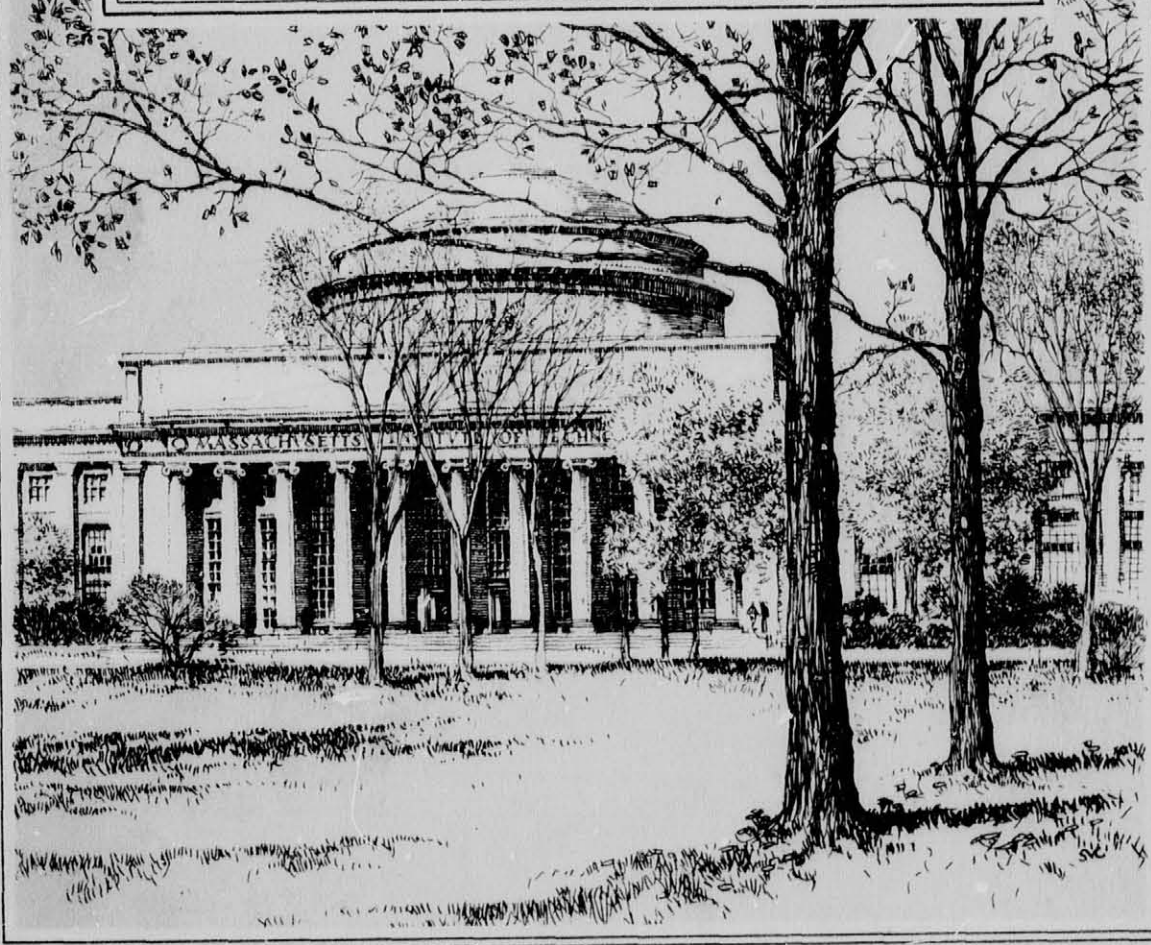
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The Institute reserves the right to make changes in the regulations and courses announced in this Bulletin.

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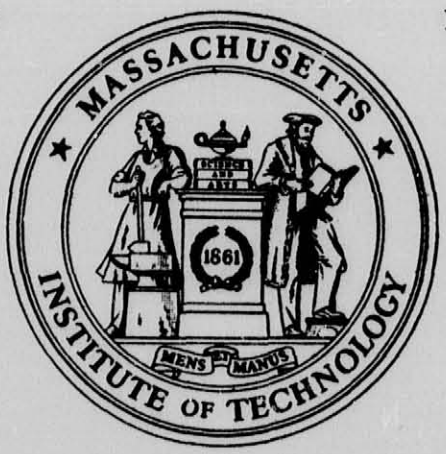


MASSACHUSETTS INSTITUTE OF TECHNOLOGY BULLETIN

CATALOGUE ISSUE 1946

A Bulletin of Information
About the Institute, its Government, Staff, Regulations,
Requirements for Admission, Facilities, and Courses of Instruction,
both Undergraduate and Graduate

VOLUME 81 NUMBER 4



PUBLISHED BY THE INSTITUTE
CAMBRIDGE

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CALENDAR

CALENDAR 1946–1947

FALL TERM 1946–1947

	1946
Fall Term Begins	Sept. 30
Columbus Day (*Holiday*)	Oct. 12
Armistice Day (*Holiday*)	Nov. 11
Thanksgiving Day (*Holiday*)	Nov. 28
Christmas Vacation	Dec. 23 through Jan. 1
	1947
Last Exercises, Fall Term	Jan. 24
Examination Period	Jan. 25 through Feb. 1

SPRING TERM 1947

	1947
Spring Term Begins	Feb. 10
Washington's Birthday (*Holiday*)	Feb. 22
Spring Recess	April 16 through April 19
Last Exercises, Spring Term	May 29
Examination Period	May 31 through June 7

SUMMER TERM 1947

Summer Term Begins	June 16

FALL TERM 1947–1948

Fall Term Begins	Sept. 29

1946

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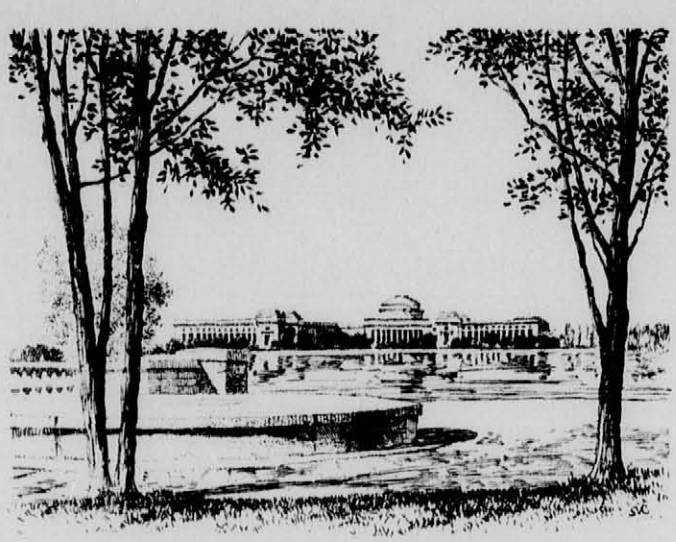


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OBJECTIVES AND POLICIES OF THE INSTITUTE

WITH a lively and prophetic vision of the part that science was capable of playing in advancing human welfare, William Barton Rogers (1804–1882), geologist and natural philosopher of the University of Virginia, planned and worked for nearly a decade prior to the Civil War for the establishment of a great institute of technology. He selected Boston as the most advantageous location because, as he said, "ever since I have known something of the knowledge-seeking spirit and the intellectual capabilities of the community in nd around Boston, I have felt that it was the one most certain to derive the highest benefits from a polytechnic institution. The occupations and interests of the great mass of the people are immediately connected with the applications of physical science, and their quick intelligence has already impressed them with just ideas of the value of scientific teaching in their daily pursuits."

As stated in its charter, granted by the Commonwealth on April 10, 1861, the Institute was established "for the purpose of instituting and maintaining a society of arts, a museum of arts, and a school of industrial science and aiding generally by suitable means the advancement, development, and practical applications of science in connection with arts, agriculture, manufactures and commerce." As its first President, Rogers, aided by far-sighted colleagues, set the Institute squarely on the course laid down in this charter and engendered among the Staff those high ideals of intellectual leadership and public service that have given continuing vitality to the Institute and that have made it not the local institution originally planned but one of national and international influence.

Motivated by the pioneering spirit of its founder, the Institute proceeded rapidly to make many seminal contributions to education and industry. It pioneered in extending the laboratory methods of instruction as an indispensable educational technique. It virtually created the modern profession of chemical engineering; its courses in electrical and aeronautical engineering, in applied physics, and in biological engineering were probably the first in the world. It was the first technological institution to recognize and provide for the important place of economics in the training of the engineer.

In attaining its present position, the Institute has constantly kept before it three objectives — the education of men, the advancement of knowledge, and the rendering of service to industry and the nation. It aims to give its students such a combination of humanistic, scientific, and professional training as will fit them to take leading positions in a world in which science, engineering, and architecture are of basic importance. This training is especially planned to prepare students, according to their desires and aptitudes, to become practicing engineers or architects, investigators, business executives, or teachers. The useful knowledge and mental discipline gained in this training are, however, so broad and fundamental as to constitute an excellent general preparation for other careers.

Realizing that the Institute trains for life and for citizenship, as well as for a career, its Staff seeks to cultivate in each student a strong character, high ideals, and a worthy purpose, as well as a keen intellect.

Along with his professional work, the student at the Institute devotes a large amount of study to the arts of expression, both written and oral. Since a high standard of accomplishment is

expected, a student planning to attend the Institute should devote special attention to this aspect of his preparation. This emphasis on expression is a part of a broad program in the humanities which is included in all regular undergraduate curricula and which aims to deepen the student's understanding of himself and his environment. There is also a wholesome regard for those extra-curricular activities which tend to broaden a man's outlook and to give him valuable experience in dealing with people, and these have had the cordial support of Faculty and Administration.

To vitalize its educational procedure and to fulfill its objectives, the Institute is placing increasing emphasis on original research in pure and applied science. Experience has demonstrated that teaching of the highest type, especially in science and its applications, thrives best in an atmosphere of steady progress in the understanding of the subject taught. He who is still a student, who is still himself learning, whether it be new relationships of the most fundamental scientific nature, or sounder and more economical ways of applying scientific knowledge for the promotion of industry and the public welfare, can best guide those about to enter upon a professional career.

Advancement in professional understanding is best acquired by intimate association with creative workers who are, through research, extending the boundaries of their professions. The most striking features of research in science and engineering at the Institute are the spirit of coöperative effort in which it is conducted and the extent to which both undergraduate and graduate students participate in it as an integral part of their educational experience.

All this makes the Institute a place where a man may study, in the true atmosphere of a professional school, those aspects of science, architecture, or engineering for which he is qualified, with opportunity to map out his own path with the aid and counsel of the Staff.

Karl T. Compton

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Term expires January, 1948
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Term expires January, 1950
HARRY CARROTHERS WIESS

Term expires January, 1951
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HAROLD BUGBEE

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WILLIAM JASON MIXTER

Term expires June, 1950
EDWARD SAMUEL FARROW
HORACE WINSLOW McCURDY
RAYMOND STEVENS

Term expires June, 1951
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A. WARREN NORTON

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[1] Address correspondence to Massachusetts Institute of Technology.
* On leave of Absence.

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Assistant Treasurer

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Secretary*	
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H. J. Shea	1949
A. E. Fitzgerald	1950

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W. N. Locke	1949
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N. Levinson	1950
G. G. Marvin	1950

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C. A. Myers	1949
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J. R. Markham	1950
G. P. Wadsworth	1950
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C. R. Soderberg

SOLAR ENERGY CONVERSION

H. C. Hottel (*Chairman*)
A. C. Hardy
E. H. Huntress
A. R. von Hippel

L. Harris
G. R. Harrison
G. Scatchard
G. B. Wilkes
Dean of Engineering*

* Ex officio.
** Appointed by the President.

OTHER COMMITTEES AND BOARDS
1946–1947

CONDUCT OF EXAMINATIONS
A. T. Gifford (*Chairman*)
S. G. Simpson
A. Sloane
G. P. Wadsworth
L. M. Dawes
J. A. Hrones
C. H. Norris
E. N. Gelotte
C. Goodman
J. B. Rae

STABILIZATION OF ENROLLMENT
H. E. Lobdell (*Chairman*)
L. F. Hamilton
W. H. McAdams
F. W. Sears
C. R. Soderberg
B. A. Thresher
C. E. Tucker

TECHNOLOGY MUSEUM
H. R. Barlett (*Chairman*)
Dard Hunter
H. L. Beckwith
R. D. Douglass
F. K. Morris
F. W. Sears
E. R. Schwarz
H. B. Richmond*

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H. S. Ford
J. W. M. Bunker
J. C. MacKinnon
E. R. Schwarz
C. L. Svenson
J. B. Wilbur

STUDENT-FACULTY
C. M. Wareham (*Chairman*)
T. P. Pitré
M. F. Gardner
F. W. Sears
H. R. Bartlett
J. Holt
G. Putnam

SPECIAL PROGRAMS AND CONFERENCES
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H. R. Bartlett
A. F. Holmes
W. K. Lewis
J. C. MacKinnon
T. P. Pitré
C. E. Tucker
B. E. Warren

PATENT POLICY
J. W. M. Bunker (*Chairman*)
A. C. Hardy
F. G. Keyes
H. L. Hazen
T. K. Sherwood
N. McL. Sage

PATENT MANAGEMENT
J. W. M. Bunker (*Chairman*)
E. L. Moreland
N. McL. Sage
H. S. Ford
J. R. Killian, Jr.

DORMITORY BOARD
L. F. Hamilton (*Chairman*)
H. E. Lobdell
D. L. Rhind
A. A. Ashdown

LOAN BOARD
H. E. Lobdell (*Chairman*)
K. T. Compton
B. A. Thresher
H. S. Ford
D. L. Rhind (*Secretary*)

BOARD OF PUBLICATIONS
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Vice-President*
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E. H. Huntress
R. T. Jope
J. R. Loofbourow

UNDERGRADUATE BUDGET BOARD
H. S. Ford (*Chairman*)
H. E. Worcester
D. L. Rhind
H. E. Lobdell
R. T. Jope

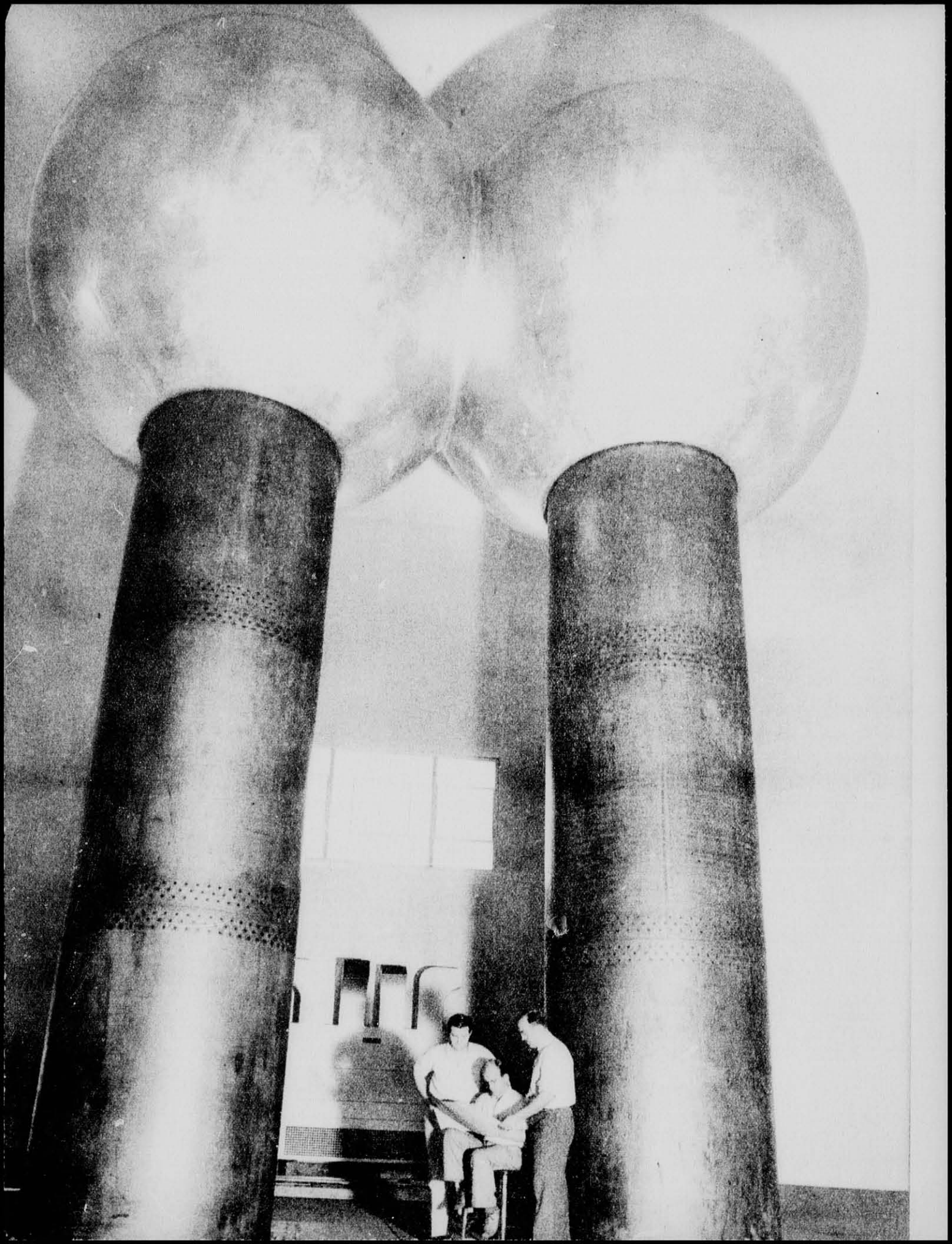
STAFF — ADMINISTRATION
Staff
J. E. Arnold
R. L. Bishop
R. M. Cunningham
J. G. Linvill
P. M. Morse
F. W. Sears
G. C. Williams

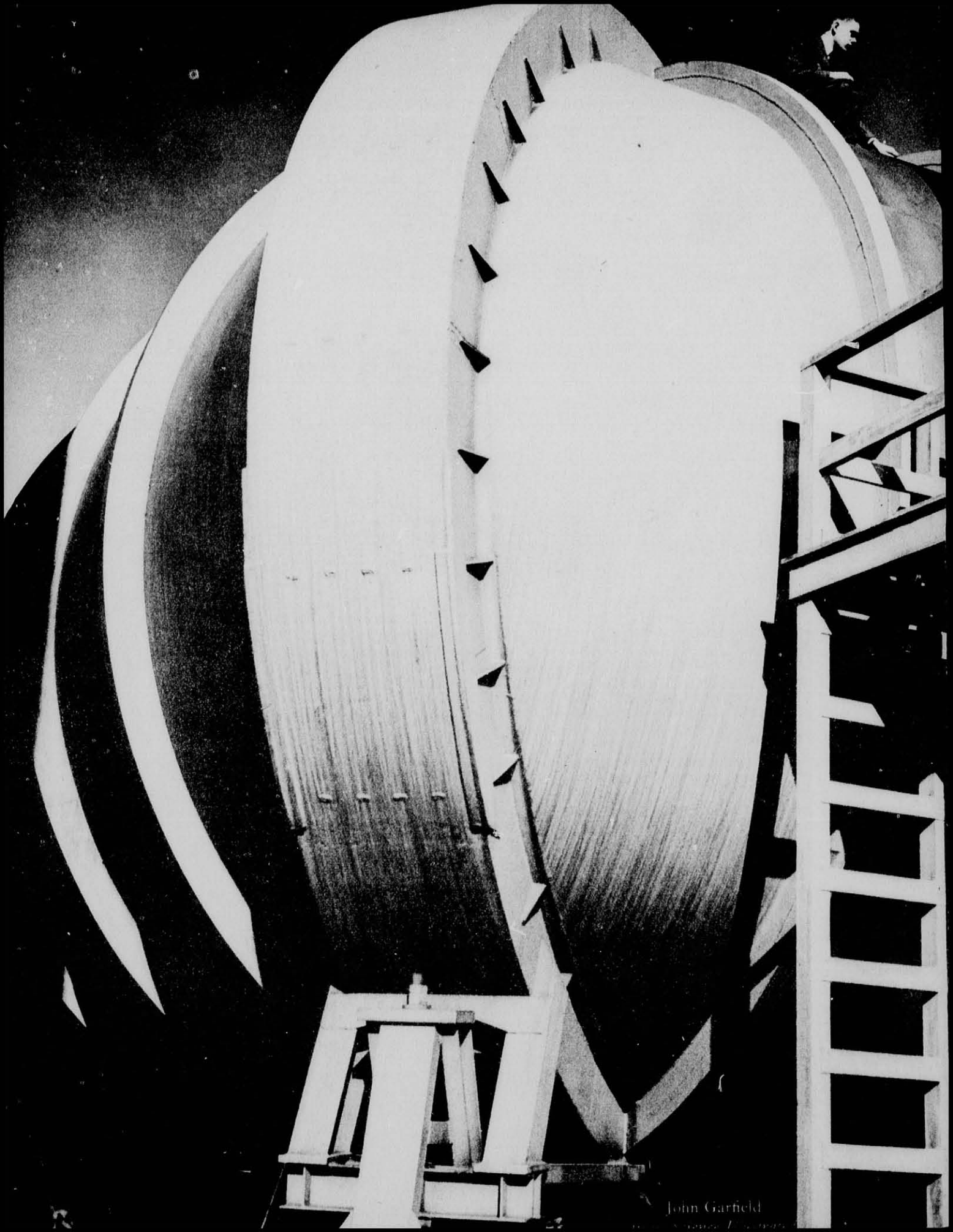
Administration
G. R. Harrison
T. K. Sherwood
R. G. Caldwell
H. E. Lobdell
J. C. Hunsaker
H. S. Ford
J. R. Killian, Jr.

HOBBY SHOP
H. R. Bartlett (*Chairman*)
R. M. Cunningham
J. J. Rowlands

ADVISORY COMMITTEE ON SPECTROSCOPY LABORATORY
R. C. Lord (*Chairman*)
G. R. Harrison
J. R. Loofbourow

* Ex officio.




John Garfield

GENERAL INFORMATION

LOCATION

AFTER occupying for fifty years its site in Boston, the Institute in 1916 moved into a completely new plant located on the Cambridge side of the Charles River Basin. Here, on a tract of eighty acres, extending along the river, are the twenty-five educational buildings and laboratories, infirmary, Walker Memorial (the student union), student houses, and athletic plant, including gymnasium, swimming pool, playing fields, field houses, sailing pavilion, and boat house.

The location of the Institute enables its students to profit from the manifold cultural advantages to be found in Boston and its environs — an area richly provided with great libraries and museums and other foundations devoted to literature, art, music, and science. Proximity to many large industries affords students ample opportunities to supplement their academic work by plant visits and other profitable contacts with industry and commerce.

GOVERNMENT AND ADMINISTRATION

In a legal sense the Institute is a body of trustees known as the Corporation which, as provided in its bylaws, consists "of its Chairman, President, Vice-President, and Treasurer and, if eligible, the President of the Alumni Association *ex officiis*, of the *ex officiis* members as provided by act of the Legislature, of not less than twenty-five nor more than thirty-five life members, of fifteen alumni term members, and of not more than five special term members. . . . No professor, teacher or lecturer, under engagement for compensation to be paid by the Institute, shall be a member of the Corporation."

Three of the alumni term members are nominated annually for five-year terms by ballot of the Alumni Association. The *ex officiis* members provided by the act of the Legislature are the Governor of the Commonwealth, the Chief Justice of the Supreme Judicial Court, and the Commissioner of Education.

Four stated meetings of the Corporation are held each year, in October, January, March, and June. Between meetings it functions through its officers, its Executive Committee, other committees on Membership, Finance, and Auditing, and its Visiting Committees for the various departments of the school.

The President presides over the Faculty of the Institute, to which body are entrusted by custom all questions relating to educational policies. The Corporation bylaws provide that the President "shall have the superintendence of the several departments of the Institute, and, subject to the direction of the Executive Committee, shall act as its general executive and administrative officer. . . ."

To aid the President and Treasurer there are other duly appointed officers of administration and instruction. Chief among the former are the Deans of Engineering, Science, Architecture, Humanities, the Graduate School, and Students; the Vice-President; the Bursar; and the Director of the Division of Industrial Coöperation. These, together with the Chairman of the Faculty, who is elected by that body, the Director of Libraries, and the President of the Alumni Association, compose the Administrative Council.

