other Participating Departments

In addition to the faculty of the Department of Thermal Sciences, faculty members in other departments of the College of Engineering will offer graduate level courses in related areas. These will include courses in energy conversion, molecular theory of fluids, advanced engineering analysis and computer logic.

Courses

A. Advanced undergraduate courses

EST 373 Continuum Mechanics
EST 375 Viscous Fluids

B. Graduate courses to be offered beginning 1962-63

EST 401, 402 Advanced Heat Transfer, 3 hrs. each 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.

EST 411, 412 Advanced Fluid Mechanics I and II, 3 hrs. each semester. Properties of fluids, equations of motion in general form. Compressible flows; isentropic flows and shock waves. Viscous flows; non-Newtonian flows, isotropic turbulence, jets and electromagnetic fields and boundary layers. Topics in rarefied gas dynamics.

EST 421 Rarified Gas Dynamics, 3 hrs. Basic concepts from statistical thermodynamics and the theory of non-uniform gases are introduced and applied to the flow of rarefied gases.

EST 422 Magnetohydrodynamics, 3 hrs. General concepts of ionized gases, charge and current densities, the Maxwell equations, the electromagnetic boundary conditions, MHD wave phenomena, motion of a single charged particle in electric and magnetic fields, scalar and tensor electric conductivity, the MHD conservation equations, regimes of MHD flows, internal MHD flows, external MHD boundary layer flows.

EST 431 Advanced Thermostatics, 3 hrs. Review of foundations of classical thermostatistics: chemical equilibrium, phase and other aspects of multicomponents, system equilibrium. Advanced formulations of the first and second laws, the Caratheodory formulations; stability of thermostatic systems; thermostatics in fields; surfact and interfacial systems; higher-order phase transitions.

EST 444 Aerothermochemistry, 3 hrs. A generalized treatment of combustion thermodynamics including a systematic derivation of thermodynamic equations, Bridgman tables, criteria for 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.

EST 492 Seminar in Thermal Sciences, variable credit. Consideration of fundamental topics of current interest in the field of thermomechanics with joint participation of students and faculty.

EST 496 Special Problems in Thermal Sciences, 3 hrs. Conducted jointly by graduate students and one or more members of the faculty.

EST 499 Research, variable and repetitive credit.

ESA 401 Advanced Engineering Analysis I, 3 hrs. Propagation problems in discrete systems, integral transform techniques, system functions, convolution operations, theory of residues, complex inversion techniques.