The Faculty consists of all Professors, Associate Professors, and Assistant Professors, certain designated Instructors and Research Associates, and the following administrative officers *ex officiis:* the President, Vice-President, Executive Vice-President, Deans, Director of Admissions, Registrar, Librarian, Associate Dean of Students, Assistant Director of Admissions, Director of Libraries, and Assistant Registrar. For its government the Faculty has adopted a set of "Rules and Regulations" which set forth the duties and powers of its Chairman, Secretary, and Assistant Secretary, and of its standing committees which include those on the Graduate School, Undergraduate Courses, Admissions, Petitions, Provisional Students and Discipline, Undergraduate Scholarships, the Courses in General Science and General Engineering, General Studies, the Library, and on First-, Second-, Third-, and Fourth-Year Students.

These "Rules and Regulations" also provide for a system of Registration Officers and for a Faculty Council. The Registration Officers, of whom there is one for each year of each Course above the first year, serve as academic advisers and ensure that each student's particular problems will receive individual consideration. The Faculty Council permits preliminary discussion of questions of major policy by a smaller group prior to submission of these questions for action at the general Faculty meetings.

In order most effectively to administer and to develop the educational and research work of the Institute, and also in order better to coördinate the work of those departments which are naturally similar in outlook, the academic phases of the Institute are divided, as implied above, into the following groups: the Graduate School, the School of Architecture and Planning, the School of Science, the School of Engineering, the Division of Humanities, and the Division of Industrial Coöperation.

In the Schools of Architecture and Planning, Engineering, and Science are grouped those departments of study which lead to degrees and which embody the primary educational objective of the Institute. In the Division of Humanities are grouped the studies through which students may supplement the cultural values inherent in their scientific and engineering subjects with the broadening discipline of the humanities. The Graduate

School coördinates the work leading to advanced degrees in all the departments. In the Division of Industrial Coöperation are centered the organized activities of departments and individual members of the staff which are devoted wholly or in part to the assistance of industry in the solution of its problems or development of new products and methods.

Although the Institute work is thus divided for administrative purposes, the educational policies remain under the control of the Faculty as a whole.

DEGREES GRANTED

The Institute offers both undergraduate and graduate Courses of Study. The former lead to the degrees of Bachelor of Science (S.B.), Bachelor in Architecture (B.Arch.), or Bachelor in City Planning (B.C.P.); the latter, to the degrees of Master of Science (S.M.), Master in Architecture (M.Arch.), Master in City Planning (M.C.P.), Doctor of Philosophy (Ph.D.), or Doctor of Science (Sc.D.). It also affords to advanced students and to experienced investigators opportunities for the pursuit of original scientific investigations.

COMBINED PLAN OF STUDY WITH LIBERAL ARTS COLLEGES

Many prospective students of engineering wish to attend a liberal arts college before undertaking their professional training. Two years are generally required to qualify for the S.B. degree in engineering at M. I. T. after graduation from a liberal arts college. The total time and expense of this entire educational program may constitute serious obstacles, especially if the student then continues with post-graduate work, as more and more of the better students are finding it advisable to do.

In order to facilitate the combination of a liberal arts course with education in science and engineering, the Institute has entered into a combined arrangement with a selected group of colleges whose work in the prerequisite fields of science and mathematics is of exceptional merit. Under this arrangement, and by properly planning his studies, a student of high standing may pursue a combined five-years' program in which the first three years are spent at the college and the last two at the Institute, leading to the Bachelor's degree from each institution. Thus one year is saved, and the experience and the degrees of both institutions are secured.

A student who wishes to follow this combined program is advised to consult the dean or registrar of the college of his selection in regard to his most advantageous schedule of studies.

The following colleges have united with the Institute in this program: Amherst College, Amherst, Massachusetts; Bowdoin College, Brunswick, Maine; Miami University, Oxford, Ohio; Middlebury College, Middlebury, Vermont; Ohio Wesleyan University, Delaware, Ohio; Reed College, Portland, Oregon; Ripon College, Ripon, Wisconsin; St. Lawrence University, Canton, New York; Washington and Jefferson College, Washington, Pennsylvania; College of William and Mary, Williamsburg, Virginia; Williams College, Williamstown, Massachusetts; and the College of Wooster, Wooster, Ohio.

GENERAL REGULATIONS

Academic Year. Exercises of the Institute begin on the last Monday in September and end early in June. The exercises are omitted on the following Massachusetts legal holidays: January 1, February 22, April 19, May 30, July 4, Labor Day, October 12, November 11, Thanksgiving Day and December 25.

Registration. At a date specified in the registration instructions, before the opening of each term, the student is required to fill in and present registration forms to the Registrar.

Provisional Admission. All students admitted to subjects without having fulfilled the usual preparation requirements are considered as provisional students in such subjects. Students whose work is generally low, and students readmitted to the Institute after dismissal, or after withdrawal incident to low standing, are considered as provisional in all subjects. Provisional admission to a subject may be cancelled when it becomes evident that the work of the student is unsatisfactory.

A student taking a dependent subject without a clear record in each required preparatory subject may be required to drop that subject at any time if his work is unsatisfactory.

Attendance. After approval of his registration the student must attend all exercises, including the final examinations, in the subjects for which he is registered. Irregular attendance, habitual tardiness, or inattentiveness may lead to probation. With the exception of an interval of one hour in the middle of the day, students are, in general, expected to devote themselves to the work of the school between the hours of 9 A.M. and 5 P.M. There are usually no exercises on Saturday after 1 P.M. Students who withdraw during the term should give advance notification to the Dean of Students and to the Registrar.

Final Examinations. Final examinations are held at the end of each term.

No member of the Instructing Staff is empowered to grant excuse from a final examination. Absence from any final examination is equivalent to a complete failure except as, on presentation in writing of adequate evidence of sickness or other valid reason for the absence, the Dean of Students may permit a student whose term work has been satisfactory to take the ensuing examination in the subject.

Conditions received at the end of a term must be made up by examinations during the succeeding term on Saturday afternoons, the exact dates for these examinations being announced after the term has begun. A student not taking an examination at the time stated forfeits the right to this examination.

The ability of students to continue their subjects

is determined in part by means of examinations, but regularity of attendance and faithfulness to daily duties are considered equally essential.

EXAMINATIONS FOR ADVANCED STANDING. Registered undergraduate students of all classes, with a cumulative rating of 3.50 and above, may take examinations for advanced standing during the condition examination periods in each term provided that they have never been registered for the subjects, or have never attended classes in the particular subjects. Notice of intention must be filed with the Registrar on the usual petition forms, and must be submitted at least two weeks before the day of the first scheduled examination of the examination period. Endorsement by members of the Faculty is not necessary. The privilege of an examination in a subject which involves laboratory instruction, or drawing, must be approved by the Faculty member in charge.

HEALTH OF STUDENTS. The work of the Medical Department is carried out in the Homberg Memorial Infirmary under the supervision of the Medical Director, Dr. Dana L. Farnsworth. A staff of nine doctors conducts clinics daily, except Sunday.

A graduate nurse is on clinical duty from 8.30 A.M. to 4.30 P.M. and a staff physician is in attendance from 8.30 A.M. to 5 P.M. (Saturday, 8.30 A.M. to 12 noon). Any student may receive medical and minor surgical treatment in the clinics without charge. In connection with these, adequate X-ray, physiotherapy and laboratory facilities are maintained.

In addition to the clinics, the Homberg Memorial Infirmary has a hospital equipped to care for thirty-three bed patients. There are six finely appointed, attractive wards, seven private rooms, and a large solarium. A well-equipped kitchen provides excellent food and dietary service. The hospital is open twenty-four hours daily throughout the year with a staff of graduate nurses and a visiting physician in attendance.

The charges are nominal: food, nursing, and medical care in the wards cost one dollar a day, and the same service in a private room is furnished at two dollars a day. After 5 P.M. on week-days (12 noon on Saturday) entrance to the second and third floor hospital must be made through the corridor in the basement, leading past the Photographic Department to the elevator.

Every entering student, undergraduate or graduate, is required to report to the Medical Department for a complete physical and dental examination within six weeks after matriculation. All other civilian undergraduates are required to have a physical re-examination each calendar year, an appointment for which should be arranged with the Medical Department.

CONDUCT. It is assumed that students come to the Institute for a serious purpose, and that they will cheerfully conform to such regulations as may be, from time to time, made by the Faculty or Administration. In case of injury to any building, or to furniture, apparatus, or other property of the Institute, the damage will be charged to the student or students known to be immediately concerned; but if the persons who cause the damage are unknown, the cost of repairing it may be assessed equally upon all the students of the school.

Students are expected to behave with decorum, to obey the regulations of the Institute, and to pay due respect to its officers. Conduct inconsistent with general good order, or persistent neglect of work, or failure to respond promptly to official notices, may be followed by dismissal. If the offense be a less serious one, the student may be placed on probation.

It is the aim of the Faculty to administer the discipline of the school so as to maintain the highest standard of integrity. The attempt of any student to present as his own the work of another, or any work which he has not honestly performed, or to pass any examination by improper means, is regarded by the Faculty as a most serious offense, and renders the offender liable to immediate expulsion. The aiding or abetting of a student in any dishonesty is also held to be a grave breach of discipline.

PETITIONS. The Committee on Petitions is the Faculty body through which the student may appeal for special consideration of his individual case. All requests must be submitted in writing on petition blanks which may be obtained at the Information Office, Room 7-111.

ADVISERS. The Dean of Students is the general consulting officer for all students, and coöperates with the President in matters of discipline and general student relations. On request to his office, advisers from the Instructing Staff will be assigned to new students. It is not intended that the advisers shall become, in any sense, guardians of the students assigned to them; nor does the Faculty by this action assume any responsibility for the conduct of students outside the halls of the Institute.

Each student is assigned to a Registration Officer who is a member of the Faculty having responsibility for, and control of, his academic program. The Associate Dean of Students serves as Registration Officer for all first-year students. However, the Deans of Architecture and Planning, Engineering and Science act as general consultants to first year students who seek advice relating to their choice of professional Courses.

FEES, DEPOSITS, PAYMENTS, EXPENSES

The following Tuition Fees apply only to the Academic year 1946-1947. Tuition Fee, beginning June, 1947, will be $350.00 per term. Other tuition fees will also be increased.

TUITION FEES. For all students pursuing regular courses, undergraduate or graduate, the tuition fee of $300 per academic term must be paid *in advance*, the date and hour to be specified in the Registration Instructions issued prior to the opening of the par-

ticular term. Special students pay, in general, the full fee; but when a few subjects only are pursued, application for reduction may be made to the Bursar.

Veterans of World War II under PL 16 or 346 are requested to call at room 4-132 for details regarding their bills and fees, after filing certificates of eligibility at the office of the Dean of Students, room 7-133.

Members of the teaching or research staff pursuing programs leading to the Master's or Doctor's degree, taking more than one subject or engaged on research, and on full-time Corporation appointment pay $100, on half-time appointment $150, on one-third-time appointment $250, for each term for which they are registered as proceeding toward the degree. The above fees admit members of the staff working for the Master's or Doctor's degree to all subjects, including thesis work, which are approved by their respective department committees. If they are taking but a single subject and not engaged on thesis or research, the tuition is at the rate of $6 per unit credit, with a minimum fee of $15.

A candidate for the Doctor's degree who has been absent from the Institute and who returns for the final examination on his thesis must register for the examination and pay a fee of $25.

Other Fees. A charge of $5 is made for each condition or advanced standing examination taken, and $5 for the removal of each deficiency.

Late Registration Fine. A fine of $5 is imposed for late registration or late payment of tuition. Students should note that registration is not complete until tuition fees are paid.

Deposits to Cover Chemical Supplies, Military Uniforms, etc. All first-year students will be required to make a deposit of $25, from which the costs of chemicals and laboratory supplies, shoes, non-returnable equipment and damage to military uniforms are to be deducted.

All upperclassmen and graduate students taking subjects requiring the use of the Division of Chemical Laboratory Supplies will be required to make a deposit of $25 against which the cost of chemicals and laboratory supplies will be charged.

All deposits must be made at the beginning of the year.

If the total cost of chemicals and supplies used exceeds the amount of this deposit, an additional amount sufficient to cover this excess must be paid.

No refund of deposits will be made during the school year except to students leaving the Institute.

Graduate and Undergraduate Activities. For each student registered, the Institute will appropriate the sum of $3.50 per regular academic term to be devoted to the promotion of student life with special reference to the physical and social welfare of the students. No part will be spent for any class function, athletic event, or social entertainment that is not open without charge to every qualified member of the student body in good standing.

These funds will be expended under the general direction of the Institute Committee subject to the approval of the Undergraduate Budget Board appointed by the President.

Subject to modification, funds will be apportioned per term as follows:

Institute Committee	$0.265
Classes	.175
Athletics	2.90
Reserve and Contingent Fund	.16

In addition to the amount made available through the above, the Institute yearly appropriates from its operating budget funds to cover athletic coaching salaries and the maintenance and operation of Walker Memorial, Athletic Fields, the Boat House, Sailing Pavilion, Launches, Swimming Pool and Squash Courts.

Payments. *No bills are sent.* All payments should be made to D. L. Rhind, Bursar, Massachusetts Institute of Technology, Cambridge 39, Mass. *Students are advised to make their payments by mail.*

Estimated Expenses. An estimate of expenses exclusive of personal expenditures such as transportation, clothing, recreation, etc., is given below:

For a Period of One Academic Term	
Tuition	$300
Board	180
Room	130
Books and materials	50
	$660

To assist students desiring to help themselves in meeting their expenses, the Student Employment Bureau is maintained by the Technology Christian Association. It is to be understood, however, that the demands of the Institute curriculum are such as to make it impracticable to devote much time to outside employment, and prospective students are advised to have sufficient funds to cover the expenses of the first year at least. Students from foreign lands, in particular, should clearly understand that the opportunities to secure remunerative employment for them are seriously restricted by their unfamiliarity with the English language and American business customs.

LOANS, SCHOLARSHIPS, FELLOWSHIPS AND PRIZES

See Appendix A for Complete Details

Resources for financial aid to students include: the Technology Loan Fund, available for undergraduate and graduate students; Freshman Competitive and other scholarships open to students entering from secondary schools; undergraduate scholarship aid to upperclassmen; fellowships, and graduate scholarships; Teaching Fellowships, and full- and part-time Assistantships to aid students pursuing work leading to the Master's or Doctor's degree; and prizes.

The extent of these resources is indicated by the facts that, since its establishment in 1930, over 2,600 men have borrowed more than $1,900,000 from the Technology Loan Fund; and that approximately $90,000 and $102,000 are annually available for undergraduate and graduate scholarship aid respectively.

PLACEMENT

Without assuming responsibility of finding employment for graduates, the Institute assists them in their placement problems. Senior and graduate students are offered a program of placement training planned to acquaint them with industrial opportunities and to outline the principles to be observed in seeking employment. The placement training program is approached from the long-range point of view rather than in terms of the first position after graduation, and stress is placed upon the importance of each individual's finding the type of opening for which he is best qualified by reason of his special aptitudes and training.

A Placement Bureau is also maintained by the Institute to assist Technology seniors and alumni in securing positions for which they are particularly fitted, and to aid industry in selecting men for positions requiring engineering or scientific education. For this service there is no charge.

EDUCATIONAL BUILDINGS

The characteristic spirit of the Institute finds its material embodiment in its great educational plant in Cambridge. Here all departments of instruction and research are brought together in a group of conjoined buildings containing over one million square feet of floor space.

This unity and coördination of structure permit flexibility in the allotment of space to the departments and promote desirable coöperation among the various disciplines. The several sciences and the humanities, by organization and by common housing, are thus members of a single intellectual family at the Institute, and the objectives which they pursue, both in teaching and in research, are dealt with as coöperative projects, to be studied and solved coöperatively.

LABORATORIES. Another marked characteristic of the Institute from the material point of view is found in its numerous large and well-equipped laboratories. Notable among these are the George Eastman Research Laboratories of Physics and Chemistry, the Laboratory for Nuclear Science and Engineering, the Research Laboratory of Electronics, the Gas Turbine Laboratory, the Acoustics Laboratory, the Laboratory of Mechanical Metallurgy, the Spectroscopy Laboratory, the Guggenheim Aeronautical Laboratory, the Wright Brothers Memorial Wind Tunnel, the Pierce Engineering Laboratory, the Sloan Automotive and Aircraft Engine Laboratory, and the Laboratories of Steam and Compressed Air, Refrigeration, Testing Materials, Hydraulics, Metallurgy, Chemical Engineering, Physical Chemistry, Applied Physics, Electrical Engineering, Biology, and Geology and Mineralogy.

THE LIBRARY. The Institute Library, one of the leading collections in science and engineering in the United States, includes the Central Library and a number of strong branch libraries, containing all together approximately 390,000 volumes. A comprehensive collection of periodicals and society publications, remarkably complete in subjects within the scope of the Institute's programs of study and research, is maintained by the current receipt of over 1,600 periodicals and upwards of 1,900 transactions, yearbooks, and other serials.

The Central Library, on the fifth floor of Building 10 (under the great dome), is easily reached by elevators from the main lobby. Here are located large collections in physics, chemistry, chemical engineering, biology, meteorology, and mechanical and electrical engineering; also an extensive collection of basic reference books and bibliographies. Especially notable is the Vail Collection in electrical engineering, described more fully under Electrical Engineering in the Graduate School section.

The Central Library is open on week days during term time from 8.45 A.M. to 9 P.M., except on Saturdays when it is closed at four o'clock. Individual reference service, bibliographical aid, and assistance in the use of the card catalogue are given at the Reference desk and the Vail desk in the Central Library and also in the branch libraries. Seniors, graduate students, and others engaged on theses or other research are granted admission to the stack.

Books and periodicals which the Institute does not own can often be obtained from other libraries, or, in lieu of the actual book, it is generally possible to obtain photostats or microfilm reproductions; the latter may be read in the Library's projector.

The following branch libraries, well organized and in charge of competent librarians, are located near the departments which they serve and supplement the service of the Central Library: Aeronautical Engineering, Arthur Rotch (architecture, housing, and city planning), Dewey (civil and mechanical engineering, building construction, naval architecture and marine engineering, economics, social science, industrial relations, and business and engineering administration), Eastman (for graduate students and others doing advanced work in physics, mathematics, and chemistry), Lindgren (geology, metallurgy, and ceramics), and Walker Memorial. The last-named, primarily a library for recreational reading, contains also the principal collections in history and literature and to some extent serves as a humanities library. The material in all these libraries is listed in the Central Library card catalogue, and telephone interconnection affords a well-integrated service.

A leaflet entitled "A Brief Guide to the Institute Library" is given to all new students; a handbook, "How to Use the Institute Library," may be had upon application.

MUSEUMS. The museum of science, engineering and industry is continually expanding within the main group of buildings. Each department has its own exhibits, along the corridor adjacent to its laboratories and offices; and these exhibits, largely the result of the research or the ingenuity of the staff, broaden and enrich the educational program of the students. In addition, two of the most significant units have ample quarters of their own: the Dard Hunter Paper Museum, containing the most complete collection of handmade paper and papermaking equipment in the world; and the Francis Russell Hart Nautical Museum, containing a magnificent collection of ship models and prints, and the Allan Forbes and Henry P. Kendall whaling collections. The collections of ceramics and of minerals, though not fully displayed in public, are also distinguished.

In addition to the permanent exhibitions the Institute has a policy of providing monthly traveling exhibitions covering the fields of art, of craft, and of the other works of man. These are displayed in the public lobbies of the Institute, often for the only showing in the Boston area, and range from handcraft to machine craft, from primitive art through that of the fully developed periods to the art of the experimental present. They are intended to serve as an introduction to the Institute family of a wide number of ideas and presentations of ideas and to enrich the entire cultural life of the Institute community.

SUMMER SURVEYING CAMP. (*Summer Camp instruction is temporarily suspended while the Institute is operating on a continuous basis. It is expected that the Surveying Camp will be reopened in the summer of 1947.*) Camp Technology, an admirably located and amply equipped engineering camp, is maintained by the Department of Civil and Sanitary Engineering. During the summer session at this camp, students are given field practice by competent instructors and, incidentally, obtain the healthful experience of approximately two months of ourdoor life.

The camp is located on the shore of Gardner Lake about eight miles from East Machias, Maine and, in a direct line, is less than three miles from tidewater.

It comprises about 850 acres of rolling terrain, some of which is wooded, in a region well adapted for carrying out projects in plane, geodetic and route surveying as well as opportunities for hydrographic field work.

Bemis Hall, the headquarters of Camp Technology, has a sightly location on a high bluff overlooking Gardner Lake. In Bemis Hall and other buildings connected with it by covered passages are lounging and dining facilities, lecture, recitation and drafting rooms, office accommodations for the Staff, a store and post office.

Sleeping quarters for students are provided in eight wooden barracks facing the lake. Other structures include a geodetic observatory, extra space for drafting or classroom use and an infirmary which serves as an emergency hospital. A physician is in attendance during the entire camp session.

The Camp is equipped with excellent sanitary facilities, electric light, and a wholesome water supply from driven wells. A baseball field and two tennis courts are located on the Camp property.

THE SOCIETY OF ARTS

The Society of Arts was provided for in the Charter of the Institute. In the early days, the meetings of the Society were given over to public lectures on new inventions and discoveries, followed by general discussions by the audience. Beginning in 1917, the Society has set its course by an annual series of Popular Science Lectures. These discourses, always illustrated, are held in Huntington Hall on one week-end in the months of December, January, February and March. On Friday and Saturday afternoons, invitations are sent to the secondary schools, but Sundays find the audience made up of corporation members, the faculty and the public in general. Because they follow the lines of study and research for which the Institute is known, the lecturers explain many present-day developments in science and engineering.

STUDENT HOUSING

Complete information on housing for graduate and undergraduate students, giving details regarding applications, allotment of rooms, equipment, rentals, payments and so forth, is presented in Appendix C (Student Housing) of this bulletin.

RECREATIONAL FACILITIES

Walker Memorial, built in memory of a late president, General Francis Amasa Walker, is the center of the social activities of the Institute. The building was finished in 1917 at a cost exceeding $500,000, contributed in part by alumni.

On the third floor are a gymnasium with a regulation basketball court, lockers and dressing rooms, offices for the various student activities, and rooms for handball. Below are recreation and reading rooms, and an excellent and growing open-shelf library, and, on the first floor, a large dining hall with cafeteria service at low prices. In the grill room soda fountain service is provided, and private rooms are available for class dinners and gatherings of any Technology organization. In the basement are bowling alleys and a lounge room for the "5:15 Club," composed of commuting students.

Adjacent to this building and the dormitories are tennis courts, Technology's swimming pool building completed in 1940, which contains a deep pool for recreational swimming, and a shallow one for use by "beginners," and other facilities for conducting the recreational program of twelve sports.

The Barbour Field House, opened in September, 1934, has, in addition to modern shower and locker facilities, special rooms for visiting teams. Con-

nected with the Field House is a Squash Building containing eight courts.

On the land west of Massachusetts Avenue are fields for soccer, lacrosse, and football; additional tennis courts and a quarter-mile cinder track with a 220-yard straightaway completed in 1939. During the winter, an outdoor board track is provided near Briggs Field House.

A boathouse on the Charles River supplied with indoor rowing machines has also a number of singles and wherries available for students, in addition to the opportunities offered to all undergraduates to learn how to row in an eight-oared shell under competent coaching. The Sailing Pavilion, located on the Charles River in front of Walker Memorial, is the headquarters of the Nautical Association.

Students who wish to pursue or develop hobbies as a recreation have access to the Hobby Shop — a name describing both a physical facility and the group of students brought together by it. Since the shop was opened in 1938, with space and equipment provided by the Institute, it has been doubled in size. All the machines and other tools needed for woodworking, metalworking, and the like, are installed, and equipment for new groups interested in radio, photography, electroplating, and telescope-making, is now being assembled.

UNDERGRADUATE ACTIVITIES

To complement and aid its educational work and to enrich its community life, Technology provides extensive opportunities for students to participate in those extra-curricular pursuits — athletic, literary, dramatic, and social — which further the development of character and personality and yield health, pleasure, and friendship. These enterprises are administered by the students themselves, under a well-organized system of student government, which inculcates responsibility, leadership and initiative.

ATHLETICS. The purpose of athletics at the Institute is not to develop highly trained athletes, but rather to encourage all students to participate in some form of physical recreation. Control is vested in the M. I. T. Athletic Association, an undergraduate organization composed of all captains and managers of varsity teams as working members, and assistant managers and officials of class teams as associate members. Funds are secured by undergraduate dues, appropriated by the Institute, but disbursed by the Undergraduate Association. An Advisory Council of Alumni exercises the functions which its name implies.

No attempt is made to concentrate on coaching the few men composing a single varsity team, but instruction is given to all men reporting for a sport. As a corollary to this, the success of a given athletic activity is gauged by the number of men it attracts. Among the activities are: track and field sports, cross country running, rowing, basketball, fencing, golf, lacrosse, rifle, swimming, tennis, soccer, squash racquets. Spirited intramural league competitions are held annually in the sports of touch football, basketball, and softball.

NAUTICAL ASSOCIATION. The Nautical Association offers every student an opportunity to learn sailing. A fleet of forty dinghies, constituting a special Technology class designed by Technology men, three Class B dinghies, and four 24-foot sloops are available for sailing on the Charles River Basin. The Sailing Pavilion, located directly in front of Walker Memorial, provides a large landing float, a rigging and maintenance shop, and storage space.

The Association sponsors a shore school, offering instruction in the theory of sailing and in the handling and maintenance of yachts.

PUBLICATIONS. Undergraduate publishing activities offer opportunities for students to broaden contacts and to acquire practical experience in journalism which may in after years prove to be of material value. All work incident to the editing and financing of the publications is carried on by students, with an Alumni Advisory Council available for consultation.

There are four self-supporting undergraduate publications: *The Tech*, the student newspaper; *The Tech Engineering News*, a monthly technical journal; *Technique*, the yearbook; and *Voo Doo*, a comic magazine. *The Tech*, the official undergraduate news organ, is one of the oldest of college newspapers, having been founded in 1881. *The Tech Engineering News* is the undergraduate scientific magazine, to the editorial columns of which prominent graduates and professional men, as well as undergraduates, contribute. Quite frequently its articles are quoted in professional technical journals, and it has won numerous awards as an outstanding student journal. *Technique* is the yearbook containing pictures and records of seniors and graduate students and, in addition, accounts of all regular undergraduate activities and outstanding social functions of the year.

MUSIC, DRAMA, AND PUBLIC SPEAKING. The Combined Musical Clubs, consisting of the Glee Club, the Concert and Popular Orchestras, and the Chamber Music Society, provide opportunities for training and expression in instrumental and vocal music. *The Dramashop produces plays.* Members of the Debating Society participate in intercollegiate debates and exhibition contests.

STUDENT PROFESSIONAL SOCIETIES. The Professional Societies, of which there are twelve, hold meetings for the presentation of scientific papers by students, culminating in the presentation of the Stratton Prizes at Commencement.

There are many other societies and activities which bring students of mutual interest together, and which organize social activities. The Junior Prom and Senior Week committees; the class organizations; and organized groups such as Sigma Xi and Tau Beta Pi for scholarship; Gridiron, the journalism society; Scabbard and Blade, the military society; the 5:15 Club, for commuting students; the Radio Society; and a score of other organizations, social

and honorary, furnish important adjuncts to student life.

TECHNOLOGY CHRISTIAN ASSOCIATION. This activity aims to be of practical service and to foster among members of the Institute community the ideals of Christian living and active Christian service. It organizes students for social service and religious activity in Metropolitan Boston, maintains a theater ticket service and book exchange, operates the Student Employment Bureau, the Tech Cabin and Freshman Camp, and publishes the Freshman *Handbook*.

THE INSTITUTE COMMITTEE. The activities described above are component parts of the student state — the M. I. T. Undergraduate Association. Over this Association as chief executive presides the Senior Class President who shares with the Institute Committee, a legislative and judicial body representing the four classes and every important student activity, the government of student affairs. Sub-committees of the Institute Committee supervise the finances of undergraduate activities, consider jointly with the Faculty and Administration matters affecting students, administer Walker Memorial, and, by a system of points, control the extent to which any one student may participate in extra-curricular activities.

THE LOWELL INSTITUTE SCHOOL

The Trustee of the Lowell Institute established in 1903 under the auspices of the Massachusetts Institute of Technology, a Free Evening School.

This School offers, at present, two regular courses — Mechanical Course and Electrical Course each extending over two years; and a number of advanced or supplementary single subjects of varied length. It is expected that the Building Course will be reopened at an early date.

These courses are intended to bring the systematic study of applied science within the reach of young men who are following industrial pursuits and who desire training to fit themselves for higher positions.

Circulars giving detailed information regarding the nature of the entrance examinations and other requirements may be obtained by sending a stamped, self-addressed envelope to Professor Arthur L. Townsend, Director, The Lowell Institute School, Massachusetts Institute of Technology, Cambridge 39, Mass.

REQUIREMENTS FOR ADMISSION

ENTRANCE DATES

The Institute returns in 1946 to its normal calendar. First Year students will enter once a year on the last Monday in September, and will not be accepted at other dates.

An exception to the above rule will be made in the term of February 10, 1947, in which term qualified veterans of the United States armed services may start as first year students. Applications from veterans for this entering class must be received by the Director of Admissions by December 1, 1946.

ADMISSION FROM SECONDARY SCHOOLS

Selection of Applicants. Under the Institute's policy of stabilized enrollment, the size of the First Year class is limited. Since it is expected that the number of applications will be far in excess of the number that can be accommodated, the Faculty Committee on Admissions will exercise discretionary powers of selection.

Applicants to whom admission has been granted in earlier years, but who were prevented from actually entering by reason of military service are not automatically accepted for later entrance. While each such case will be given careful consideration, it is not likely that all can be accepted.

Preference will be accorded applicants whose evidence of academic fitness and of professional promise indicates that they are particularly qualified to pursue Institute Courses with success. It is the desire of the Faculty to admit only those candidates who possess qualities, both of character and intellect, which indicate their adaptability to an academic environment, and which show promise of their development into useful and forceful citizens.

Applicants for admission to the First Year class are expected to have a conference with the Director of Admissions. Office hours are nine to four, Saturdays nine to twelve; it is not necessary to make an appointment in advance. Applicants outside New England are expected to arrange a conference with an alumnus designated by the Director of Admissions. It is recommended that this be done as early as possible in the applicant's final year of secondary school.

The candidate is requested to indicate his tentative choice of professional Course at the time of filing his application. After admission, he may reconsider his choice, and he has the option of changing at any time during the first year. Continuation in a Course after the first year, or a change of Course, will depend upon the student's scholastic record, his apparent aptitudes for the particular field of work, and the facilities available at the Institute.

Academic Preparation. The better high and preparatory schools in the United States, and equivalent schools in other countries will, in general, provide suitable preparation to the student who takes full advantage of the opportunities which such schools afford. The candidate should bear in mind that the wider his intellectual development and the more extensive his attainments, the greater will be the advantages he may expect to gain from study at the Institute. The preparatory course should be a broad one, not confined to technical subjects.

Attention is called particularly to the necessity of thorough preparation in English and mathematics. It is presupposed that a candidate's training in English has been such that he can express his ideas clearly in oral or written form. In mathematics, emphasis should be on thorough mastery of fundamental principles, operations and definitions rather than on covering a wide range of topics.

Each applicant is required to have completed the following specific preparatory subjects; the figures in parentheses represent the usual "unit" rating, a unit being a full year's study in a secondary school subject taken four or five times a week:

English (3)	Physics (1)
Algebra (2)	Trigonometry (½)
Plane Geometry (1)	Solid Geometry (½)

English is normally studied through four years, and this is counted as three units. In some states, algebra is completed in 1½ years; this will satisfy the algebra requirement.

In addition to the above subjects specifically required, the applicant must also have completed seven additional units, or their equivalent, in secondary school studies. No limitations are imposed in the choice of these elective subjects, and in the selection of the entering class the Committee will be guided by the quality of the applicant's work and by his apparent promise on grounds of intellect and character, rather than by his choice of electives.

It is nevertheless recommended, though not required, that the elective subjects should include a year of chemistry, as preparation for the first year chemistry course at the Institute, and one or more years study of history.

While there is no requirement of language for admission, the study of modern foreign languages in secondary school is obviously desirable and is recommended. No limitations are imposed with regard to languages, except that if a language is offered at all, it must total at least two units. The choice of

languages should be guided by the student's own interest, by the educational opportunities open to him, and by the nature of his probable future work.

A student who has ties with a particular foreign country, or who expects to develop such ties, should naturally study the appropriate language. Thus any who expect to have contacts with Latin America may need Spanish or Portuguese. Those who look forward to advanced work in research or design in a scientific or engineering field are likely to need a knowledge of German, Russian or French since there is an extensive and important technical literature in each of these languages. Since, however, relatively few public high schools in the United States offer German, and very few schools of any kind offer Russian, the student may find it expedient to take French and to postpone until a later stage the study of German, Russian or other languages appropriate to his professional specialty.

Application Procedure. Evidence of academic preparation is of two kinds: first, the School Report form mentioned below, and second, entrance examinations as noted below, which may, however, be waived in certain cases.

A Preliminary Application form, which may be obtained from the Director of Admissions, should be filed as far as possible in advance of the anticipated date of entrance. This insures that the applicant will receive any announcements which may be issued, as well as Final Application forms, at the proper time.

A Final Application form and two personal endorsement forms will be sent in January preceding the date of entrance, to candidates who have filed Preliminary Application forms. At the same time, a School Report form will be sent directly to the principal or headmaster of each secondary school which the applicant has attended, and will be returned by the school directly to the Institute.

A report of his status with respect to admission will be sent to each applicant as soon as possible after the Committee on Admissions has reviewed his completed application.

Entrance Examinations. Candidates are in general required to take a series of tests given by the College Entrance Examination Board. This consists of the Comprehensive Mathematics examination, and one-hour tests in English Composition, Physics, and Chemistry. (Those who have not studied chemistry may substitute any other one-hour test in science, social studies or language.) The Scholastic Aptitude Test is not required.

This group of tests forms a one-day examination sequence given in the principal cities of the United States and in foreign centers on each of the following dates: December 7, 1946, April 12, 1947, June 7, 1947, August 27, 1947. A list of the places and dates of examinations is published each year by the Board. Candidates should take the tests not later than June, if possible, since it will not be feasible to reserve more than a very few places in the entering class for those who take the August examination. Application for the examination must be made by the candidate on a form to be obtained from the College Entrance Examination Board, P. O. Box 592, Princeton, New Jersey. If the application is received sufficiently early the fee for the series is $9. The Board will report the result of the examination directly to the Institute, but not to the candidate. The Committee on Admissions will decide whether the examination grade, taken in conjunction with the applicant's school record, is satisfactory.

Applicants from schools in the State of New York may offer in place of the examinations described above, Regents examinations in corresponding subjects, namely, Algebra, Plane Geometry, Solid Geometry, Trigonometry, English, Physics and Chemistry (if chemistry has been taken). Only grades of 85 or better will be accepted. The official report of these examinations will be secured by the Institute from the Board of Regents in Albany.

Entrance examinations may be waived for students entering directly from secondary schools if they graduate in the highest fifth of the class and if the school has qualified for this privilege by sending to the Institute a number of graduates whose records at the Institute have been satisfactory. Applicants will be notified whether they are required to take the examinations; those whose schooling has been interrupted by military service will be expected to take the examinations regardless of their school standing.

ADMISSION WITH ADVANCED STANDING

It is expected that no students whose previous studies would entitle them to advanced standing can be accepted before September 1947, and thereafter only in very limited numbers, as openings are available. The following statements apply to normal conditions under which some such students can be accepted.

Selection of Students. Students who have completed one or more years with high standing at a recognized college, university, engineering school or junior college, and who are entitled to honorable dismissal, may apply for admission by transfer without examination. Their eligibility for admission will be determined by the Committee on Admissions after a review of their academic records. They will be expected in every case to have completed the academic preparation required of students entering the Institute from secondary schools.

Acceptance in a particular Course, for a transfer student entering the third or fourth year, may be contingent upon his first term record at the Institute.

Students who plan to attend another college with the intention of later applying for admission to the Institute should note the Combined Plan in effect between the Institute and certain colleges. (See page 25.)

Advanced Credit. Students admitted by transfer may expect to receive advanced credit for subjects of study completed elsewhere which are substantially equivalent to corresponding Institute subjects.

A grade above the lowest passing grade is necessary.

All such credits are provisional and become final only after the student has demonstrated his ability to do satisfactory work in the Course of his choice. Students whose records appear not to warrant advanced credit in a subject may be permitted to demonstrate by passing an examination that they are entitled to such credit.

A student in another college contemplating transfer to the Institute should so plan his program of study as to cover the basic subjects of the Course he expects to enter. If in doubt as to the best choice of subjects he should consult the Director of Admissions.

Application Procedure. Early in the last term before his contemplated transfer to the Institute an applicant should submit the following, enclosed in one envelope:

1. Application for Admission with Advanced Standing, indicating all subjects which will have been completed at the time of transfer.
2. Certified transcript of college record to date, including a statement of honorable dismissal or its equivalent. A certified statement covering subjects subsequently taken should be sent as soon as it is available.
3. Catalogue pages describing all subjects which will have been completed; the applicant's name should be written on each page and each subject indicated by a check mark in the margin.

As soon as the applicant's status is determined he will be informed whether or not he is admitted and how much advanced credit he will be granted. In some cases, it may be necessary to defer action until the applicant's final grades are available.

All remaining questions about credits must be settled within two weeks after the opening of the academic year. In these cases, the student should consult the Director of Admissions.

Applicants desiring credit in Electrical Engineering Laboratory should present their reports as well as their college records in that subject.

Applicants seeking admission with advanced standing in Architecture will be graded in Design in accordance with their performance in their first problem.

SPECIAL STUDENTS

It is expected that no students whose previous studies would entitle them to admission as special students can be accepted before September 1947, and thereafter only in very limited numbers, as openings are available. The following statements apply to normal conditions under which some such students can be accepted.

Qualified applicants above the usual age, wishing to carry on a special program of study with a clearly defined objective, may be admitted as Special Students. Such students are not candidates for a degree.

A prospective Special Student should first obtain an application form from the Director of Admissions. The application and program of study must be approved by the department in which the major part of his work is to be carried on, and by the Director of Admissions. The applicant must present academic credentials of high quality, or evidence of professional experience such as to justify the expectation that he can profitably undertake the program desired. In the absence of adequate academic preparation, Special Students will be required to take examinations in subjects prerequisite to those in which they wish to register.

Admission of Special Students in Architecture

Applicants desiring admission as special students in Architecture must be college graduates; or must be at least twenty-one years of age, with not less than three years' experience in an architect's office, or have had equivalent and satisfactory preparation. They must register for those subjects which, in the opinion of the Registration Officer, will best complete the students' educational equipment.

The first week of the course in freehand drawing and the first problem in Design will be considered as test exercises to determine the standing of the student. The arrangement of subjects must be approved by the head of the department and satisfactory records obtained in order to continue architectural subjects.

FOREIGN STUDENTS

Students of foreign citizenship may enter the Institute only in the September term each year. Applications for admission will be reviewed on May 1. Completed applications should be in the Admissions Office by that date if a student wishes consideration for entrance the following September. Applications received before May 1, will be held until that date for action. Notices concerning admission will be sent out about May 20.

Since competition for places at the Institute is severe, it is possible to take action on admissions only after complete application material has been received. Applications accompanied by incomplete credentials cannot be considered.

UNDERGRADUATE COURSES OF STUDY

IN the Schools of Architecture and Planning, Engineering, and Science the undergraduate may elect any one of the professional Courses of Study listed below. In most of these Courses leading to the Bachelor's degree, options or electives in professional subjects are available, thereby offering the student wide flexibility in the selection of a schedule of subjects best adapted to his special interests, abilities, and objectives.

In order to qualify for continued attendance at the Institute, students must meet the minimum requirements of the scholastic rating system, a full explanation of which is sent to all new students and their parents. The number of second-year students admitted to certain professional Courses is limited.

In the following list each Course is indicated by its name and the Roman numeral associated with it.

School of Architecture and Planning

ARCHITECTURE, Course IV.
CITY PLANNING, Course IV-B.

School of Engineering

AERONAUTICAL ENGINEERING, Course XVI.

BUILDING ENGINEERING AND CONSTRUCTION, Course XVII, with options. Heavy Construction (1), Light Construction (2).

BUSINESS AND ENGINEERING ADMINISTRATION. Course XV-A, Based on Physical Sciences and Course XV-B, Based on Chemical Sciences.

CHEMICAL ENGINEERING, Course X, and Chemical Engineering Practice, Course X-B.

CIVIL ENGINEERING, Course I.

ECONOMICS AND ENGINEERING, Course XIV, with options. Human Relations (1), Industrial Relations (2).

ELECTRICAL ENGINEERING, Course VI, with options. Electric Power (1), Illumination Engineering (2), Electrical Communications (3), Electronic Applications (4). Also Coöperative Course in Electrical Engineering, VI-A.

GENERAL ENGINEERING, Course IX-B.

MARINE TRANSPORTATION, Course XIII-C.

MECHANICAL ENGINEERING, Course II, with options. General Mechanical Engineering (1), Engineering Science (2), Automotive Engineering (3). Also Coöperative Course in Mechanical Engineering, II-A.

METALLURGY, Course III, with options. Metallurgy (1), Mineral Dressing (2).

METEOROLOGY, COURSE XIX.

NAVAL ARCHITECTURE AND MARINE ENGINEERING, Course XIII.

School of Science

CHEMISTRY, Course V.
FOOD TECHNOLOGY, Courses XX and XX-A.
GENERAL SCIENCE, Course IX-A.
GEOLOGY, Course XII.

MATHEMATICS, Course XVIII, with options. Pure and Applied Mathematics (1), Industrial Statistics (2).

PHYSICS, Course VIII.

QUANTITATIVE BIOLOGY, Course VII. Also Physical Biology, VII-A.

These Courses provide a thorough training in the fundamental sciences and in design. They lay far more stress on the development of power to deal effectively and creatively with new problems than on the acquirement of an extensive knowledge of technical specialties and details. Neither the student nor his professor can possibly foresee what special knowledge or technique the student will be called upon to exercise in his professional career. If, however, his education has emphasized the fundamental principles of science and engineering which underlie all specialties, he will be in a position to attack intelligently the variety of specialized problems which he will meet.

In addition to the above, a five-year course in ECONOMICS AND ENGINEERING or ECONOMICS AND NATURAL SCIENCE is offered which leads to the degree of Bachelor of Science in that one of the above professional Courses in which undergraduate work is taken, together with the degree of Master of Science in Economics and Engineering or Economics and Natural Science. For details see the Graduate School section of this Bulletin.

The first year is devoted to such fundamental subjects as physics, chemistry, mathematics, and English. The student, therefore, may change his course of study at any time before the beginning of the second year.

In the second year, the fundamental subjects of mathematics, physics, and history are required in all curricula. The courses based on chemistry continue this subject, while the other courses begin the study of applied mechanics. In addition, the professional work is begun by each course, the schedule including one or more introductory professional subjects in each term.

Architecture (Course IV) requires five years for the Bachelor's degree. Courses II-A, VI-A, VII-A, and XX-A are of five years' duration, and lead to the degrees of Bachelor of Science and Master of Science. Courses II-A and VI-A are coöperative courses requiring outside work in industry.

Division of Humanities

The four-year program in the humanities and social sciences provides that, in addition to courses in modern languages, students will take one course in this division each year. The work of the first year is devoted to English with emphasis on written and oral expression. Special provisions are made for students who are ready for advanced work in English and for foreign students who require intensive instruction. The emphasis on written and oral expression continues throughout the four years. In the second year all students are given an introductory course in modern history with special reference to the place of the United States in world affairs. On the basis of the preceding courses, especially history in the second year, the third year is devoted to the social sciences, including economics and psychology. Under this program in the second half of the third year students are permitted to choose between a limited number of options in the general field of the social sciences.

In their senior year students are given an opportunity to choose one of four options: (1) music and the fine arts; (2) international relations; (3) the history of science and thought; or (4) western world literature. Each of the four programs is closely coördinated with the objectives and purposes of those given in the preceding three years. All classes are held in small sections and constant opportunity is given for improvement in both written and oral expression. The Program is outlined under the Description of Subjects.

PROFESSIONAL SUMMER SCHOOLS

(Not offered in Summer 1946)

REQUIREMENTS FOR THE BACHELOR'S DEGREE

To receive the Degree of Bachelor of Science (S.B.), Bachelor in Architecture (B. Arch.) or Bachelor in City Planning (B.C.P.), the student must have attended the Institute not less than one academic year, which must, in general, be that next preceding his graduation. He must have completed the required curriculum for the Class with which he will graduate unless minor substitutions are permitted. No substitution will be permitted in the First-year Program, in the Second-year Program excluding professional subjects, and in the Humanities Programs of the third and fourth years including Economic Principles Ec11. Substitution is not permitted for professional subjects in the second year and for subjects marked with an asterisk (*) in the third and fourth years unless the proposed subject has practically the same subject content, same objectives, and at least the same number of units as the subject in the curriculum.

The ability of the student to perform an original piece of work is considered an important feature of his degree requirements and theses are required in all course schedules. All theses and records of work done in preparation of theses are the permanent property of the Institute, and must not be published, either wholly or in part, except by authorization of the heads of the respective departments.

No degree will be conferred until all dues to the Institute are paid.

SUBJECT NUMBERING SYSTEM

Subjects are grouped and numbered according to the Department under which the instruction is given. A Course is a program of study made up of subjects selected from the several Departments, and leads to a degree in a given field of science or engineering. The arabic numerals for the subjects correspond to the Roman numerals of the Courses in the same Department, except Courses IX, XIV, and XVIII.

Department	Subject Numbers
Civil and Sanitary Engineering	1·00 to 1·99
Mechanical Engineering	2·00 to 2·99
Metallurgy	3·00 to 3·99
Architecture and Planning	4·00 to 4·99
Chemistry	5·00 to 5·99
Electrical Engineering	6·00 to 6·99
Biology	7·00 to 7·99
Physics	8·00 to 8·99
Chemical Engineering	10·00 to 10·99
Geology	12·00 to 12·99
Naval Architecture and Marine Engineering	13·00 to 13·99
Business and Engineering Administration	15·00 to 15·99
Aeronautical Engineering	16·00 to 16·99
Building Engineering and Construction	17·00 to 17·99
Meteorology	19·00 to 19·99
Food Technology	20·00 to 20·99
Graphics	D1 to D99
Economics and Social Science	Ec1 to Ec99
English and History	E1 to E99
General Studies	G1 to G99
Languages	L1 to L99
Mathematics	M1 to M99
Military Science and Tactics	MS1 to MS99

The time given to each subject is expressed in units, one unit representing 15 hours' work. (Units in class are placed first, followed by preparation units.) The units of preparation represent the estimated time for the average student.

One unit of Recitation or Lecture credit is equivalent to one semester hour. Two units of Drawing or Laboratory credit are equivalent to one semester hour. The division between Recitation or Lecture and Drawing or Laboratory time is shown in the Tabulation of Subjects.

FIRST YEAR FOR ALL COURSES

First Term	5·01	Chemistry, General	7–4
	8·01	Physics	6–5
	D11	Engineering Drawing	6–0
	E11	English Composition	3–5
	M11	Calculus	3–6
	MS11	Military Science	3–0
			28–20

Second Term	5·02	Chemistry, General	7–4
	8·02	Physics	6–5
	D12	Descriptive Geometry	6–0
	E12	English Composition	3–5
	M12	Calculus	3–6
	MS12	Military Science	3–0
			28–20

UNDERGRADUATE COURSE SCHEDULES

I. CIVIL ENGINEERING

CIVIL ENGINEERING is the broadest in scope of the engineering professions, being the stem from which most of the other branches of engineering have developed. Today the Civil Engineer serves and utilizes these other branches as he plans and builds projects such as airports, superhighways, and modern industrial buildings. He develops and adapts new knowledge and new skills as he controls the use of water for power and navigation, and for domestic and industrial purposes. He has at his command new materials of construction as he designs the avenues of transportation, with their bridges, tunnels, and terminal facilities. He is involved in the basic economy and in the organization and execution of major enterprises. Dealing, as he does, with both the forces of nature and with social and economic responsibilities, the Civil Engineer must combine fundamental knowledge of science and engineering with experience and judgment, and with personal characteristics of the highest order.

The objective of the Course in Civil Engineering is to enable students of superior ability to develop their potential qualities for becoming leaders in the field. The curriculum emphasizes the basic principles of mathematics and science and the general application of these principles. Electricity, thermodynamics, and engineering geology are required to broaden the professional base. As the student progresses, the emphasis in application is directed to subjects such as structures, hydraulics, and soil mechanics, which are essential in all branches of the profession. In the fourth year, group elective subjects permit special study in a professional subdivision such as transportation, sanitation, or water power. A limited number of vocational subjects, such as drafting and surveying fieldwork, are included in the curriculum because they afford an excellent opportunity to train a student in proper methods of working, and are helpful in the early stages of his career, but major attention centers on professional subjects.