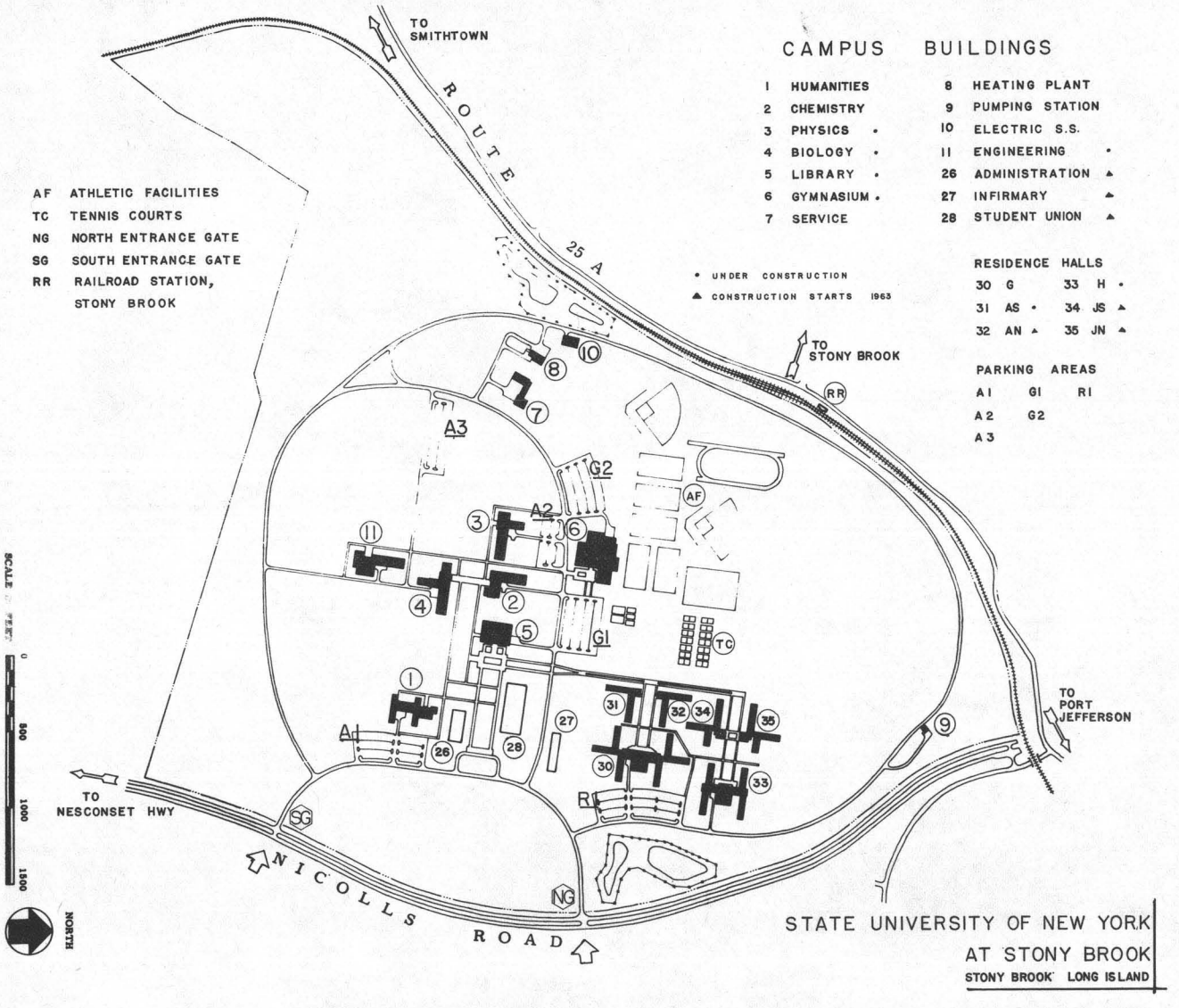
ESA 402 Advanced Engineering Analysis II, 3 hrs. Propagation problems in continuous systems, solution of partial differented equations by transform techniques, asymptotic relations, iterative structures, sampled-data systems, z-transform systems with memory.

ESM 401 Molecular Theory of Fluids, 3 hrs. A course presenting an advanced development of the molecular theory of gases and liquids based on the theory of intermolecular forces, quantum statistics and the Bolzmann equation. Applications are provided to such phenomena as diffusion, viscosity, and thermal conductivity.

ESM 402 Techniques and Materials in Modern Energy Conversion, 3 hrs. A study of recently developed techniques and materials for the direct conversion of primary energy sources to electricity. Topics discussed include thermoelectric generators and materials, solar cells, fuel cells, thermionic generators, nuclear fusion, space sciences applications.

C. Graduate courses to be offered beginning 1963-64

Boundary Layer Theory
Viscous Fluids
Homogeneous Turbulence
Advanced Thermostatics and Thermodynamics
Compressible Fluid Mechanics
Statistical Fluid Mechanics
Mechanics of Non-Newtonian Fluids
Physical Gas Dynamics
Theories of Transition
Perfect Fluid Theory




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 • | 26 | ADMINISTRATION ▲ |
| 6 | GYMNASIUM • | 27 | INFIRMARY ▲ |
| 7 | SERVICE | 28 | STUDENT UNION ▲ |

• UNDER CONSTRUCTION
▲ CONSTRUCTION STARTS 1963

RESIDENCE HALLS

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

PARKING AREAS

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

SCALE 0 600 1000 1500

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STATE UNIVERSITY OF NEW YORK
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