Throughout the Course constant endeavor is made to aid students in developing their personal potentialities. This development is greatly aided by the period spent at the end of the first year at the Summer Surveying Camp near East Machias, Maine.

The Course leads to the degree of Bachelor of Science in Civil Engineering.

First Year (See page 42)

Required During Summer.		At Camp Technology¶
1·00T	Surveying Fieldwork	13–0
1·01T	Surveying Fieldwork, Adv.	4–0
1·20	Route Surveying Fieldwork	6–0

Second Year

First Term	1·03	Surveying, Adv.	6–6	*Second Term*	1·21	Route and Constr. Surveys	2–4
	2·00	Statics	3–5		1·61	Fluid Mechanics	2–4
	8·03	Physics	5–5		2·01	Dynamics	3–5
	E21	U. S. in World Hist. — Humanities II	3–5		8·04	Physics	5–5
	M21	Calculus	3–6		E22	U. S. in World Hist. — Humanities II	3–5
	MS21	Military Science	3–0		M22	Differential Equations	3–6
			23–27		MS22	Military Science	3–0
							21–29

Third Year

First Term	*1·62	Fluid Mechanics	3–6	*Second Term*	*1·40	Structures	6–6
	*2·04	Strength of Materials	3–6		*1·43	Reinf. Concrete Design	6–0
	2·41	Heat Engineering	4–5		2·373	Testing Materials Lab.	5–2
	§12·321	Engineering Geology	4–4		2·687	Hydraulic Laboratory	2–2
	*17·75	Materials	3–6		*6·18	Electrical Eng., Fund.	4–6
	Ec11	Economic Prin. — Humanities III	3–5			†Humanities III	3–5
			20–32				26–21

Fourth Year

(a) Sanitary; (b) Transportation; (c) Hydraulic; (d) General

First Term	1·271	(*b*) Transportation Engineering	6–6	*Second Term*	1·272	(*b*) Transportation Engineering	6–3
	1·28	(*d*) Highways and Airports	3–3		*1·42	Structures	3–6
	*1·35	Soil Mech. and Found. Eng.	6–6		‡1·442	Structural Design	6–0
	*1·41	Structures	3–6		1·71	(*c*) Water Power Eng.	6–3
	*1·441	Bridge Design	6–0		1·76	(*a*) Sewerage & Sewage Treatment	6–3
	1·70	(*c*) Hydrol. and Flood Control	6–6		1·77	(*d*) Water Supply and Sewerage	6–3
	1·72	(*d*) Hydrol. and Water Power Eng.	3–3		*1·92	Engineering Construction	3–3
	1·75	(*a*) Water Supply and Purification	6–6			*Thesis	9
	*1·91	Professional Problems	2–4			†Humanities IV	3–5
		†Humanities IV	3–5				47
			26–27				

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

‡ 1·79 Sanitary Engineering Design 6–0 may be taken as optional substitution by students taking the professional elective in Sanitary Engineering.

§ Students planning to take the professional elective in Sanitary Engineering may substitute 1·78 Sanitary Analysis 6–2.

¶ During the period in which the Summer Surveying Camp is suspended, the following changes will be made: 1·00T, 1·01T, 1·20, 1·03, and one term of the third of fourth year Humanities Program will be omitted; 1·00, 1·01, 1·054, and 1·13T will be added.





II. MECHANICAL ENGINEERING

THE Course in Mechanical Engineering is planned to provide a sufficient foundation of basic science applied to engineering methods and techniques, to prepare the graduate to enter any industry dealing with heat, power, materials and machinery. The Course does not attempt to teach current commercial practice nor specialized knowledge of the product of any one industry. On the contrary, graduates are expected to obtain their practical experience by direct service in industry.

During the first two years the fundamental subjects which are the basis of the student's later professional work are studied, viz., mathematics, chemistry, physics, and applied mechanics, a thorough knowledge of which is essential in all branches of mechanical engineering. The student is also trained in elements of the more important mechanical processes in order that he may acquire the knowledge of modern machine tools, foundry practice, forging and welding, necessary for the successful designer of machinery.

The professional work of the third and fourth years includes the study of the mechanics of fluids and of rigid and elastic bodies with applications to design. The study of thermodynamics is applied to heat engineering, and to the analysis and design of power plants, turbines, steam and internal combustion engines, and to refrigeration and air conditioning systems. The materials, especially the metals, commonly employed in mechanical engineering, are the subject of lectures and laboratory exercises planned to correlate physical properties with constitution, heat treatment and working.

In general, instruction by lectures is paralleled by laboratory work in which the student is given opportunity, not only to familiarize himself with materials, engines and machinery, but also to develop his ability to apply theory to the analysis of their characteristics.

Three options with professional elective subjects permit a diversification of the student's program in the fourth year.

Under normal conditions a reading knowledge of German or French is required for admission to the Senior year. Due to the war, this requirement has been waived temporarily.

The Course leads to the degree of Bachelor of Science in Mechanical Engineering.

Honors Course

The opportunity will be afforded a limited number of students of superior ability to join an Honors Course group. The selection of members of this group will be made by the Department from students who may wish to avail themselves of the opportunity to pursue a coördinated schedule of studies through the Senior and Graduate years. A single thesis with a minimum of 30 units will be required in the Graduate year and the time allotted to thesis in the Senior year will be available for advanced mathematics or other subjects preparatory to the program of graduate studies. Before registration for the fifth year, the students selected under this plan must have had at least two months industrial employment satisfactory to the Department. A member of the Department will serve as adviser to aid the members of the group in selecting the senior and graduate schedules which may be best suited to their individual interests.

The Honors Course leads to the degrees of Bachelor of Science and Master of Science in Mechanical Engineering awarded simultaneously at the end of the Graduate year

First Year (See page 42)

Second Year

First Term	2·00	Statics	3-5	*Second Term*	2·01	Dynamics	3-5
	2·701	Machine Drawing	6-0		2·30	Engineering Materials	5-4
	2·851	Machine Tool Lab.	4-0		2·852	Machine Tool Prac.	4-0
	8·03	Physics	5-5		8·04	Physics	5-5
	E21	U. S. in World Hist. — Humanities II	3-5		E22	U. S. in World Hist. — Humanities II	3-5
	M21	Calculus	3-6		M22	Differential Equations	3-6
	MS21	Military Science	3-0		MS22	Military Science	3-0
			27-21				26-25

Third Year

First Term	*2·04	Strength of Materials	3-6	*Second Term*	*2·06	Dynamics	3-6
	*2·251	Fluid Mechanics	3-6		*2·252	Fluid Mechanics	3-6
	*2·40	Heat Engineering	4-5		*2·37	Testing Materials Lab.	4-4
	*2·730	Machine Design	4-2		*2·42	Heat Engineering	3-6
	*6·18	Electrical Eng., Fund.	4-6		*2·731	Machine Design	4-2
	Ec11	Economic Prin. — Humanities III	3-5			†Humanities III	3-5
			21-30				20-29

Fourth Year

Option 1. General Mechanical Engineering

First Term	2·081	Strength of Materials	3-6	*Second Term*	2·56	Mechanical Eng. Prac.	3-6
	2·31	Engineering Metals	4-4		2·682	Engineering Laboratory	3-3
	2·43	Heat Engineering	3-6			*Thesis	9
	2·681	Engineering Laboratory	3-3			†Humanities IV	3-5
		†Humanities IV	3-5			Prof. Elective Subjects (see next page)	18
		Prof. Elective Subject (see next page)	9				
			49				50

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

II. *Mechanical Engineering Continued*

First Term Professional Elective Subjects‡

2·66	Air Conditioning	3–6
2·791	Internal Combustion Eng.	3–6
6·19	Electrical Eng., Fund.	4–6
15·70	Production	3–6

Second Term Professional Elective Subjects‡

2·261	Lubrication & Friction	2–4
2·32	Engineering Metals	3–6
2·34	Mech. Properties of Metals	3–6
2·47	Steam Turbine Eng.	3–6
2·48	Gas Turbine Eng.	3–6
2·621	Refrigeration	3–6
2·622	Refrigeration, App.	3–6
2·732	Machine Design	5–4
2·78	Hydraulic Machinery, Des.	5–4
2·79	Internal Combustion Eng., Elem.	3–6
2·792	Internal Combustion Eng.	3–6
2·871	Manufacturing Eng.	3–6
15·76	Mass Production Methods	3–6

Option 2. Engineering Science§

First Term	2·081	Strength of Materials	3–6		
	2·31	Engineering Metals	4–4		
	2·43	Heat Engineering	3–6		
	2·681	Engineering Laboratory	3–3		
	6·19	Electrical Eng., Fund.	4–6		
		†Humanities IV	3–5		
			20–30		
Second Term	2·082	Dynamics			3–6
	2·44	Heat Engineering			3–6
		*Thesis			12
		†Humanities IV			3–5
		Prof. Elective Subject			12
					50

Professional Elective Subjects‡

2·128	Experimental Stress Anal.	8–4
2·322	Engineering Metals	6–6
2·482	Gas Turbine Eng.	6–6
2·562	Mechanical Eng. Prac.	6–6
2·782	Mech. Systems, Des.	6–6

Option 3. Automotive Engineering§

First Term	2·081	Strength of Materials	3–6		
	2·31	Engineering Metals	4–4		
	2·43	Heat Engineering	3–6		
	2·681	Engineering Laboratory	3–3		
	2·791	Internal Combustion Eng.	3–6		
		†Humanities IV	3–5		
			19–30		
Second Term	2·082	Dynamics			3–6
	2·792	Internal Combustion Eng.			3–6
	2·794	Internal Combust. Eng. Lab.			4–2
		*Thesis			9
		†Humanities IV			3–5
		Prof. Elective Subject			9
					50

Professional Elective Subjects‡

2·126	Experimental Stress Anal.	5–4
2·32	Engineering Metals	3–6
2·48	Gas Turbine Eng.	3–6
2·796	Internal Combust. Eng. Des.	3–6
15·70	Production	3–6
16·81	General Aeronautics	3–6

II-A. MECHANICAL ENGINEERING

In Coöperation with the General Electric Company and the Boston Edison Company

(*Applications for admission to Course II-A are not being accepted.*)

III. METALLURGY

THE Course in Metallurgy provides training in the beneficiation and dressing of ores and minerals, in the production and purification of metals, and in the use of metals and alloys. Emphasis throughout the four years is laid on the basic sciences of mathematics, physics, chemistry, and economics, and the Junior year is devoted almost exclusively to an application of these sciences to the various branches of Metallurgy.

Two options are offered, one in Metallurgy and the other in Mineral Dressing.

The Metallurgy option covers both process metallurgy, which is concerned primarily with the winning of the metals from ores or concentrates, and the making of steel and other alloys, and physical metallurgy, which stresses the physical properties, structures, testing and uses of metals and alloys. The two subdivisions of Metallurgy are so closely interrelated that a sharp separation is undesirable. A limited amount of specialization in one of the two fields is made possible by the freedom of choice in the selection of electives and of a thesis subject in the fourth year.

The Mineral Dressing option is primarily concerned

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

‡ Other electives may be chosen with approval of registration officer.

§ Application for admission to this option should be made to the Head of the Department before the end of the third year, since registration is limited.

III. Metallurgy Continued

with the mechanical, physical, and chemical preparation of ores, solid fuels, ceramic raw materials and other non-metallic mineral products. This preparation has as its goal the elimination at low cost of the bulky impurities commonly found in raw mineral products, and the production of the valuable content as concentrate.

Both options lead to the degree of Bachelor of Science in Metallurgy.

CERAMICS. The instruction and research in Ceramics are mainly intended for graduate work leading to a Master's or Doctor's degree. It is advisable for an undergraduate student interested in this subject to register in Course IX-B, General Engineering, and take as electives, subjects bearing on Ceramics. This procedure will also give an excellent foundation for graduate work. The subjects dealing with Ceramics are intended to give a fundamental training in the usual manufacturing processes as well as in the testing of raw materials and finished ware.

FIRST YEAR (See page 42)

SECOND YEAR

First Term	2·011	Statics & Dynamics	3–5	*Second Term*	2·04	Strength of Materials	3–6
	5·11	Qualitative Analysis	7–3		5·12	Quantitative Analysis	7–3
	8·03	Physics	5–5		8·04	Physics	5–5
	E21	U. S. in World Hist. — Humanities II	3–5		E22	U. S. in World Hist. — Humanities II	3–5
	M21	Calculus	3–6		M22	Differential Equations	3–6
	MS21	Military Science	3–0		MS22	Military Science	3–0
			24–24				24–25

REQUIRED DURING SUMMER

2·851 Machine Tool Laboratory 4–0

THIRD YEAR‡

First Term	*3·12	Met.: Iron and Steel	2–4	*Second Term*	2·50	(1) Heat Measurements	3–1
	*3·31	Physical Metallurgy I	5–4		*3·01	Non-Ferrous Metallurgy I	4–4
	*3·81	Mineral Dressing I	6–4		*3·04	Metallurgical Laboratory	4–0
	*5·61	Physical Chemistry I	4–4		3·09	(1) Metallurgical Calculations	2–4
	*12·011	Mineralogy	3–1		*3·32	(1) Physical Metallurgy II	5–4
	*12·20	Elem. Crystallography	2–2		*3·41	(1) Industrial Non-Fer. Alloys	2–2
	Ec11	Economic Prin. — Humanities III	3–5		*3·82	(2) Mineral Dressing II	2–4
			25–24		*3·86	(2) Quant. Mineragraphy	7–2
					*5·62	Physical Chemistry II	4–4
					12·91	(2) Mining, Elements	3–5
						†Humanities III	3–5
							27–24

FOURTH YEAR

OPTION 1. METALLURGY

First Term	2·33	Metal Processing	4–4	*Second Term*	6·19	Electrical Eng., Fund	4–6
	2·371	Testing Materials Lab	2–2			*Thesis	12
	3·20	Metal. Thermodynamics	4–4			†Humanities IV	3–5
	3·33	Industrial Physical Met	3–2			Elective Subjects	18
	6·18	Electrical Eng., Fund	4–6				48
		†Humanities IV	3–5				
		Elective Subject	6				
			49				

First Term Elective Subjects

3·02	Non-Ferrous Metallurgy II	2–4
3·041	Electric Furnaces	3–2
3·05T	Metallurgy, General	3–6
3·40	Cor. & Heat Res. Alloys	2–4
3·50	X-ray Metallography	4–4
3·70	Ceramics	5–4
3·71	Optical Ceramics	6–2
3·83	Mineral Dressing III	2–4

Second Term Elective Subjects

3·21	Steelmaking, Prin.	2–4
3·42	Powder Metallurgy	2–4
3·422	Powder Metallurgy Lab.	4–2
3·51	Physics of Metals	2–4
3·65	Theory of the Solid State	3–6
3·82	Mineral Dressing II	2–4

OPTION 2. MINERAL DRESSING

First Term	3·20	Metal. Thermodynamics	4–4	*Second Term*	3·84	Mineral Dressing IV	2–4
	3·83	Mineral Dressing III	2–4		3·88	Mineral Dressing Prac.	2–4
	3·87	Ore Testing	10–0		10·32	Chemical Engineering	4–6
	5·41	Organic Chemistry I	4–4		12·24	Theoretical Crystallog.	2–4
	10·31	Chemical Engineering	4–6			*Thesis	14
		†Humanities IV	3–5			†Humanities IV	3–5
			27–23				50

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

‡ Students planning to take a certain option in the fourth year, take the Group Electives indicated by the corresponding number.

IV. ARCHITECTURE

THE objective of the Course in Architecture is to produce graduates who will be effective and valuable in the planning and execution of all kinds of building projects. The professional contribution includes understanding of the building needs of communities and individuals, ability to analyze accurately the requirements in specific cases, skill in the effective and orderly disposition of building elements on sites and in the organization of interior spaces, coördination of the general plan with a simple and economical structural system, research into best methods and materials of construction, control over proportions and details to achieve effective and eloquent expression and integration of planning with equipment and materials necessary to maintain desired conditions of health, enjoyment, and convenience.

Unusual opportunities are available for fundamental training in the basic sciences underlying building technology, for close contact with outstanding laboratory and research facilities in engineering fields related to architecture, and for understanding of the broad economic and social approach of the city planner.

In recognition of a vital need in the profession for ever greater technical ability and judgment, the curriculum in Architecture integrates technical resources with social and cultural needs.

The Course leads to the degree of Bachelor in Architecture

FIRST YEAR (See page 42)

SECOND YEAR

First Term	2·011	Statics & Dynamics	3–5	*Second Term*	2·04	Strength of Materials	3–6
	4·721	Architectural Design	9–3		4·07	Shop	4–0
	8·03	Physics	5–5		4·722	Architectural Design	9–3
	E21	U. S. in World Hist. — Humanities II	3–5		17·71	Materials	2–4
	M21	Calculus	3–6		Ec83	Urban Sociology	2–4
	MS21	Military Science	3–0		E22	U. S. in World Hist. — Humanities II	3–5
			26–24		MS22	Military Science	3–0
							26–22

THIRD YEAR

First Term	*1·771	Sanitation	2–4	*Second Term*	*2·662	Heating & Ventilation	2–4
	*2·661	Heating & Ventilation	2–4		*4·032	Visual Fundamentals	4–0
	*4·031	Visual Fundamentals	4–0		*4·732	Architectural Design	12–6
	*4·731	Architectural Design	12–6		*4·812	Structural Analysis	8–0
	*4·811	Structural Analysis	8–0		*17·72	Materials	2–4
	Ec11	Economic Prin. — Humanities III	3–5			†Humanities III	3–5
			31–19				31–19

FOURTH YEAR

First Term	*4·741	Architectural Design	12–6	*Second Term*	*2·373	Testing Materials Lab	5–2
	*6·16	Electricity	3–6		4·042	Light & Color	6–0
	8·132	Architectural Acoustics	5–3		*4·641	City Planning, Prin.	2–4
	*17·73	Materials	2–4		*4·742	Architectural Design	12–6
		†Humanities IV	3–5		*6·17	Illumination	2–4
			25–24			†Humanities IV	3–5
							30–21

FIFTH YEAR

First Term	4·051	Graphic Presentation	6–0	*Second Term*	4·052	Graphic Presentation	6–0
	*4·451	History of Architecture	3–6		*4·452	History of Architecture	3–6
	*4·621	Site Plan. & Construction	9–3		Ec88	Building Economics	2–4
	*4·751	Architectural Design	9–3			*Thesis	21
	Ec85	Land Economics	2–4			Prof. Elective Subject	6
		Prof. Elective Subject	6				48
			51				

IV-B. CITY PLANNING

THE undergraduate Course in City Planning has been developed in response to the need for a curriculum which is oriented to this professional field early in the program and which provides for a synthesis of the economic, sociological, administrative, and engineering aspects of city planning impossible in courses developed from existing curricula in specialized professional fields.

The expansion which has taken place in the social and economic aspects of planning, the development of improved technical procedures, and the rapidity with which planning and zoning legislation has placed new instruments of social control into the hands of local and state governments have greatly increased the scope of professional activity. This fact in its turn has placed a greater responsibility on the planning technician or consultant, who must be well equipped in the methods of social and economic research as well as in the techniques of physical planning.

The curriculum of Course IV-B includes preparatory

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

IV-B. City Planning Continued

subjects in engineering and in the natural and social sciences with the object of developing in the student an understanding of basic principles and relationships. The content of the third and fourth years is primarily technical in character with emphasis on the economic and administrative aspects, but with considerable time given to the working out in the drafting room of actual problems in the field of city and regional planning.

A feature of the Course is the close relations maintained between the student group and planning agencies in the Boston metropolitan district, advantage being taken of the many opportunities for evaluating "planning in action." Students develop planning studies in various communities as part of their regular program of instruction, such studies including proposals for zoning, traffic circulation, housing, and rehabilitation, as well as comprehensive plans for future development. While these do not of course take the place of official plans and surveys, the procedure enables a student to carry through a planning project under conditions which approximate those of actual practice.

The Course in City Planning, IV-B, covers four years and leads to the degree of Bachelor in City Planning. Graduates of the Course, if accepted for admission to the Graduate School, should be able to complete the requirements for the degree of Master in City Planning in one year.

First Year (See page 42)

Summer Term — At Camp Technology

1·00T	Surveying Fieldwork	13–0
1·01T	Surveying Fieldwork	4–0
1·20	Route Surveying Fieldwork	6–0

Second Year

First Term	4·721	Architectural Design	9–3	*Second Term*	4·641	City Planning, Prin.	2–4
	8·03	Physics	5–5		4·722	Architectural Design	9–3
	12·321	Engineering Geology	4–4		8·04	Physics	5–5
	E21	U. S. in World Hist. — Humanities II	3–5		Ec32	Economic Statistics	3–6
	G38	Public Speaking	3–3		E22	U. S. in World Hist. — Humanities II	3–5
	MS21	Military Science	3–0		MS22	Military Science	3–0
			27–20				25–23

Third Year

First Term	1·771	Sanitation	2–4	*Second Term*	1·24	Municipal Engineering	3–3
	4·59	Govt. & Public Admin.	3–6		4·652	City Planning, Th. & Prac.	3–6
	4·651	City Planning, Th. & Prac.	3–6		4·682	City & Regional Planning	12–6
	4·681	City & Regional Plan.	12–6		Ec33	Urban Sociology	2–4
	Ec11	Economic Prin. — Humanities III	3–5			†Humanities III	3–5
			23–27				23–24

Required during Summer

4·50 Office Practice . . . . . 40 h.p.w.

Fourth Year

First Term	4·62	Site Plan & Constr.	9–3	*Second Term*	4·60	Plan. Legis. & Admin.	2–4
	4·683	City & Regional Plan.	9–3		Ec86	Land Economics	3–6
	Ec49	Public Finance	2–4			*Thesis	20
	Ec85	Land Economics	2–4			†Humanities IV	3–5
		†Humanities IV	3–5			Prof. Elective Subject	6
		Prof. Elective Subject	6				49
			50				

V. CHEMISTRY

THE main objective of the Course in Chemistry is to provide a general and fundamental education based on science for those who seek the Bachelor's degree and a career in some field in which a sound knowledge of chemistry is important, and for those who wish to go on to graduate study and a professional career in chemistry.

Students receive thorough instruction in the principles of inorganic, analytical, organic and physical chemistry, supplemented by instruction in mathematics and physics and in the humanities, including English, history, German, French, and other nonprofessional subjects.

In the third and fourth years, elective time is available to enable the student to extend his knowledge in fields of special interest. Students intending to take graduate work, for example, may elect a series of subjects tending to increase their ability to utilize the opportunities in graduate study. Students intending to enter industry may take subjects which offer a command of the fundamentals in a selected field of science or engineering. Elective time is also available for additional subjects in the humanities.

Elective series are available in advanced inorganic, organic, and physical chemistry, in chemical engineering,

* See Requirements for Bachelor's Degree, page 42.

† See page 125 for list of subjects.

V. Chemistry Continued

ceramics, textiles, economics, metallography, mineralogy and geology, biology and biochemistry, and metallurgy.

The Course aims to stimulate and develop the research attitude, and the schedule includes the thesis in the fourth year to provide an opportunity for the student to demonstrate his aptitude for creative effort. Fourth-year students who intend to continue with graduate study may register for Graduate Research Conference in inorganic, organic, or physical chemistry as a part of thesis, subject to the approval of the Thesis Supervisor and Registration Officer. Throughout the Course, the student has the benefit of counsel by experienced instructors who assist him in selecting electives and aid him in acquiring the education and training necessary for well-balanced and intelligent living.

The Course leads to the degree of Bachelor of Science in Chemistry.

FIRST YEAR (See page 42)

REQUIRED DURING SUMMER

*5·10	Qualitative Analysis	15–3	

SECOND YEAR

First Term	5·12	Quantitative Analysis	7–3	*Second Term*	5·13	Quantitative Analysis	7–3
	8·03	Physics	5–5		8·04	Physics	5–5
	E21	U. S. in World Hist. — Humanities II	3–5		E22	U. S. in World Hist. — Humanities II	3–5
	M21	Calculus	3–6		M22	Differential Equations	3–6
	MS21	Military Science	3–0		MS22	Military Science	3–0
		‡Language	3–5			‡Language	3–5
			24–24				24–24

THIRD YEAR

First Term	*5·141	Analytical Chemistry	4–2	*Second Term*	*5·417	Quant. Organic Analysis	4–0
	*5·41	Organic Chemistry I	4–4		*5·42	Organic Chemistry II	4–4
	*5·414	Organic Preparations	9–0		*5·424	Organic Compounds, Ident.	9–0
	*5·61	Physical Chemistry I	4–4		*5·62	Physical Chemistry II	4–4
	*5·611	Physical Chem. Lab. I	4–0		*5·621	Physical Chem. Lab. II	4–0
	Ec11	Economic Prin. — Humanities III	3–5			†Humanities III	3–5
		Elective Subject	6			Elective Subject	6
			49				47

FOURTH YEAR

First Term	*5·061	Inorganic Chemistry, Adv.	2–4	*Second Term*	*5·062	Inorganic Chemistry, Adv.	2–4
	*5·43	Organic Chemistry III	2–4		*5·44	Organic Chemistry IV	2–4
	*5·63	Thermodynamics, Int.	2–4		*5·64	Radiation Chem., Int.	2–4
	*5·65	Kinetics & Chem. React.	2–4			or	
		*Thesis	15		*5·66	Surface & Colloid Chem.	2–4
		†Humanities IV	3–5			*Thesis	15
		Elective Subject	6			†Humanities IV	3–5
			53			Elective Subject	6
							47

VI. ELECTRICAL ENGINEERING

THE objective common to all options in Electrical Engineering is to train men for professional, industrial, or commercial careers in progressive applications of present engineering art and in the development of new engineering applications of electrical science. In preparation for such a career, the electrical engineering student must develop a working mastery of the basic sciences of mathematics and physics emphasizing mechanics, thermodynamics and especially electricity and magnetism. On these are built his fundamental professional work in principles of electrical engineering and associated applications. Equally vital to him is the ability to write and speak English effectively. He also needs the elements of chemistry and economics.

Various special features of the Department's work contribute strongly to the development of initiative, judgment, resourcefulness, and responsibility. Emphasis is placed on individual study under staff guidance: Close association among staff and students is considered part of a healthy educational atmosphere. Laboratory work is normally largely of the project type stressing individual experimental investigation under supervision rather than standardized experiments. Small class sections, including students of similar interests and aptitudes, serve to encourage vigorous discussion. The Honors Group Plan requires a large measure of initiative and responsibility in the third and fourth years on the part of accepted candidates. Several Colloquia each year led by outstanding industrial engineers provide case studies in current engineering developments. (The Honors Group Plan and the Colloquia are temporarily suspended.)

By means of options provision is made for interests in the small-current fields of communications, electronics, measurement, and control, as well as in the large-current or power field. Additional flexibility to meet the needs of the individual student is provided by permitting him to make substitutions in the curriculum with the permission of the head of the department provided these are well considered and directed toward sound objectives.

Course VI provides four options described below.

OPTION 1. ELECTRIC POWER. Emphasis is given to electrical machinery, power generation, transmission, and

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

‡ Students credited with Elementary and Intermediate French will take Elementary German. Students credited with Elementary and Intermediate German will take Elementary French. Students credited with Elementary French and Elementary German will take Intermediate German. Students who present neither French nor German on entrance will take Elementary German.

VI. Electrical Engineering Continued

distribution. The student is offered a logical preparation for work with heavy apparatus manufacturers, public power utilities, and users of heavy electrical equipment.

Option 2. Illumination Engineering. Particular attention is given to the scientific basis of vision, color, optical apparatus, and production and good use of illumination. Makers and users of illumination equipment require men with such training.

Option 3. Electrical Communications. A study is made of the techniques underlying the translation, transmission, reproduction, and recording of intelligence by electrical means. Circuit theory, electronics, electromagnetic theory, and acoustics are basic professional studies. The field of practical application includes aids to navigation, automatic control, and others in which the same techniques are essential.

Option 4. Electronic Applications. Emphasis is given to the rapidly increasing use of electrical methods of measurement, control, and implementation in all types of industry and engineering, as the emergence of a field of great future importance. Particular attention is paid to electromechanical and electrothermal systems, principles of measurement, and electronic applications.

The purpose of differentiation into options is primarily to provide the incentive to accomplishment which comes from emphasis on that portion of the electrical engineering field which arouses a student's special interest. All of these options lead to the degree of Bachelor of Science in Electrical Engineering.

First Year (See page 42)

Second Year

First Term	2·00	Statics	3–5	*Second Term*	2·01	Dynamics	3–5
	2·851	Machine Tool Laboratory	4–0		6·00T	Electrical Eng., Prin.	4–8
	6·05	Electrical Eng., Prin.	3–5		8·04	Physics	5–5
	8·03	Physics	5–5		E22	U. S. in World Hist. — Humanities II	3–5
	E21	U. S. in World Hist. — Humanities II	3–5		M22	Differential Equations	3–6
	M21	Calculus	3–6		MS22	Military Science	3–0
	MS21	Military Science	3–0				21–29
			24–26				

Third Year‡

First Term	*2·04	(1, 3, 4) Strength of Mat.	3–6	*Second Term*	*2·07	(1, 4) Dynamics	3–6
	*2·40	(1) Heat Engineering	4–5		2·42	(1) Heat Engineering	3–6
	*6·01T	Electrical Eng., Prin.	3–6		*6·02T	Electrical Eng., Prin.	3–6
	*6·75	Electrical Meas. Lab.	4–5		*6·27	(2) Illuminating Eng., Prin.	3–6
	*8·061	(2, 3, 4) Physics, Int.	3–6		*6·30	(3) Electrical Com., Prin.	3–6
	8·161	(2) Optics	3–6		*6·76	Elec. Electronics Lab.	3–3
	Ec11	Economic Prin. — Humanities III	3–5		*6·77	(1, 3, 4) Elec. Mach. Lab.	4–4
	M31	Differential Equations	2–4		8·062	(2, 3, 4) Physics, Int.	3–6
			(1) 19–31		M77	(2) Vector Analysis	3–6
			(2, 3, 4) 18–32			†Humanities III	3–5
							(1, 3, 4) 19–30
							(2) 18–32

Fourth Year

Option 1. Electric Power

First Term	1·64	Hydraulics	3–6	*Second Term*	6·01	Electrical Eng., Prin.	3–6
	2·681	Engineering Lab.	3–3		6·79T	Electrical Mach. Lab.	3–3
	*6.03T	Electrical Eng., Prin.	3–6			*Thesis	9
	*6·78	Electrical Mach. Lab.	4–4			†Humanities IV	3–5
		†Humanities IV	3–5			Prof. Elective Subjects	18
		Prof. Elective Subject	9				50
			49				

Professional Elective Subjects

6·20	(1, 2, 3) Electronic Control & Meas.	3–6		6·202	Electronic Control and Meas.	3–6
6·211	App. Electricity to Industry	3–6		6·212	App. Electricity to Industry	3–6
6·221	Power Syst. Meas., Anal. & Control	3–6		6·213	Ind. App. of Servomechanisms	3–6
6·251	Electric Machine Design	3–6		6·222	Power Syst. Meas., Anal. & Control	3–6
6·26	Insulators and Semi-Conductors	3–6		6·23	(1, 2, 3) Electrical Implementation	3–6
6·281	Wire Communications, Prin.	3–6		6·252	Electric Machine Design	3–6
6·80	Electrical Meas. Lab.	Time arr.		6·27	(1, 3, 4) Illuminating Eng., Prin.	3–6
6·86	Electrical Machinery Lab.	Time arr.		6·312	Electrical Communications, Prin.	3–6
				6·322	Electrical Communications, Prin.	3–6
				6·48	Electrical Equip. Bldgs.	2–4
				6·80	Electrical Meas. Lab.	Time arr.
				6·86	Electrical Machinery Lab.	Time arr.
				8·462	(1, 3, 4) Int. to Theoret. Physics II	4–8
				M77	(1, 3, 4) Vector Analysis	3–6

Option 2. Illumination Engineering (Not offered 1946–47)

First Term	*6·03T	Electrical Eng., Prin.	3–6	*Second Term*	*6·272	Illuminating Eng., Prin.	3–6
	*6·271	Illuminating Eng., Prin.	3–6		8·462	Int. Theoret. Physics II	4–8
	8·461	Int. Theoret. Physics I	4–8			*Thesis	9
		†Humanities IV	3–5			†Humanities IV	3–5
		Prof. Elective Subject (See Option 1)	9			Prof. Elective Subject (See Option 1)	9
			47				47

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

‡ Students planning to take a certain option in the fourth year, take the Group Electives indicated by the corresponding number.

VI. Electrical Engineering Continued

OPTION 3. ELECTRICAL COMMUNICATIONS

First Term	*6·03T	Electrical Eng., Prin.	3–6	*Second Term*	*6·332	Electrical Com. Lab.	4–5
	*6·311	Electrical Com., Prin.	3–6		*6·781	Electrical Mach. Lab.	3–3
	*6·321	Electrical Com., Prin.	3–6			*Thesis	9
	*6·331	Electrical Com. Lab.	3–3			†Humanities IV	3–5
	8·13	Vibration & Sound	3–6			Prof. Elective Subjects (See Option 1)	18
		†Humanities IV	3–5				50
			18–32				

OPTION 4. ELECTRONIC APPLICATIONS

First Term	2·251	Fluid Mechanics	3–6	*Second Term*	*6·23	Elec. Implementation	3–6
	*6·03T	Electrical Eng., Prin.	3–6		*6·781	Electrical Mach. Lab.	3–3
	*6·20	Electronic Control & Meas.	3–6		*6·84	Elec. Implement. Lab.	4–5
	*6·83	Electronic Eng. Lab.	3–3			*Thesis	9
		†Humanities IV	3–5			†Humanities IV	3–5
		Prof. Elective Subject (See Option 1)	9			Prof. Elective Subject (See Option 1)	9
			50				50

VI-A. ELECTRICAL ENGINEERING

COÖPERATIVE COURSE

THE engineering graduate, before he can take responsibility for important industrial projects, must have an educational background of sound fundamental scientific and economic principles, and in addition, must be acquainted with industrial practices in his specialized field of employment. This interlinking of theory and practice is provided in the Coöperative Course in Electrical Engineering, in which a selected group of students pursues a course of study and practice which correlates the scientific and engineering principles of the classroom and laboratory with approximately seventy weeks of practical experience in the plants of a particular industry. This educational plan makes it possible for the student to do his "undergraduate" work in industry in parallel with his undergraduate academic studies at the Institute and, at the time of graduation, to be in a position to utilize immediately the more advanced principles studied in the senior and graduate years. The first four years are identical in academic content with that option of Course VI which the student elects. The fifth or final year includes a complete academic year of graduate work subject to the provisions of the Graduate School. The Course leads to the degrees of Bachelor of Science and Master of Science in Electrical Engineering awarded simultaneously at the end of the Graduate year.

The following five companies coöperate with the Institute by offering practical experience in one or more of the fields represented by the four options of Course VI:

The GENERAL ELECTRIC COMPANY affords practical experience in all four options, emphasis being placed on training for the technical and executive responsibilities incident to the electrical manufacturing industries. The manufacturing practice is taken in plants located in Lynn, Schenectady, Pittsfield, and Philadelphia. The earlier assignments deal with the manufacturing processes and planning, and the testing of manufactured products. The later assignments may include research or development projects in the various laboratories and engineering offices.

The BOSTON EDISON COMPANY affords practical experience in the power option as related to maintenance, operation and administration of a company which furnishes electric light and power as a public service. Students trained in the plants of the Company work on projects involving the repair and maintenance of lines and equipment, the testing of instruments, insulators and transformers, the handling of customer relations, the operation of generating stations, and the solution of transmission and distribution engineering problems.

The AMERICAN TELEPHONE AND TELEGRAPH COMPANY offers experience in the development and manufacture of communications and electronic devices. Students who obtain their experience with the Bell System may go first to an operating company, where they work with installers supplying customer service and in telephone exchanges on the installation and maintenance of central office equipment. The second assignment is to the Western Electric Company at Kearny, N. J., where the students work on problems of plant layout, factory processes, and manufacturing economy. The third assignment is to the Bell Telephone Laboratories, where the students usually confine their attention for the whole term to one specific research or development project. The final assignment may be at one of the Bell-System plants mentioned above or may be with one of the other associated companies, at the discretion of the officials of the American Telephone and Telegraph Company, the coördinating organization of the Bell System.

The GENERAL RADIO COMPANY provides practical experience in the manufacture of communications and electronic apparatus. The first period is spent in the factory, where the student becomes acquainted with shop practices, materials and products of manufacture. The second term is spent in the instrument calibration laboratory, where the students learn to test the behavior of manufactured instruments or of experimental models which may be in the developmental stage. The third term is spent as Junior Engineering Assistant in the development laboratories, and the final term is specially arranged to meet the needs of the individual student.

The PHILCO CORPORATION offers experience in the development and manufacture of electronic and communication appliances and in television transmission practices. Students obtain experience in production planning, and manufacturing methods, in addition to spending a considerable part of the works periods in the research and development laboratories, including the experimental television broadcasting station.

Candidates for admission to the third year are selected from the second-year class at the Institute, and from transfer students who have completed substantially the equivalent of the first two years of Course VI. Since the Course leads to the Master's degree, acceptance into the coöperative year is made by the Institute on the basis of a promising scholastic record, and by the companies upon personal qualifications which indicate adaptability to the work of the company involved.

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

VI-A. Electrical Engineering Continued

Each class is divided into two groups (A and B) which alternate after the second year, one group studying at the Institute in Cambridge while the other group is working at the plants of the coöperating companies.

The men when in training at the plants are subject to the usual company regulations. They receive regular compensation for their work, the total of which approximates the tuition charges for the three years of coöperation. During the practice periods classes are ... two evenings a week in electrical engineering and other professional studies, in this way maintaining a continuous study of the principles of electrical engineering, whether at the Institute or at the plant.

On account of the limitations of number and the unitary nature of the training, men who are admitted to a course with the approval of both parties are expected to carry it through to completion unless prevented by exceptional circumstances. Also, the companies are expected to continue the course of practical training to completion for the students who have already enrolled, unless industrial conditions arise which minimize the educational value of the engineering practice.

At the conclusion of the course graduates are not obligated to accept employment with the coöperating company, nor is the company obligated to offer such employment.

A reading knowledge of German or French is required for the Master's degree as stated in detail under the Graduate School.

(*Same as Course VI through Second Year.*)

GROUP A

THIRD YEAR‡

At M. I. T.

Summer	*2·04	Strength of Materials	3–6
Term	*2·40	(1) Heat Engineering	4–5
	*6·01T	Electrical Eng., Prin.	3–6
	*6·75	Elec. Meas. Lab.	4–5
	*8·061	(3, 4) Physics, Int.	3–6
	Ec11	Economic Prin., Humanities III	3–5
	M31	Differential Equations	2–4
			(1) 19–31
			(3, 4) 18–32

At Plants

First Term	*6·02T	Elec. Eng. Principles	3–6
	6·901, 6·911, 6·941, 6·951, 6·961	Industrial Practice (Students to register for one of these subjects.)	40 h.p.w.

At M. I. T.

Second Term	*2·07	(1, 4) Dynamics	3–6
	2·42	(1) Heat Engineering	3–6
	*6·20	(4) Elec. Cont. & Meas.	3–6
	*6·30	(3) Elec. Com., Prin.	3–6
	*6·321	(3) Elec. Com., Prin.	3–6
	*6·76	Elec. Electronics Lab.	3–3
	*6·77	Elec. Mach. Laboratory	4–4
	8·062	(3, 4) Physics, Int.	3–6
		†Humanities III	3–5
		(1) Prof. Elective Subject	9
			49

FOURTH YEAR

OPTION 1. ELECTRIC POWER; OPTION 3. ELECTRICAL COMMUNICATIONS; OPTION 4. ELECTRONIC APPLICATIONS

At Plants

Summer Term	*6·03T	Elec. Eng., Prin.	3–6
	6·902, 6·912, 6·942, 6·952, 6·962	Industrial Practice (Students to register for one of these subjects.)	40 h.p.w.

At M. I. T.

First Term	1·64	(1) Hydraulics	3–6
	2·251	(4) Fluid Mechanics	3–6
	2·681	(1) Engineering Lab.	3–3
	6·04	(1) Elec. Eng., Prin.	3–6
	*6·23	(4) Elec. Implementation	3–6
	*6·311	(3) Elec. Com., Prin.	3–6
	*6·322	(3) Elec. Com., Prin.	3–6
	*6·331	(3) Elec. Com. Lab.	3–3
	*6·78	(1) Elec. Mach. Lab.	4–4
	*6·781	(3, 4) Elec. Mach. Lab.	3–3
	6·79T	(1) Elec. Mach. Lab.	3–3
	*6·83	(4) Electronic Eng. Lab.	3–3
	*6·84	(4) Elec. Implement. Lab.	4–5
	8·13	(3) Vibration & Sound	3–6
		†Humanities IV	3–5
			(1) 46
			(3, 4) 47

At Plants

Second Term	6·501	Seminar	2–10
	6·903, 6·913, 6·943, 6·953, 6·963	Industrial Practice (Students to register for one of these subjects.)	40 h.p.w.

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

‡ Students planning to take a certain option in the fourth year, take the Group Electives indicated by the corresponding number.

VI-A. Electrical Engineering Continued

GRADUATE YEAR

At M. I. T.

Summer	6·502	Seminar	2–2
Term		†Humanities IV	3–5
		Grad. Study	36
			48

At Plants

First Term		Thesis	8
	6·904 6·914 6·944 6·954 6·964	Industrial Practice (Students to register for one of these subjects.)	40 h.p.w.

At M. I. T.

Second Term		Graduate Study and Thesis	48
			48

GROUP B

The content of the Group B curriculum is the same as that for Group A, with a slight rearrangement of subjects. Group B begins work at the plants in the third year summer, then attends alternately M. I. T. one term, and the plants the next term. The complete curriculum may be obtained from the Registration Officer.

VII. QUANTITATIVE BIOLOGY

THE curriculum in the biological sciences is devised to furnish fundamental training in pure and applied biology which may prepare students for careers in professional biology (teaching and research), for medical training, and for work involving technical applications, for example in industries concerned with biological materials and fermentation processes. Stress is laid on the application of quantitative, analytical methods in the subjects in pure biology, hence particular emphasis is given to those fields which, in the present stage of development, are susceptible of such treatment.

The first two years are devoted to fundamental subjects in mathematics, physics, and chemistry plus introductory biology and studies in the humanities; specialization begins in the third year.

This Course is designed primarily for students looking forward to careers in experimental biology and medicine. While insuring a sound background in the basic sciences of mathematics, physics and chemistry, and the fundamentals of modern biology, provision is made for a wide choice of electives both in the biological sciences and in the humanities. The Course is, therefore, well suited, not only for students wishing to prepare for teaching and research posts in biology, but also for premedical students. Modern medicine is rapidly becoming less empirical and more scientific. It is important, therefore, particularly for those who wish to prepare for medical research, to become acquainted with the quantitative approach to biological phenomena. The Course leads to the degree of Bachelor of Science in Quantitative Biology.

FIRST YEAR (See page 42)

SECOND YEAR

First Term	5·11	Qualitative Analysis	7–3	*Second Term*	5·12	Quantitative Analysis	7–3
	7·01	General Biology I	6–4		7·02	General Biology II	6–4
	8·03	Physics	5–5		8·04	Physics	5–5
	E21	U. S. in World Hist. — Humanities II	3–5		E22	U. S. in World Hist. — Humanities II	3–5
	M21	Calculus	3–6		M22	Differential Equations	3–6
	MS21	Military Science	3–0		MS22	Military Science	3–0
			27–23				27–23

REQUIRED DURING SUMMER

5·41	Organic Chemistry I	4–4
5·428	Organic Chemistry Lab.	10–0
		14–4

THIRD YEAR

First Term	*5·61	Physical Chemistry I	4–4	*Second Term*	*5·62	Physical Chemistry II	4–4
	*5·611	Physical Chem. Lab. I	4–0		*5·621	Physical Chem. Lab. II	4–0
	*7·14	Comparative Anatomy	8–4		*7·11	Embryology	8–4
	*7·80	Biochemistry	8–4			Language	3–5
	Ec11	Economic Prin. — Humanities III	3–5			†Humanities III	3–5
		Language	3–5			Elective Subject	8
			30–22				48

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

VII. Quantitative Biology Continued

FOURTH YEAR

First Term	*7·19	General Physiology I	2–4	*Second Term*	*7·03	Genetics	2–4
	*7·211	Gen. Physiol. Lab. I	4–0		*7·20	General Physiology II	2–4
		*Thesis	10		*7·212	Gen. Physiol. Lab. II	4–0
		†Humanities IV	3–5			*Thesis	10
		Elective Subjects	18			†Humanities IV	3–5
			46			Elective Subjects	12
							46

VII-A. PHYSICAL BIOLOGY

THE purpose of this course is to prepare students for work of a research character in experimental and applied biology. In the wide range from pure biology to applications in the industries, attractive opportunities await those who have sound training both in biology and in the exact sciences. Graduates may continue their studies toward the doctorate or may expect to find employment in research laboratories and industries dealing with biochemicals, drugs, medical supplies and instrumentation, textiles, leather, and related fields. It is not only efficient but pedagogically desirable for the student to obtain his training in the separate disciplines simultaneously rather than to study physics, chemistry, and mathematics either before or after specializing in biology. Course VII-A makes possible this combination. Subjects in physics and chemistry are taken in each of the first four years, together with substantially the same amount of work in biology, as is required in Course VII. These aspects of physical biology are correlated in the Biophysics subjects in the graduate year. Electives in the fourth and fifth years permit the selection, subject to approval of the registration officer, of subjects having a bearing on specialized fields of pure or applied biology such as bacteriology, biochemistry, biophysics, general physiology, economic entomology, and others. Training in research methods is provided through the solving of a thesis problem which may be selected in a field of pure or applied biology.

Because of the diversified technical courses of study prescribed in this curriculum each applicant for admission to Course VII-A should interview the registration officer for this course to determine if he is qualified to undertake the work.

Course VII-A leads to the degrees of Bachelor of Science in Quantitative Biology and Master of Science in Physical Biology.

Same as Course VII through Third Year.

FOURTH YEAR

First Term	*7·19	General Physiology I	2–4	*Second Term*	*7·03	Genetics	2–4
	*7·211	Gen. Physiol. Lab. I	4–0		*7·20	General Physiology II	2–4
	*7·31	Biology of Bacteria	7–4		*7·212	Gen. Physiol. Lab. II	4–0
	*8·09	Physical Measurements	3–2		*8·311	Atomic Structure	3–6
		†Humanities IV	3–5		*8·312	Atomic Structure Lab.	3–2
		Elective Subjects	12			†Humanities IV	3–5
			46			Elective Subject	8
							46

GRADUATE YEAR

First Term	7·85	Biophysics I	2–2	*Second Term*	7·86	Biophysics II	2–2
	7·881	Biophysics Lab. I	4–0		7·882	Biophysics Lab. II	4–0
	7·91	Instrument. in Biol. I	6–4		7·92	Instrument. in Biol. II	6–4
		Thesis	20			Thesis	20
		Elective Subject	8			Elective Subject	8
			46				46

VIII. PHYSICS

THE Course in Physics is intended to give its graduates a broad training in classical and modern physics, both experimental and theoretical. The student gains a knowledge of the facts of physics, training in modern experimental methods, and experience in applying mathematical methods to physical problems. This preparation is broad enough so that the graduate is equipped either to take a place in industry in a field employing physics for practical purposes, or to undertake graduate training in physics, to fit him for an industrial or academic career involving fundamental research or the more advanced aspects of physics.

Electives in the fourth year, to be chosen in consultation with the registration officer, may be taken in physics, in such fields as X-rays, nuclear physics, spectroscopy, electronics, and optics; or in other fields, such as mathematics, chemistry, metallurgy, or electrical engineering.

The Course leads to the degree of Bachelor of Science in Physics.

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

VIII. Physics Continued

FIRST YEAR (See page 42)

SECOND YEAR

First Term	5·11	Qualitative Analysis	7–3	*Second Term*	6·00T	Electrical Eng., Prin.	4–8
	8·03	Physics	5–5		8·04	Physics	5–5
	E21	U. S. in World Hist. — Humanities II	3–5		E22	U. S. in World Hist. — Humanities II	3–5
	M21	Calculus	3–6		M22	Differential Equations	3–6
	MS21	Military Science	3–0		MS22	Military Science	3–0
		Language	3–5			Language	3–5
			24–24				21–29

THIRD YEAR

First Term	6·11T	Electrical Eng., Prin.	3–6	*Second Term*	*8·062	Physics, Intermediate	3–6
	6·82T	Electrical Electronics Lab.	3–3		*8·202	Electronics Laboratory	3–2
	*8·061	Physics, Intermediate	3–6		*8·311	Atomic Structure	3–6
	*8·09	Physical Measurements	3–2		*8·312	Atomic Structure Lab.	3–2
	*8·161	Optics	3–6		M77	Vector Analysis	3–6
	*8·162	Optical Measurements	3–2			†Humanities III	3–5
	Ec11	Economic Prin. — Humanities III	3–5				18–27
			21–30				

FOURTH YEAR

First Term	8·11	Experimental Physics	8–4	*Second Term*	8·462	Int. Theoretical Physics II	4–8
	8·461	Int. Theoretical Physics I	4–8			*Thesis	18
		†Humanities IV	3–5			†Humanities IV	3–5
		Elective Subjects	15			Elective Subject	9
			30				47

IX-A. GENERAL SCIENCE

(Administered by a Committee of the Faculty)

THE Course in General Science provides an opportunity for a student with a special objective to map out his own program of study in the fundamental sciences.

Since one-quarter of the units required for graduation are elective, the student may choose a comprehensive program involving several sciences, with specialization in one field. If his objective falls within one of the professional science courses, such as Biology, Chemistry, Food Technology, Geology, Physics, or Mathematics, he may depart from the prescribed course curriculum for the purpose of concentrating upon some specialty. Alternatively he may pursue a specialty breaking across the boundaries of the professional courses, such as acoustics, economics, medical preparation, optics, photography, plastics, or teaching.

The choice of electives is subject to the approval of the Committee on Course IX and, for the third and fourth years, must include a total of at least 48 units in one field of science. Substitutions may be made for the subjects marked (**) by subjects of similar content or in the same field. The composite group of science subjects must comprise an amount of scientific training equivalent to that obtained in the standard science courses.

Course IX-A is not separated from the other science courses until the third year. A student intending to transfer to Course IX-A at the beginning of the third year should consult the Course IX Registration Officer and register in the second-year course schedule which relates most closely to the student's objective.

The Course leads to the degree of Bachelor of Science in General Science.

FIRST YEAR (See page 42)

SECOND YEAR (See text above)

THIRD YEAR

First Term	**5·41	Organic Chemistry I	4–4	*Second Term*	**5·42	Organic Chemistry II	4–4
	**8·061	Physics, Intermediate	3–6		**8·062	Physics, Intermediate	3–6
	Ec11	Economic Prin. — Humanities III	3–5		**M37	Advanced Calculus	3–6
	**M36	Advanced Calculus	3–6			†Humanities III	3–5
		‡Elective Subjects	16			‡Elective Subjects	16
			50				50

FOURTH YEAR

First Term	*Thesis	5	*Second Term*	*Thesis	10
	†Humanities IV	3–5		†Humanities IV	3–5
	‡Elective Subjects (See next page)	35		‡Elective Subjects (See next page)	30
		48			48

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects. **Substitutions may be made only with subjects in the same field.

‡ Total elective subjects for the two years must include a total of at least 48 units in one field of science. Elective subjects other than those suggested will be approved if they conform to the student's general objective.

IX-A. General Science Continued

Elective Subjects

5·414	Organic Preparations	9–0
5·61	Physical Chemistry I	4–4
5·611	Physical Chem. Lab. I	4–0
7·01	General Biology I	6–4
7·211	General Physiology Lab I	4–0
8·09	Physical Measurements	3–2
8·132	Architectural Acoustics	5–3
8·161	Optics	3–6
8·162	Optical Measurements	3–2
8·461	Int. Theoretical Physics I	4–8
12·321	Engineering Geology	4–4
20·41	Bacteriology	6–2
M31	Differential Equations	2–4

Elective Subjects

5·424	Organic Compounds, Ident.	9–0
5·62	Physical Chemistry II	4–4
5·621	Physical Chem. Lab. II	4–0
7·02	General Biology II	6–4
7·11	Embryology	8–4
7·31	Biology of Bacteria	7–4
8·15	Photography	2–1
8·173	Color Measurements	3–2
8·202	Electronics Lab.	3–2
8·311	Atomic Structure	3–6
8·312	Atomic Structure Lab.	3–2
8·462	Int. Theoretical Physics II	4–8
12·322	Engineering Geology	2–4
M77	Vector Analysis	3–6

IX-B. GENERAL ENGINEERING

(Administered by a Committee of the Faculty)

THE Course in General Engineering provides an opportunity for a student with a special objective to map out his own program of study in the fundamental engineering subjects.

Since one-quarter of the units required for graduation are elective, the student may choose a comprehensive program involving several engineering subjects, with specialization in one field. If his specialization falls within one of the professional engineering courses, such as Aeronautical, Chemical, Civil, Electrical, Mechanical or Metallurgical, he may depart from the prescribed course curriculum for the purpose of concentrating upon some specialty. Alternatively he may pursue a specialty breaking across the boundaries of the professional courses, such as ceramics, fire protection, instrumentation, manufacturing, prepatent law, or textiles.

The choice of electives is subject to the approval of the Committee on Course IX and, for the third and fourth years, must include a total of at least 48 units in one field of engineering. Substitutions may be made for the subjects marked (**) by subjects of similar content or in the same field. The composite group of engineering subjects must comprise an amount of engineering training equivalent to that obtained in the standard engineering courses.

Course IX-B is not separated from the other engineering courses until the third year. A student intending to transfer to Course IX-B at the beginning of the third year should consult the Course IX Registration Officer and register in the second-year course schedule which relates most closely to the student's objective.

The Course leads to the degree of Bachelor of Science in General Engineering.

FIRST YEAR (See page 42)

SECOND YEAR (See text above)

THIRD YEAR

First Term	**2·04	Strength of Materials	3–6
	**2·40	Heat Engineering	4–5
	Ec11	Economic Prin. — Humanities III	3–5
		‡Elective Subjects	24
			50

Second Term	**2·42	Heat Engineering	3–6
	**6·40	Electrical Eng., Elem.	4–6
		†Humanities III	3–5
		‡Elective Subjects	23
			50

FOURTH YEAR

First Term		*Thesis	5
		†Humanities IV	3–5
		‡Elective Subjects	35
			48

Second Term		*Thesis	10
		†Humanities IV	3–5
		‡Elective Subjects	30
			48

Elective Subjects

1·05	Surveying	3–1
1·64	Hydraulics	3–6
2·081	Strength of Materials	3–6
2·66	Air Conditioning	3–6
2·683	Engineering Laboratory	4–4
2·701	Machine Drawing	6–0
2·730	Machine Design	4–2
2·791	Internal Combustion Eng.	3–6
3·12	Met.: Iron & Steel	2–4
6·19	Electrical Eng., Fund.	4–6
6·221	Power Syst. Meas., Anal. & Control	3–6
6·85	Electrical Eng. Lab.	2–3
15·61	Law of Contracts	3–6
E33	Report Writing	2–4
M36	Advanced Calculus	3–6

Elective Subjects

1·401	Structures	3–6
2·06	Dynamics	3–6
2·30	Engineering Materials	5–4
2·50	Heat Measurements	3–1
2·621	Refrigeration	3–6
2·792	Int. Comb. Engines	3–6
5·35	Applied Chemistry	2–4
6·17	Illumination	2–4
6·48	Elec. Equipment of Bldgs.	2–4
15·50	Accounting	5–4
M37	Advanced Calculus	3–6

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

** Substitutions may be made only with subjects in the same field.

‡ Total elective subjects for the two years must include a total of at least 48 units in one field of engineering. Elective subjects other than those suggested will be approved if they conform to the student's general objective.

X. CHEMICAL ENGINEERING

THE needs of chemical industry for men competent to develop, design and operate new processes and to improve existing ones require a training which combines knowledge both of the underlying chemical reactions and of the engineering principles basic to design, construction and operation of plant equipment. The Course in Chemical Engineering is planned to afford students broad training in the fundamentals of science, chemistry and engineering.

The work in chemistry, covering inorganic, analytical, physical and organic chemistry, is practically the same as that given to students in chemistry during the first three years, except for some reduction in laboratory requirements. The subjects in mechanical and electrical engineering are intended to supply the fundamentals which are needed by the chemical engineer and the instruction is adapted to his requirements. The work in chemical engineering and in industrial chemistry is of a distinctly professional nature and is designed to develop capacity for original thought. Competent students may make substitutions in the curriculum with approval of the Head of the Department.

A graduate year of the Course, in Chemical Engineering or in Chemical Engineering Practice, provides opportunity for the development, correlation and application of the basic professional subjects.

The Course leads to the degree of Bachelor of Science in Chemical Engineering.

First Year (See page 42)

Second Year

First Term	5·11	Qualitative Analysis	7–3	*Second Term*	2·011	Statics & Dynamics	3–5
	8·03	Physics	5–5		5·12	Quantitative Analysis	7–3
	E21	U. S. in World Hist. — Humanities II	3–5		8·04	Physics	5–5
	M21	Calculus	3–6		E22	U. S. in World Hist. — Humanities II	3–5
	MS21	Military Science	3–0		M22	Differential Equations	3–5
		**Language	3–5		MS22	Military Science	3–0
			24–24				24–24

Third Year

First Term	2·04	Strength of Materials	3–6	*Second Term*	5·42	Organic Chemistry II	4–4
	5·41	Organic Chemistry I	4–4		5·426	Organic Compounds, Ident.	6–0
	5·416	Organic Preparations	6–0		5·62	Physical Chemistry II	4–4
	5·61	Physical Chemistry I	4–4		5·622	Physical Chem. Lab. II	2–0
	5·612	Physical Chem. Lab. I	2–0		10·17	Industrial Chemistry	3–4
	10·28	Chemical Engineering	4–6		10·29	Chemical Engineering	4–6
	Ec11	Economic Prin. — Humanities III	3–5			†Humanities III	3–5
			26–25				26–23

Required During Summer

10·26 Industrial Chem. Lab. 20–0

Fourth Year

First Term	2·371	Testing Materials Lab.	2–2	*Second Term*	6·85	Electrical Eng. Lab.	2–3
	2·681	Engineering Laboratory	3–3		10·21	Industrial Chemistry	3–6
	6·18	Electrical Eng., Fund.	4–6		10·32	Chemical Engineering	4–6
	10·18	Industrial Chemistry	3–6			*Thesis	9
	10·31	Chemical Engineering	4–6			†Humanities IV	3–5
		*Thesis	3			Elective Subject	6
		†Humanities IV	3–5				47
			50				

X-B. CHEMICAL ENGINEERING PRACTICE

THE privileges of the School of Chemical Engineering Practice are available for a selected group of undergraduates during the second half of the senior year. Students desiring to take this Course should register in the first term of the fourth year and those accepted will spend the second term at the Field Stations of the School of Chemical Engineering Practice. The nature of the work in the School of Chemical Engineering Practice is described under the section on Chemical Engineering in The Graduate School.

The Course leads to the degree of Bachelor of Science in Chemical Engineering Practice.

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.
**Students who have not had German will take German. Students who have had German will take Russian.

XII. GEOLOGY

THE following program for the second, third, and fourth years is designed for students desiring a broad training in geology, as well as for those planning to follow one of the several lines of specialization. The schedule is sufficiently flexible to permit an adequate range of specialization by the use of electives. Students whose interests and aptitudes have led to a choice may by consultation with their major professor arrange a suitable schedule. The principal lines of specialization are:

General Geology and Stratigraphy. A broad training in general geology, with emphasis on paleontology, stratigraphy, sedimentation, and allied subjects. This line of training gives suitable preparation for academic and professional work in general geology and its applications to coal, petroleum, and natural gas.

Physical and Economic Geology. This line of special interest leads to the application of physics and chemistry to fundamental research in geology, and is intended for those who plan to enter the field of geology as applied to ore deposits and non-metallic resources.

Mineralogy. Students desiring to prepare themselves for specialization and research in the science of mineralogy may arrange a schedule of subjects particularly designed for this purpose.

Geophysics. In recognition of the growing importance of fundamental research in geophysics and of the demand by petroleum and mineral industries, as well as by certain phases of engineering operations, for men trained along the combined lines of physics and geology, this Department is staffed and equipped to provide sound fundamental training in geology and geophysics. The training designed for this objective places special emphasis on physics, mathematics and certain phases of electrical engineering.

Engineering Geology. For students wishing to enter the field of engineering geology a suitable combination of subjects may be chosen from geology and civil engineering.

Mineral Industry. This division provides for specialized studies in the economics and evaluation of mineral resources and in certain phases of mining engineering for students interested in operational work in mineral industry. Schedules are sufficiently flexible to permit the student to elect those mineral industry subjects pertinent to his field.

This Course leads to the degree of Bachelor of Science in Geology.

FIRST YEAR (See page 42)

SECOND YEAR

First Term	5·11	Qualitative Analysis	7–3	*Second Term*	5·12	Quantitative Analysis	7–3
	8·03	Physics	5–5		8·04	Physics	5–5
	12·301	General Geology	7–3		12·302	General Geology	7–3
	E21	U. S. in World Hist. — Humanities II	3–5		E22	U. S. in World Hist. — Humanities II	3–5
	M21	Calculus	3–6		M22	Differential Equations	3–6
	MS21	Military Science	3–0		MS22	Military Science	3–0
			28–22				28–22

THIRD YEAR

First Term	5·61	Physical Chemistry I	4–4	*Second Term*	5·62	Physical Chemistry II	4–4
	*12·011	Mineralogy	3–1		*12·012	Mineralogy	4–2
	*12·20	Elem. Crystallography	2–2		*12·15	Petrography	6–2
	*12·23	Optical Crystallography	5–4		*12·702	Structural Geology	3–6
	*12·701	Structural Geology	3–6			*Language	3–5
	Ec11	Economic Prin. — Humanities III	3–5			†Humanities III	3–5
		*Language	3–5				23–24
			23–27				

FOURTH YEAR

First Term	*12·40	Economic Geology	3–6	*Second Term*	*12·37	Geomorphology	3–6
	*12·41	Economic Geology Lab.	6–0		*12·581	Sedimentation	5–4
		†Humanities IV	3–5			*Thesis	15
		Elective Subjects	24			†Humanities IV	3–5
			47			Elective Subject	6
							47

XIII. NAVAL ARCHITECTURE AND MARINE ENGINEERING

STUDENTS desirous of preparing for a professional career in the design and building of ships and their propulsion machinery, or in allied industries, will find in this Course a curriculum to meet their objectives.

For the first two years the program mainly comprises fundamental and basic subjects in science and the humanities, which provide an essential foundation for the professional subjects of the upper years. In the second year, however, there is included an introductory course in ship construction which deals with the broad aspects of shipbuilding and the power plant equipment of vessels, and with the operation of shipyards.

In the third and fourth years instruction in naval architecture and ship design are carried on concurrently with instruction in marine engineering. The study of allied subjects such as applied and fluid mechanics, heat engineering and electrical engineering, is also taken up. Naval architecture and ship design include considerations such as: stability, subdivision of the hull, freeboard and tonnage, ship motions among waves, powering, steering, launching, and structural design, while marine engineering embraces steam machinery and Diesel engines, arrangement of machinery in the ship, and auxiliary equipment used in marine power plants.

The Course leads to the degree of Bachelor of Science in Naval Architecture and Marine Engineering.

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects

XIII. Navel Architecture and Marine Engineering Continued

FIRST YEAR (See page 42)

SECOND YEAR

First Term	2·00	Statics	3–5	*Second Term*	2·01	Dynamics	3–5
	2·30	Engineering Materials	5–4		2·852	Machine Tool Prac.	4–0
	2·851	Machine Tool Lab.	4–0		8·04	Physics	5–5
	8·03	Physics	5–5		13·40	Ship Construction, Elem.	5–2
	E21	U. S. in World Hist. — Humanities II	3–5		E22	U. S. in World Hist. — Humanities II	3–5
	M21	Calculus	3–6		M22	Differential Equations	3–6
	MS21	Military Science	3–0		MS22	Military Science	3–0
			26–25				26–23

THIRD YEAR

First Term	*2·04	Strength of Materials	3–6	*Second Term*	*2·062	Strength of Materials and Dynamics	3–6
	*2·251	Fluid Mechanics	3–6		*2·42	Heat Engineering	3–6
	*2·40	Heat Engineering	4–5		*13·02	Naval Architecture	3–6
	*13·01	Naval Architecture	3–6		*13·42	Ship Drawing	6–0
	*13·34	Ship Construction	3–3		*13·52	Marine Engineering	3–6
	Ec11	Economic Prin. — Humanities III	3–5			†Humanities III	3–5
			19–31				21–29

FOURTH YEAR

First Term	2·371	Testing Materials Lab.	2–2	*Second Term*	*13·46	Ship Design	7–0
	*2·683	Engineering Lab.	4–4		*13·55	Marine Engineering	2–4
	*6·18	Electrical Eng., Fund.	4–6		*13·62	Marine Engineering Design	7–1
	*13·45	Ship Design	7–3		15·11	Business Management, Int.	3–6
	13·54	Marine Engineering	2–4			*Thesis	10
	*13·61	Marine Engineering Design	6–0			†Humanities IV	3–5
		†Humanities IV	3–5				48
			28–24				

XIII-C. MARINE TRANSPORTATION

IT is the intention in this five-year Course to provide for students who wish to enter the various branches of the shipping industry, or who wish to engage in other fields of marine transportation or allied pursuits, such as marine insurance, admiralty law, and port administration. The Course is a combination of science, engineering, economics, business studies and naval architecture.

It is essential that a student have a certain amount of actual experience aboard ships at sea in order to grasp thoroughly the problems of ship operation before finishing his course of study. It is also deemed necessary that sea experience be obtained before engaging in the various shore activities of a steamship company. For these reasons students in the Course are required to spend a year at sea as part of the requirements for graduation.

A number of American steamship companies coöperate, as far as their facilities will allow, in placing the students at sea as cadets or student observers following the completion of the third year at the Institute. Part of the time at sea ordinarily is spent in the engine room and part on deck. In some cases, it also includes duty in the purser's department. Three months may be spent on the piers in connection with cargo handling.

While at sea the students are assigned regular duties in connection with the operation of the ship for which they receive a moderate amount of pay. The year at sea is considered an integral part of the student's educational program and he is required to make reports on assigned topics in addition to his regular duties on shipboard. Students entering the Institute with the required sea experience can finish the Course in four years by completing certain specified work.

The studies at the Institute are arranged to coördinate with the year at sea. In the second and third year, subjects are given in heat engineering, marine engineering, ports and port facilities and cargo handling and stowage, economic geography, naval architecture and a foreign language to give the student the proper preparation for the year at sea. During the fifth year the student takes advanced professional studies and approaches these with his practical knowledge gained at sea.

As a thorough knowledge of a ship's power plant is essential to the ship operator who must have a large share in its selection and economic operation, marine engineering is given a prominent place in the Course.

As the handling of ships' cargoes is one of the largest items of expense in connection with ship operation, and also influences the ship's stay in port, special attention is given to this phase of ship management.

The Course leads to the degree of Bachelor of Science in Marine Transportation.

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

XIII-C. Marine Transportation Continued

FIRST YEAR (See page 42)

SECOND YEAR

First	2·00	Statics	3–5	*Second*	2·01	Dynamics	3–5
Term	8·03	Physics	5–5	*Term*	8·04	Physics	5–5
	E21	U. S. in World Hist. — Humanities II	3–5		12·36	Econ. Geography of World	2–4
	M21	Calculus	3–6		E22	U. S. in World Hist. — Humanities II	3–5
	MS21	Military Science	3–0		M22	Differential Equations	3–6
		Language	3–5		MS22	Military Science	3–0
			20–26			Language	3–5
							22–30

THIRD YEAR

First	*2·04	Strength of Materials	3–6	*Second*	2·42	Heat Engineering	3–6
Term	*2·40	Heat Engineering	4–5	*Term*	*2·683	Engineering Laboratory	4–4
	*2·851	Machine Tool Lab.	4–0		*13·021	Naval Architecture	2–4
	*13·01	Naval Architecture	3–6		*13·52	Marine Engineering	3–6
	*13·34	Ship Construction	3–3		*13·84	Cargo Handling & Stowage	5–3
	*13·83	Ports & Port Facilities	3–4			†Humanities III	3–5
	Ec11	Economic Prin. — Humanities III	3–5				20–28
			23–29				

FOURTH YEAR (At Sea. See text above.)

FIFTH YEAR

First	*6·18	Electrical Eng., Fund	4–6	*Second*	*13·47	Ship Design	7–1
Term	*13·56	Marine Engineering	3–6	*Term*	*13·82	Ship Operation	3–6
	*13·81	Ship Operation	3–6		*15·20	Ocean Shipping Admin.	2–4
	*15·52	Accounting	4–2		Ec54	Corporations	2–4
	15·61	Law of Contracts	3–6			*Thesis	10
		†Humanities IV	3–5			†Humanities IV	3–5
			20–31				47

XIV. ECONOMICS AND ENGINEERING

THE purpose of this course is to provide a basic training in economics and engineering. The course is designed for those planning to become staff executives in the economic, personnel, statistical or other departments of a business, governmental, or labor organization, as well as for those who will go on to graduate work in Economics in preparation for teaching. In the past such persons have typically come into their profession from the liberal arts colleges. This course offers the engineering approach. The student will be equipped to use the methodology of exact science in the analysis of economic and social problems.

The subjects in Economics and Social Science have been selected with a view to achieving three main objectives: (1) to impart some knowledge of human behavior; (2) to indicate how our economy is organized and how it operates; and (3) to give a conception of the broader aspects of economic, political, and social problems. Students have their choice of two options: *Human Relations*, or *Industrial Economics*.

The *Human Relations Option* emphasizes the first of these objectives. It is planned to help the student to be effective in his relations with his superiors, associates, and subordinates. It therefore includes such subjects as Advanced Psychology, Labor Relations, and Management of People. The *Industrial Economics Option* emphasizes the second of the above objectives — to provide an understanding of economic institutions and of the functioning of our economic system. It therefore includes such subjects as Industrial Economics, Banking and Finance, and Prices and Production. In both options, professional electives in the fourth year afford an opportunity to pursue further study in these and related fields.

On the engineering side, the student will elect one of three programs of co-ordinated subjects in Mechanical, Electrical, or Chemical Engineering. Each of these programs has been designed to provide a thorough understanding of the fundamental concepts in the particular field as well as a knowledge of some of the most important practical applications.

This Course leads to the degree of Bachelor of Science in Economics and Engineering.

FIRST YEAR (See page 42)

SECOND YEAR**

First	2·00	(*a*, *b*) Statics	3–5	*Second*	2·01	(*a*, *b*) Dynamics	3–5
Term	2·851	(*a*, *b*) Machine Tool Lab.	4–0	*Term*	5·12	(*c*) Quantitative Analysis	7–3
	5·11	(*c*) Qualitative Analysis	7–3		8·04	Physics	5–5
	8·03	Physics	5–5		§Ec70	Introductory Psychology	3–5
	Ec11	Economic Principles	3–5		E22	U. S. in World History — Humanities II	3–5
	E21	U.S. in World History — Humanities II	3–5		M22	Differential Equations	3–6
	M21	Calculus	3–6		MS22	Military Science	3–0
	MS21	Military Science	3–0				(*a*, *b*) 20–26
			(*a*, *b*) 24–26				(*c*) 24–24
			(*c*) 24–24				

*See Requirements for Bachelor's Degree, page 42.

**See Fourth Year for explanation of Engineering Group Electives.

†See page 125 for list of subjects.

§Students planning to take the Industrial Economics option substitute Ec12 Industrial Economics 3–5.

XIV. Economics and Engineering Continued

THIRD YEAR**

First Term	2·04	(*a, b*) Strength of Mat.	3–6	*Second Term*	2·30	(*a, b*) Eng. Materials	5–4
	2·40	(*a, b*) Heat Engineering	4–5		2·42	(*a, b*) Heat Engineering	3–6
	5·41	(*c*) Org. Chemistry I	4–4		5·62	(*c*) Phys. Chemistry II	4–4
	5·61	(*c*) Phys. Chemistry I	4–4		6·18	(*c*) Elec. Eng., Fund.	4–6
	6·18	(*a, b*) Elec. Eng., Fund.	4–6		6·19	(*a, b*) Elec. Eng., Fund.	4–6
	10·28	(*c*) Chemical Eng.	4–6		10·17	(*c*) Industrial Chemistry	3–4
	15·50	Accounting	3–6		‡15·70	Production	3–6
	‡Ec723	Manage. of People, Th.	2–4		Ec322	Elementary Statistics	2–4
	Ec725	Comparative Contemp. Cultures	2–4		Ec60	Labor Relations	3–5
		(*a, b*)	18–31			(*a, b*)	20–31
		(*c*)	19–28			(*c*)	19–29

FOURTH YEAR

(*a*) *Mechanical Engineering;* (*b*) *Electrical Engineering;* (*c*) *Chemical Engineering*

OPTION 1. HUMAN RELATIONS

First Term	2·251	(*a*) Fluid Mechanics	3–6	*Second Term*	2·06	(*a*) Dynamics	3–6
	6·211	(*b*) App. Elec. to Ind.	3–6		2·252	(*a*) Fluid Mechanics	3–6
	10·18	(*c*) Industrial Chem.	3–6		6·212	(*b*) App. Elec. to Ind.	3–6
	10·31	(*c*) Chemical Eng.	4–6		6·222	(*b*) Elec. Power Gen.	3–6
	Ec65	Industrial Relations	3–6		10·32	(*c*) Chemical Eng.	4–6
	Ec73	Psychology, Adv.	3–6		Ec724	Man. of People, Tech.	4–0
		†Humanities IV	3–5			*Thesis	10
		(*a, b*) Bus. or Econ. Elective Subjects	15			†Humanities IV	3–5
		(*c*) Bus. or Econ. Elective Subject	6			(*a, b*) Bus. or Econ. Elective Subject	9
		(*a, b*)	50			(*c*) Bus. or Econ. Elective Subjects	15
		(*c*)	51			(*a, b*)	49
						(*c*)	47

OPTION 2. INDUSTRIAL ECONOMICS

First Term	2·251	(*a*) Fluid Mechanics	3–6	*Second Term*	2·06	(*a*) Dynamics	3–6
	6·211	(*b*) App. Elec. to Ind.	3–6		2·252	(*a*) Fluid Mechanics	3–6
	10·18	(*c*) Industrial Chem.	3–6		6·212	(*b*) App. Elec. to Ind.	3–6
	10·31	(*c*) Chem. Eng.	4–6		6·222	(*b*) Elec. Power Gen.	3–6
	Ec13	Prices & Prod.	3–6		10·32	(*c*) Chem. Eng.	4–6
		†Humanities IV	3–5			*Thesis	14
		(*a, b*) Bus. or Econ. Elective Subjects	24			†Humanities IV	3–5
		(*c*) Bus. or Econ. Elective Subjects	15			(*a, b*) Bus. or Econ. Elective Subject	9
		(*a, b*)	50			(*c*) Bus. or Econ. Elective Subjects	15
		(*c*)	51			(*a, b*)	49
						(*c*)	47

Business and Economic Elective Subjects§

	15·41	Finance	3–6		Ec37	Theoretical Statistics	3–6
	15·71	Production	3–6		Ec49	Public Finance	2–4
	15·73	Management Lab.	6–3		Ec54	Corporations	2–4
	15·81	Marketing & Reports	4–8		Ec56	Problems in Indus. Econ.	3–6
	Ec28	Econ. of Patents & Invention	3–6		Ec731	Intro. to Group Psychol.	3–6
	Ec33	Psychological Statistics	3–6		Ec732	Intro. to Group Psychol.	3–6
	Ec35	Industrial Statistics	3–6				

XV-A AND XV-B. BUSINESS AND ENGINEERING ADMINISTRATION

THE Courses in Business and Engineering Administration provide special curricula for men who combine an initial aptitude for engineering with a potential capacity for subsequent managerial responsibilities. They were first established in the conviction that fundamental training in science and engineering inculcates habits of precise thinking which are of value in the study and the practice of business administration. To an ever-increasing extent business is now being based on engineering, science, and the humanities. The successful business man today must coördinate engineering, practical economics, and fundamental personnel relationships.

Students enrolled in Courses XV-A and XV-B take in their first two years essentially the same basic scientific subjects as do students in the purely engineering Courses. In the third and fourth years, the arrangement of studies provides time for a series of special subjects which deal with the functions of business and economic organization as they bear upon the interests of the stockholder, the employee, the market, the community, the general public

* See Requirements for Bachelor's Degree, page 42. ** See Fourth Year for explanation of Engineering Group Electives. † See page 125 for list of subjects.
‡ Students planning to take the Industrial Economics option substitute Ec70 Introductory Psychology 3–5 in the first term and Ec50 Banking and Finance 2–4 in the second term.
§ Required subjects in one option may be used as electives in the other.

XV. Business and Engineering Administration Continued

and the government. The program of required business subjects is the same for all students; at the beginning of the second year there is a choice between two courses, depending upon whether the student desires to base his technical work on the physical or the chemical sciences.

XV-A. (Based on Physical Sciences)

In Course XV-A, in which the engineering subjects are based on the physical sciences, the student is offered some latitude as to the particular type of engineering which he desires to study. This flexibility is accomplished by the provision of a number of elective hours in the fourth year and, where necessary to a well coördinated program, by a limited amount of substitution in the third year. For example, some students have arranged to take a substantial amount of work in the field of textiles and in the field of aeronautics.

XV-B. (Based on Chemical Sciences)

In Course XV-B, in which the engineering subjects are based on the chemical sciences, the complete series of subjects is prescribed, as all of them are essential to any subsequent program of specialization. Following the preliminary study of physics, chemistry, and mathematics required in the first year, the student electing the Chemical Course undertakes a dependent sequence of technical subjects which begins the coördinated three-year program.

Business and Engineering Subjects:

The program of business and economic subjects covers external as well as internal aspects of management. It aims to encourage an enlightened attitude toward business problems as they relate to economic, sociological, and political trends. Thus it stresses the responsibilities of business to the consumer (in marketing), to the employee (in labor relations), to the investor (in finance), and to other business men (in business law). Although current techniques are discussed, there is no attempt to create narrow trade skills.

First, the student is introduced through the subject of Production to the nature of modern factory operations. Immediately thereafter, he considers the subject of personnel or labor relations. He then undertakes the study of economics, in which he learns the nature of the forces which underlie business phenomena. In his third year he begins his study of business relationships, with marketing and the law of contracts. He also becomes familiar with accounting, and its application to analysis and control. In his last year he studies the more involved relationships in finance as well as the applications of the statistical method. Finally, after the various individual business functions have been studied, a term subject, Industrial Problems, serves to provide a coördinated view of business as a whole.

In addition to this basic program, the student is permitted in his fourth year to elect somewhat more advanced work in one or two functional areas, according to his own interests or aptitudes. The thesis, which is undertaken during the last year, is usually chosen within the field of this partial specialization. In the thesis the student demonstrates his capacity to carry through an individual piece of work on his own initiative.

Both Courses lead to the degree of Bachelor of Science in Business and Engineering Administration.

XV-A. Business and Engineering Administration (Based on Physical Sciences)

First Year (See page 42)

Second Year

First Term	2·00	Statics	3–5	*Second Term*	2·01	Dynamics	3–5
	2·851	Machine Tool Lab.	4–0		8·04	Physics	5–5
	8·03	Physics	5–5		15·30	Personnel Management	3–5
	15·70	Production	3–6		E22	U. S. in World Hist. — Humanities II	3–5
	E21	U. S. in World Hist. — Humanities II	3–5		M22	Differential Equations	3–6
	M21	Calculus	3–6		MS22	Military Science	3–0
	MS21	Military Science	3–0				20–26
			24–27				

Third Year

First Term	*2·04	Strength of Materials	3–6	*Second Term*	2·30	Engineering Materials	5–4
	*6·18	Electrical Eng., Fund.	4–6		*2·41	Heat Engineering	4–5
	*15·61	Law of Contracts	3–6		3·30	Metallography	4–2
	*15·81	Marketing & Reports	4–8		6·19	Electrical Eng., Fund.	4–6
	Ec11	Economic Prin. — Humanities III	3–5		*15·50	Accounting	5–4
			17–31			†Humanities III	3–5
							25–26

Fourth Year

First Term	1·63	Hydraulics	2–4	*Second Term*	15·92	Industrial Problems	3–6
	*15·41	Finance	3–6			*Thesis	10
	Ec35	Industrial Statistics	3–6			†Humanities IV	3–5
		*Thesis	1			Business or Econ. Elective Subjects	16
		†Humanities IV	3–5			Engineering Elec. Subj. (See next page)	6
		Business or Econ. Elective Subject	9				49
		Engineering Elec. Subj. (See next page)	6				
			48				

*See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects

XV. Business and Engineering Administration Continued

Suggested Engineering Elective Subjects

1·24	Municipal Engineering	3–3
1·771	Sanitation	2–4
2·31	Engineering Metals	4–4
2·66	Air Conditioning	3–6
2·79	Int. Comb. Eng., Elem.	3–6
3·40	Cor. & Heat Res. Alloys	2–4
3·70	Ceramics	5–4
6·211	App. Electricity to Industry	3–6

Suggested Engineering Elective Subjects

1·92	Engineering Construction	3–3
2·32	Engineering Metals	3–6
3·41	Industrial Non-Fer. Alloys	2–2
3·42	Powder Metallurgy	2–4
6·212	App. Electricity to Industry	3–6
6·222	Power Syst. Meas., Anal. & Control	3–6
17·71	Materials	2–4

XV-B. Business and Engineering Administration (Based on Chemical Sciences)

First Year (See page 42)

Second Year

First Term	5·11	Qualitative Analysis	7–3	*Second Term*	5·12	Quantitative Analysis	7–3
	8·03	Physics	5–5		8·04	Physics	5–5
	15·70	Production	3–6		15·30	Personnel Management	3–5
	E21	U. S. in World Hist. — Humanities II	3–5		E22	U. S. in World Hist. — Humanities II	3–5
	M21	Calculus	3–6		M22	Differential Equations	3–6
	MS21	Military Science	3–0		MS22	Military Science	3–0
			24–25				24–24

Third Year

First Term	2·41	Heat Engineering	4–5	*Second Term*	*5·62	Physical Chemistry II	4–4
	*5·41	Organic Chemistry I	4–4		*6·18	Electrical Eng., Fund.	4–6
	*5·61	Physical Chemistry I	4–4		10·17	Industrial Chemistry	3–4
	*15·50	Accounting	5–4		*15.81	Marketing & Reports	4–8
	*15·61	Law of Contracts	3–6			†Humanities III	3–5
	Ec11	Economic Prin. — Humanities III	3–5				18–27
			23–28				

Fourth Year

First Term	10·18	Industrial Chemistry	3–6	*Second Term*	10·32	Chemical Engineering	4–6
	10·31	Chemical Engineering	4–6		15·92	Industrial Problems	3–6
	*15·41	Finance	3–6			*Thesis	10
		*Thesis	1			†Humanities IV	3–5
		†Humanities IV	3–5			Business or Econ. Elective Subject	8
		Business or Econ. Elective Subject	9				45
			46				

XVI. AERONAUTICAL ENGINEERING

THE primary objective of the Course in Aeronautical Engineering is to provide a sound general training in subjects fundamental to the practice of engineering, and then to familiarize the student with the general principles of flight and with some of the detail of design and construction as applied to the airplane. To this end, the greater part of the first three years of study is devoted to fundamental subjects, most of the strictly professional work being deferred until the fourth year. During the Course, lectures and recitations are supplemented by laboratory and drafting room work.

In general, the professional subjects are directed particularly toward airplane design, but in order that the student may gain some knowledge of other branches of aeronautical activity, he is allowed to elect in the fourth year certain subjects in a related professional field.

On account of the large number of students who wish to take the Course in Aeronautical Engineering, and on account of limited facilities, it has been found necessary to limit the number admitted to the Course. Applications will be received during the second term of the first year, and notifications of admission or refusal will be issued shortly after the end of the second term of the Freshman year.

The Course leads to the degree of Bachelor of Science in Aeronautical Engineering.

Honors Course

The opportunity will be afforded a limited number of students of superior ability to join an Honors Course group. The selection of members of this group will be made by the Department from students who may wish to avail themselves of the opportunity to pursue a coördinated schedule of studies through the senior and graduate years. A single thesis with a minimum of 30 units will be required in the graduate year and the time allotted to thesis in the senior year will be available for advanced mathematics or other subjects preparatory to the program of graduate studies. A member of the Department will serve as adviser to aid members of the group in selecting the senior and graduate schedules which may be best suited to their individual interests.

The Honors Course leads to the degrees of Bachelor of Science and Master of Science in Aeronautical Engineering, awarded simultaneously at the end of the Graduate year.

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

XVI. Aeronautical Engineering Continued

FIRST YEAR (See page 42)

SECOND YEAR

First Term	2·00	Statics	3–5	*Second Term*	2·01	Dynamics	3–5
	2·30	Engineering Materials	5–4		2·701	Machine Drawing	6–0
	8·03	Physics	5–5		2·851	Machine Tool Lab.	4–0
	E21	U. S. in World Hist. — Humanities II	3–5		8·04	Physics	5–5
	M21	Calculus	3–6		16·82	Aeronautical Eng., Int.	3–1
	MS21	Military Science	3–0		E22	U. S. in World Hist. — Humanities II	3–5
			22–25		M22	Differential Equations	3–6
					MS22	Military Science	3–0
							30–22

THIRD YEAR

First Term	*2·04	Strength of Materials	3–6	*Second Term*	‡2·42	Heat Engineering	3–6
	2·371	Testing Materials Lab.	2–2		*16·02	Aeronautical Mechanics, Int.	6–6
	2·40	Heat Engineering	4–5		*16·10	Aerodynamics, Applied	4–8
	2·730	Machine Design	4–2		*16·20	Structures	3–6
	*16·01	Aeronautical Mechanics, Int.	6–6			†Humanities III	3–5
	Ec11	Economic Prin. — Humanities III	3–5				19–31
			22–26				

FOURTH YEAR

First Term	6·18	Electrical Eng., Fund.	4–6	*Second Term*	*16·16	Power Plant Perform. & Install.	3–6
	*16·13	Airplane Stability & Cont.	3–6		*16·75	Const. Details Aircraft	5–4
	*16·17	Airplane Design Practice	6–0			*Thesis	9
	*16·21	Structures	3–6			†Humanities IV	3–5
	16·62	Aerodynamic Laboratory	4–4			‡Prof. Elective Subject	10
		†Humanities IV	3–5				45
			23–27				

*Second Term Professional Elective Subjects***

	6·19	Electrical Eng., Fund.	4–6		16·30	Aircraft Instruments	5–6
	16·07T	Wing Flutter, Int.	2–4		16·50	Rotat. Wing Aircraft	3–6
	16·14	Airplane Des. Prob.	8–4		16·52	Aircraft Propeller Design	4–4
	16·22	Aircraft Structures	5–6		16·63	Aerodynamics Lab.	4–4

XVII. BUILDING ENGINEERING AND CONSTRUCTION

THE objective of the Course in Building Engineering and Construction is to provide sound basic training in the engineering design and construction of buildings. It aims to develop in the student a sound conception of the related problems of the owner, the architect, the engineer, the builder and the materials manufacturer and distributor in the process of planning and erecting buildings, to the end that he may become either a principal or a responsible manager in any of the many varied fields of this great industry.

Slightly more than half of the entire Course is devoted to fundamental and applied science. The strictly professional work is provided in a progressive sequence of correlated subjects in engineering, construction, materials and the economic aspects of the industry.

At the beginning of the fourth year, the student may choose between two Options, depending upon whether he desires to base his training upon the technical work involved in Heavy Construction or upon the technical and marketing aspects of the field of Light Construction.

OPTION 1. HEAVY CONSTRUCTION

Under this Option, the student is offered professional courses which train him in the structural design, construction and supervision of semi-fireproof and fireproof buildings of so-called heavy construction. Professional subjects provide the student opportunity for further specialization in structural design, materials, or construction practice.

OPTION 2. LIGHT CONSTRUCTION

This Option offers professional training in the planning, engineering, construction, management and marketing of structures and facilities required for housing or shelter. Not only the physical, but the legal and economic aspects of housing construction and engineering are emphasized. Summer coöperative employment is arranged so that the student may obtain intimate first-hand acquaintance with the construction and business problems of the field.

Both Options lead to the degree of Bachelor of Science in Building Engineering and Construction.

FIRST YEAR (See page 42)

SECOND YEAR

First Term	2·00	Statics	3–5	*Second Term*	2·01	Dynamics	3–5
	8·03	Physics	5–5		4·78	Planning Principles	4–0
	17·22	Building Construction	5–4		8·04	Physics	5–5
	E21	U. S. in World Hist. — Humanities II	3–5		17·71	Materials	2–4
	M21	Calculus	3–6		E22	U. S. in World Hist. — Humanities II	3–5
	MS21	Military Science	3–0		M22	Differential Equations	3–6
			22–25		MS22	Military Science	3–0
							23–25

** Other electives may be chosen with approval of registration officer.

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

‡ Students expecting to specialize in graduate research or instrumentation should substitute 16·30 Aircraft Instruments 5–6 in third year, second term, and include 6·19 Electrical Eng., Fund. 4–6 as the Elective Subject in fourth year, second term.

XVII. Building Engineering and Construction Continued

REQUIRED DURING SUMMER. AT CAMP TECHNOLOGY

1·00T	Surveying Fieldwork	13–0
1·04	Construction Survey. Fieldwork	10–0

THIRD YEAR‡

First Term	*2·04	Strength of Materials	3–6	*Second Term*	*1·401	Structures	3–6
	*2·41	Heat Engineering	4–5		*15·50	Accounting	5–4
	*6·40	Electrical Eng., Elem.	4–6		*17·32	(1) Building Construction	5–4
	*17·31	(1) Building Construction	5–4		*17·34	(2) Building Construction	5–4
	*17·33	(2) Building Construction	5–4		*17·52	Structural Problems	7–5
	Ec11	Economic Prin. — Humanities III	3–5		*17·72	Materials	2–4
			19–26			†Humanities III	3–5
							25–28

FOURTH YEAR

OPTION 1. HEAVY CONSTRUCTION

First Term	1·351	Soil Mech. and Found. Eng.	4–4	*Second Term*	*1·42	Structures	3–6
	*1·41	Structures	3–6		*2·373	Testing Materials Lab.	5–2
	*17·53	Structural Design	8–5		*17·40	Estim. and Job Manage.	5–4
	*17·73	Materials	2–4		*17·54	Structural Design	7–5
		*Thesis	4			*Thesis	5
		†Humanities IV	3–5			†Humanities IV	3–5
			49				50

OPTION 2. LIGHT CONSTRUCTION

First Term	15·41	Finance	3–6	*Second Term*	*2·373	Testing Materials Lab.	5–2
	15·61	Law of Contracts	3–6		15·82	Sales Promotion	3–6
	15·81	Marketing & Reports	4–8		*17·40	Estim. and Job. Manage.	5–4
	*17·73	Materials	2–4		*17·56	Structural Design	7–5
		*Thesis	4			*Thesis	5
		†Humanities IV	3–5			†Humanities IV	3–5
			48				50

XVIII. MATHEMATICS

THE Institute offers exceptional opportunities for the study of mathematics, either in its theoretical aspects or as applied to scientific and engineering work.

The Course outlined is for students who desire to study more mathematics than is contained in the professional courses. It is well adapted to serve as a preparation for specializing in pure mathematics, in mathematical physics, or in engineering fields requiring proficiency in pure mathematics. The course also offers excellent opportunities for students who wish to major in mathematical statistics, applied statistics or actuarial work.

Any student who has completed satisfactorily the work of the first two years in any of the professional courses in the Institute or their equivalent, provided always that a creditable record has been obtained in mathematics and physics, may be admitted to the third year in this Course.

OPTION 1. PURE AND APPLIED MATHEMATICS

Option 1 is intended for students interested in technical applications of mathematics or a career of research and teaching. Students planning to take this option are required to take electives in science and engineering which, together with their courses in pure mathematics, constitute a well-integrated program in pure or applied mathematics.

OPTION 2. INDUSTRIAL STATISTICS

Option 2 is adapted to those preparing for industrial work where the statistical interpretation of data is important, or for the actuarial profession. Students planning to take this Option are required to take subjects in mathematics and engineering related to statistics to fulfill the elective requirements.

Both options lead to the degree of Bachelor of Science in Mathematics.

FIRST YEAR (See page 42)

SECOND YEAR

First Term	5·11	Qualitative Analysis	7–3	*Second Term*	8·04	Physics	5–5
	8·03	Physics	5–5		E22	U. S. in World Hist. — Humanities II	3–5
	E21	U. S. in World Hist. — Humanities II	3–5		M22	Differential Equations	3–6
	M21	Calculus	3–6		M32	Statistics, Elementary	3–6
	MS21	Military Science	3–0		MS22	Military Science	3–0
		Language	3–5			Language	3–5
			24–24				20–27

*See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.
‡ Students planning to take a certain option in the fourth year, take the Group Electives indicated by the corresponding number.

XVIII. Mathematics Continued

THIRD YEAR**

First Term	Ec11	Economic Prin. — Humanities III	3–5	*Second Term*	*M332	(2) Math. Th. of Statistics	3–6
	*M331	(2) Math. Th. of Statistics	3–6		*M62	(1) Modern Algebra	3–6
	*M731	(1) Mechanics	3–6		*M732	(1) Mechanics	3–6
	*M77	(1) Vector Analysis	3–6		*M832	Analysis	3–6
	*M831	Analysis	3–6			†Humanities III	3–5
		(1) Elective Subject	12			(1) Elective Subject	12
		(2) Elective Subjects	21			(2) Elective Subjects	21
			47				47

FOURTH YEAR

OPTION 1. PURE AND APPLIED MATHEMATICS

First Term	M571	Differential Equations	3–9	*Second Term*	M442	Diff. Geometry, Elem.	3–6
	M681	Calculus of Variations	3–9		M572	Differential Equations	3–9
		*Thesis	4			*Thesis	7
		†Humanities IV	3–5			†Humanities IV	3–5
		Elective Subject	12			Elective Subject	12
			48				48

OPTION 2. INDUSTRIAL STATISTICS

First Term	M341	Modern Statistical Th.	3–6	*Second Term*	M342	Modern Statistical Th.	3–6
		*Thesis	4			*Thesis	7
		†Humanities IV	3–5			†Humanities IV	3–5
		Elective Subjects	27			Elective Subjects	24
			48				48

XIX. METEOROLOGY

THE rapid expansion of meteorology during recent years has led to the inauguration of a four-year undergraduate program in the field of Meteorology. It is the purpose of this course to prepare students for weather forecasting in the aviation organizations, those industries whose operations are dependent on the weather, the Weather Bureau, and for further study and research. Emphasis is placed on the application of physics, of mathematics, and of other allied subjects to the atmosphere and its processes.

In the field of dynamic meteorology, the subjects of thermodynamics, hydrodynamics, and fluid mechanics are developed with special reference to the atmosphere. In synoptic meteorology these theoretical developments (supplemented by observational, empirical, and statistical methods) are applied to the practical problems encountered by the weather forecaster. In the synoptic laboratory the student is taught to decode and plot the daily weather reports, to analyze the weather maps and prepare forecasts, and thus to put in practice the methods presented in the lectures. The facilities of the synoptic laboratory include teletype and radio receivers for the collection of weather data and equipment for the reproduction of weather maps for student instruction and for exchange with other meteorological institutions. A comprehensive file of past data and weather charts is also maintained.

The meteorological instruments laboratory provides training in the observation of weather elements, maintenance of a weather station, and care of equipment. In climatology, the atmosphere in its average state is discussed from a meteorological point of view with emphasis on the geographical distribution of various factors. In oceanography, the dynamics of the fluid, the interaction of atmosphere and ocean, and other topics of meteorological interest are stressed. The special physical phenomena of the atmosphere, such as solar and terrestrial radiation, evaporation, condensation and precipitation processes, electricity and atmospheric optics are taken up in other subjects.

The Course leads to the degree of Bachelor of Science in Meteorology.

FIRST YEAR (See page 42)

SECOND YEAR

First Term	2·00	Statics	3–5	*Second Term*	2·01	Dynamics	3–5
	2·851	Machine Tool Lab.	4–0		8·04	Physics	5–5
	8·03	Physics	5–5		E22	U. S. in World Hist. — Humanities II	3–5
	E21	U. S. in World Hist. — Humanities II	3–5		L12	German, Elementary	3–5
	L11	German, Elementary	3–5		M22	Differential Equations	3–6
	M21	Calculus	3–6		MS22	Military Science	3–0
	MS21	Military Science	3–0				20–26
			24–26				

THIRD YEAR

First Term	2·251	Fluid Mechanics	3–6	*Second Term*	19·02	Descriptive Meteorol. II	3–6
	2·40	Heat Engineering	4–5		19·30	General Climatology	2–4
	*19·01	Descriptive Meteorol. I	3–6		*19·50	Meteorol. Lab., Int.	9–3
	*19·21	Meteorol. Observations	4–2		*19·60	Thermodyn. of Atmos.	3–6
	Ec11	Economic Prin. — Humanities III	3–5		19·70	Physics of Atmos., Elem.	2–4
	M331	Math. Th. of Statistics	3–6			†Humanities III	3–5
			20–30				22–28

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

** Students planning to take a certain option in the fourth year, take the Group Electives indicated by the corresponding number.

XIX. Meteorology Continued

FOURTH YEAR

First Term	*19·43	Synoptic Meteorol. I	3–6	*Second Term*	*19·44	Synoptic Meteorol. II	3–6
	*19·51	Synoptic Lab. I	15–0		*19·52	Synoptic Lab. II	15–0
	*19·61	Dynamic Meteorol. I	2–4		*19·62	Dynamic Meteorol. II	3–6
	19·83	Oceanography	2–4			*Thesis	9
		*Thesis	3			†Humanities IV	3–5
		†Humanities IV	3–5				50
			47				

XX. FOOD TECHNOLOGY

THE marked technological progress taking place in modern food industries has created a demand for men having thorough knowledge of the basic sciences pertaining to foods, combined with the ability to apply that knowledge in the technical processes of food production, manufacture, storage, and distribution. Increasing emphasis on quality control as it concerns food and food products in manufacture has necessitated the development of new chemical, physical, biological, and microscopic techniques, and increased the demand for personnel to interpret the significance of such developments in commercial practice.

The undergraduate work in food technology is planned to provide students with a broad perspective in all the contributory sciences supplemented by the more specific technological aspects which especially concern the food industries, and to fit the men for either the laboratory or production branches of such organizations.

This training is equally valuable for those desiring to enter the fermentation industries producing beverages, glycerine, industrial alcohols, solvents, organic acids, or other commercial products of organic origin, or others which are concerned with the control of biological agents such as enzymes, and micro-organisms.

Substitutions may be made for certain of the outlined subjects at the discretion of the registration officer when students are intending to continue their studies for an advanced degree or have especial interests in contiguous fields.

The Course leads to the degree of Bachelor of Science in Food Technology.

FIRST YEAR (See page 42)

SECOND YEAR

First Term	5·11	Qualitative Analysis	7–3	*Second Term*	5·12	Quantitative Analysis	7–3
	7·01	General Biology I	6–4		7·02	General Biology II	6–4
	8·03	Physics	5–5		8·04	Physics	5–5
	E21	U. S. in World Hist. — Humanities II	3–5		E22	U. S. in World Hist. — Humanities II	3–5
	M21	Calculus	3–6		M22	Differential Equations	3–6
	MS21	Military Science	3–0		MS22	Military Science	3–0
			27–23				27–23

REQUIRED DURING SUMMER

*5·41	Organic Chemistry I	4–4
*5·428	Organic Chemistry Lab	10–0

THIRD YEAR

First Term	*5·141	Analytical Chemistry	4–2	*Second Term*	*5·62	Physical Chemistry II	4–4
	*5·61	Physical Chemistry I	4–4		*5·621	Physical Chem. Lab. II	4–0
	*5·611	Physical Chem. Lab. I	4–0		15·11	Business Management, Int.	3–6
	*20·01	Tech. & Chem. Food Sup.	6–2		*20·02	Tech. & Chem. Food Sup.	6–4
	*20·41	Bacteriology	6–2		*20·42	Industrial Microbiology	6–4
	Ec11	Economic Prin. — Humanities III	3–5			†Humanities III	3–5
		Elective Subject	6				26–23
			48				

FOURTH YEAR

First Term	2·601	Food Engineering	4–2	*Second Term*	2·602	Food Engineering	4–2
	*7·80	Biochemistry	8–4		10·29	Chemical Engineering	4–6
	10·28	Chemical Engineering	4–6		*20·12	Tech. of Food Products	6–4
	*20·11	Tech. of Food Products	6–4		20·32	Chemistry of Nutrition	2–2
		*Thesis	4			*Thesis	10
		†Humanities IV	3–5			†Humanities IV	3–5
			50				48

XX-A. FOOD TECHNOLOGY

A LIMITED number of outstanding students in the regular four-year curriculum, Course VII-B, will, upon application, be selected during the third year to enter a slightly modified fourth year course to be followed by a fifth or graduate year. A period of six months between the fourth and fifth year in this course will be spent in technical positions in selected food industries to enable each man to have some industrial experience before completing his academic work.

The Course leads to the degrees of Bachelor of Science and Master of Science in Food Technology awarded simultaneously at the end of the Graduate Year.

*See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.

XX-A. Food Technology Continued

Same as Course XX through Third Year.

FOURTH YEAR

First Term	2·601	Food Engineering	4–2	*Second Term*	2·602	Food Engineering	4–2
	*7·80	Biochemistry	8–4		10·29	Chemical Engineering	4–6
	10·28	Chemical Engineering	4–6		*20·12	Tech. of Food Products	6–4
	*20·11	Tech. of Food Products	6–4		20·32	Chemistry of Nutrition	2–2
		†Humanities IV	3–5		20·322	Chem. of Nutrition Lab.	5–0
			25–21			†Humanities IV	3–5
						Elective Subject	8
							51

GRADUATE YEAR

First Term	7·81	Enzymology	6–4	*Second Term*	20·52	Food Technology, Adv.	6–4
	20·51	Food Technology, Adv.	8–4		20·62	Food Technology Seminar	2–2
	20·61	Food Technology Seminar	2–2			Thesis	20
		Thesis	15			Elective Subjects	14
		Elective Subject	10				48
			51				

MILITARY SCIENCE

THE general object of the Reserve Officers' Training Corps is to qualify students for positions of leadership in time of national emergency. The program consists of two parts, the elementary course and the advanced course, each of two academic years, the advanced course including a summer camp. The elementary course is required; the advanced course is elective.

It is planned that during the school year 1946–1947 the elementary course of the ROTC will be continued, and the advanced course will be reactivated. As the War Department programs of instruction for the advanced course are not yet in final form, it is not now possible to publish details with reference to schedules and hours. However, insofar as practicable, it is contemplated that five units will be organized: Coast Artillery (Antiaircraft), Engineer, Signal, Ordnance, and Chemical Warfare.

ELEMENTARY COURSE

The elementary course provides first- and second-year students with general military training, including drill and instruction in the organization, operation, and customs of the Army. All physically fit male students who are citizens of the United States, under twenty-six years of age, and who enter the Institute as first-year students, are required to complete the elementary course, unless exempted therefrom on conscientious grounds as approved by the Faculty. Similarly qualified students who have received instruction in an approved ROTC unit at another institution will receive credit therefor upon presentation of suitable evidence to the Professor of Military Science and Tactics. Also, those who have been members of any of the armed services will receive credit in accordance with War Department policies.

First Year

First Term	MS11	Infantry drill and rifle marksmanship	3–0
Second Term	MS12	Infantry drill and elementary military subjects	3–0

Second Year

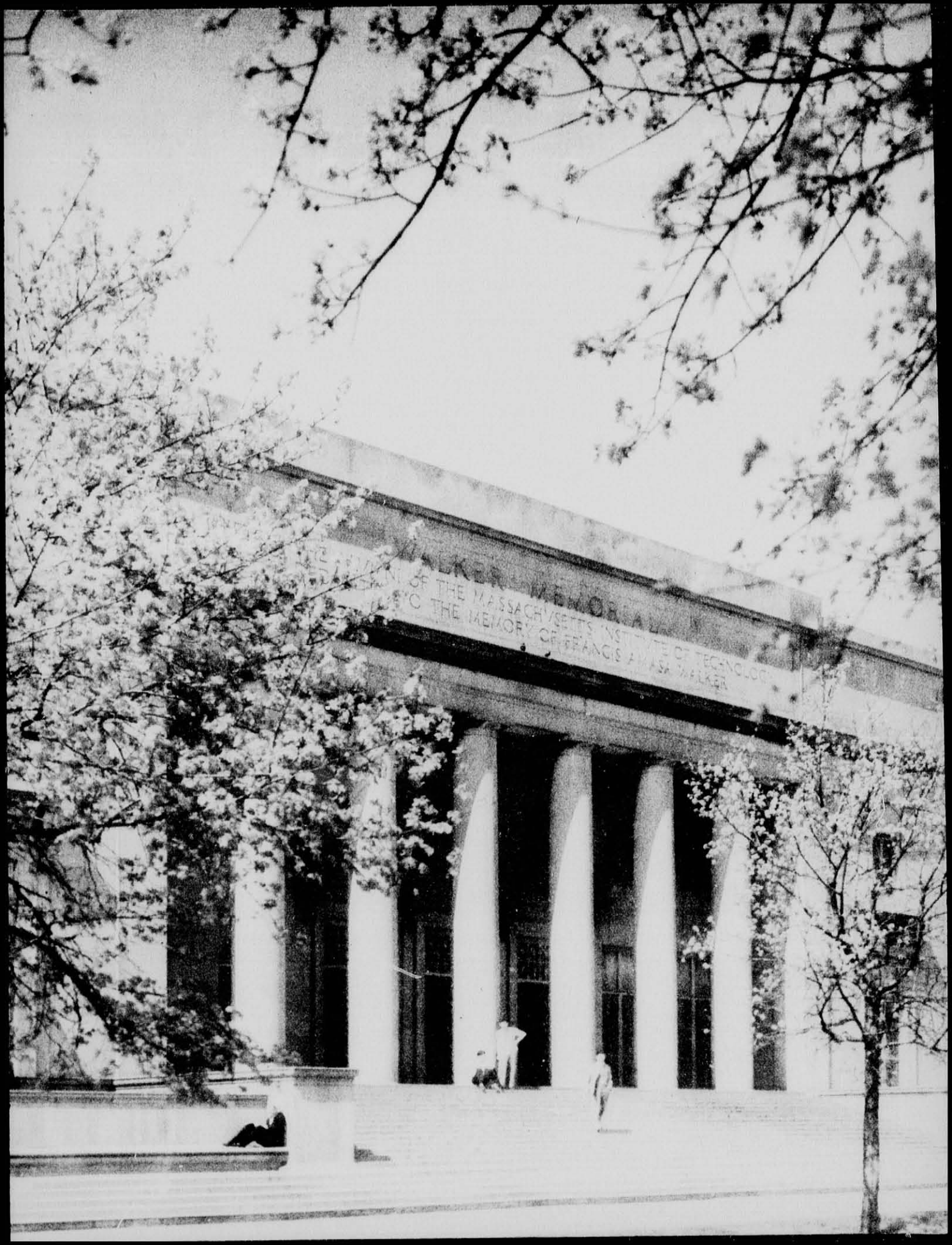
First Term	MS21	Maps and aerial photographs, evolution of warfare	3–0
Second Term	MS221	Coast Artillery (Antiaircraft) Unit: Element of antiaircraft artillery training	3–0
	MS222	Engineer Unit: Elements of engineer training	3–0
	MS223	Signal Unit: Elements of signal training	3–0
	MS224	Ordnance Unit: Elements of ordnance training	3–0
	MS225	Chemical Warfare Unit: Elements of chemical warfare training	3–0

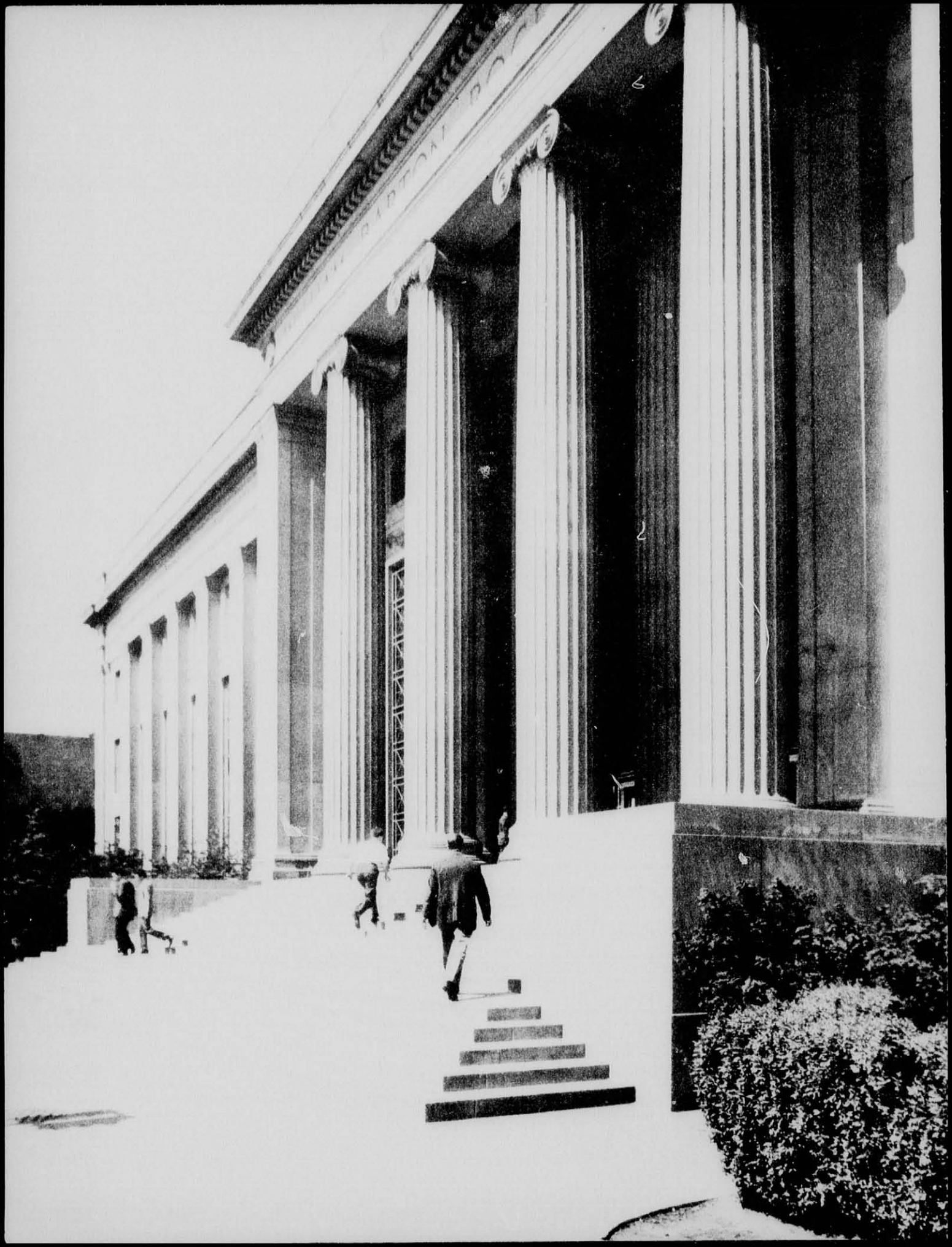
ADVANCED COURSE

The object of the advanced course is to prepare well-qualified students to become reserve officers in the Army. This course is open to students who have satisfactorily completed two years in the elementary course, or its equivalent. To be accepted, students must have the approval of the professor in charge of the course in which they are registered, and of the Professor of Military Science and Tactics.

To enroll in the advanced course the student must execute a contract to continue the course of instruction for two years, should he remain that length of time at the Institute. The contract includes the obligation to attend a summer ROTC camp, normally during June and July following the first year of the advanced course, at which all expenses, including transportation, are paid by the government. The student will receive pay for attending this camp at the rate of $80.00 per month. In exceptional cases attendance at camp may follow the sophomore or the senior year.

* See Requirements for Bachelor's Degree, page 42. † See page 125 for list of subjects.


WALKER MEMORIAL
OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY
TO THE MEMORY OF FRANCIS AMASA WALKER



THE GRADUATE SCHOOL

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Mathematics	H. B. PHILLIPS
Mechanical Engineering	C. R. SODERBERG
Metallurgy	J. CHIPMAN
Meteorology	J. M. AUSTIN
Naval Architecture and Marine Engineering	L. B. CHAPMAN
Physics	J. C. SLATER

* Correspondence regarding work of the Graduate School and graduate scholarships and fellowships should be addressed to the Dean of the Graduate School.

† Inquiries regarding prerequisites for graduate subjects and programs of graduate work in any field of study, should be addressed to the Chairman of the Committee on Graduate Students of the appropriate department.

THE GRADUATE SCHOOL

GENERAL INFORMATION

The Graduate School of the Massachusetts Institute of Technology is a natural development of a policy approved by the Corporation in 1872 and announced in the catalogue of that year as follows: ". . . advanced courses . . . are intended to afford to Bachelors of Science of this Institute — and others of equal attainment — the means of continuing their studies." Its Faculty is the Faculty of the Massachusetts Institute of Technology; its officers are the President of the Institute, the Dean of the Graduate School, and the members of the Committee on the Graduate School comprising a Faculty representative of each department which offers graduate work leading to a higher degree.

Degrees Awarded

Upon recommendation by the Faculty, the Corporation may award any of the following advanced degrees:

Doctor of Philosophy, Ph.D.
Doctor of Science, Sc.D.
Master of Science, S.M.
Master in Architecture, M.Arch.
Master in City Planning, M.C.P.

ADMISSION

Admission to Graduate School as Graduate Student

To be admitted as a Graduate Student, an applicant must have received a Bachelor's degree from a college, university, or technical school of standing acceptable to the Director of Admissions of the Massachusetts Institute of Technology, and his academic record and other credentials must be such as to indicate that he has the ability to accomplish satisfactorily an approved program of graduate study and research.

For acceptance to work toward a Master's degree, the applicant shall, in addition to the above requirement, have been ranked in the upper two-thirds of his class at graduation; for a Doctorate, in the first third of his class, or have satisfactorily completed the equivalent of requirements for a Master of Science degree in an institution acceptable to the Director of Admissions.

Admission to Graduate School as Provisional Graduate Student

Admission as a Provisional Graduate Student may be granted to an applicant who, although unable to meet the above requirements for acceptance as a graduate student, *is judged by a Department Committee on Graduate Students probably to be able to pursue successfully graduate studies*, with or without additional preparation in prerequisite subjects.

Provisional Graduate Student status will be changed to that of Graduate Student upon demonstration of ability necessary to pursue successfully graduate studies by completion of either of the following requirements:

(1) Completion with a satisfactory grade in one academic term of not less than 45 units of regular subjects, of which at least 32 units are of "A" classification,

or

(2) Completion with a satisfactory grade in two academic terms of not less than 36 units of "A" subjects.

Admission to Graduate School as Special Student

A duly qualified applicant who desires to enroll for graduate subjects with a clearly defined objective, but not as an applicant for a degree, may be admitted as a Special Graduate Student by approval of the Dean of the Graduate School and of the chairman of a departmental committee on graduate students. Such a student will be enrolled as of the department which has approved his admission. The subjects for which a Special Graduate Student may register are limited to those for which specific written approval has been granted by instructors in charge in advance of enrollment.

Acceptance of a Special Graduate Student is for one academic term only, and for continuance of this status for a succeeding term, a new application must be approved.

Procedure for Making Application for Admission to Graduate School

Before an applicant will be considered for admission to the Graduate School, he must file an "Application for Admission to the Graduate School," which may be secured by writing to the Director of Admissions, Massashusetts Institute of Technology, Cambridge 39, Massachusetts.

Admission, in general, will be restricted to the beginning of an academic year in the Fall. Application for such admission, together with all credentials, should be submitted by March 1.

Applicants who file requests for admission during their final year of work toward a degree elsewhere will be considered for admission and may be accepted conditional upon subsequent filing of evidence of satisfactory completion of such work.

Notices of decisions made on regular applications for Fall admissions, together with notification of scholarship awards for an ensuing academic year, will be mailed on or about April 1.

Correspondence concerning admissions should be addressed to the Director of Admissions. Inquiries concerning preparation or subject matter in courses should be addressed to the chairman of the appropriate Departmental Committee on Graduate Students (see page 69).

Graduate Record Examination

As additional evidence in support of an application for admission to the Graduate School, an applicant who has taken the Graduate Record Examination of the Carnegie Foundation for the Advancement of Teaching may offer an official report of this examination. It is entirely optional whether such evidence be offered by the applicant.

For a student desiring to undertake graduate work at the Institute, the results of a Graduate Record Examination are often useful in informing him and the admissions authorities of his competence in cultural subjects, particularly. Correspondence relative to the conditions and places of examination should be addressed to the Graduate Record Office, 437 West 59th Street, New York 19, N. Y. The Institute is not a participant in such arrangements, but the student may request the Examiner to submit to the Institute a report on his test scores.

UNDERGRADUATE PREPARATION FOR ADVANCED DEGREES

General Requirements for Admission

Except as stated below under requirements peculiar to an individual field, evidence of satisfactory preparation will ordinarily be required in the following undergraduate subjects:

Mathematics. Mathematics substantially equivalent to the Institute's subjects of the first and second undergraduate years, namely Calculus, M11, M12, M21 and Differential Equations, M22.

Chemistry. College chemistry substantially equivalent to the Institute's first-year chemistry, 5·01, 5·02.

Physics. College physics substantially equivalent to the Institute's first and second year physics, 8·01, 8·02, 8·03, and 8·04.

Cultural Subjects and Economics. Training in English, history, the humanities and social science, substantially equivalent in kind and amount to such subjects included in the undergraduate curricula of the Institute.

Professional Subjects

As specified below, particular professional subjects are required by individual departments.

Deficiencies in Preparation

Deficiencies in quantity or quality of training in prerequisite general or professional subjects must be removed before the student may proceed with graduate work dependent thereon.

If an applicant for admission to the Graduate School lacks so many undergraduate requirements that the attainment of the advanced degree is likely to be unduly protracted, he may be advised to postpone his application until his deficiencies have been reduced. Minor deficiencies in his preparation may be removed while he is pursuing graduate study.

In exceptional cases, the Committee on the Graduate School will pass upon a proposal for modification of certain specified requirements if initiated by a Departmental Committee on behalf of an applicant for an advanced degree in a specialized field, and may modify any of the above requirements.

THE DEGREE, MASTER OF SCIENCE

The degree MASTER OF SCIENCE is awarded by the Corporation upon recommendation of the Faculty based upon approval of the Committee on the Graduate School upon the satisfactory completion of a course of advanced study and research approved by the department in which the student has been enrolled and complying with the regulations as set forth hereunder, during residence of at least one academic year.

The residence requirement is further defined as comprising at least one academic year of study and research at the Institute including a full schedule (48 units) of such work for one regular term.

Students who complete the requirements for the S.B. degree at this Institute, together with substantial extra advanced credits in graduate subjects, may, upon application, be granted a waiver of the one year's residence requirement and will be recommended for the degree Master of Science upon completion of the requirements therefor.

A graduate of the Institute in the department in which he enrolls for the Master of Science degree, or others with equivalent preparation, may attain that degree in one year. Others with less direct and extensive preparation will require a longer time according to the amount of prerequisites which must be satisfied.

College students desiring to undertake work for an advanced degree at the Institute will find it advantageous to select electives which will satisfy the prerequisites for the advanced work which they intend to undertake. Advice on such electives may be secured by correspondence with the Chairman of the Committee on Graduate Students of the department in which it is desired to enroll. Attention is advised to the statement of professional prerequisites under the appropriate department in the following pages.

Degree Requirements. The degree of Master of Science is awarded upon satisfactory completion of a program of advanced study and research, approved by a department Committee on Graduate Students, which comprises

(1) 72 units of "A" subjects including 20 to 40 units (except where otherwise specified) of thesis.
(2) 24 units of "B" or "A" subjects.
(3) The above 96 units completed with a satisfactory academic rating. (See "Subjects of Instruction Tabulated" for "A" or "B" subjects.)

The degree is awarded with specification of field provided that at least 64 units of "A" subjects (including thesis) in the above program be in a single field of science or engineering. The degree Master of Science, without specification of field, may be awarded for a program of the above specifications in which the "A" subjects of any one field comprise less than 64 units, but the satisfactory academic rating in all 96 units must be maintained, irrespective of diversification of fields.

The requirements set forth immediately above apply equally to the degree S.M. awarded for part of a five-year curriculum even though in such cases certain "B" or "A" subjects have been taken before the fifth year.

The academic rating of a graduate student is compiled from his grades in all subjects of "A" or "B" grade for which he registers, plus credits in "A" or "B" subjects offered in anticipation from undergraduate years at this Institute, or obtained by examination for advanced standing; it does not comprise credits for work completed in other institutions and accepted in lieu of advanced subjects at this Institute.

Credit cannot be granted for thesis work, done in absentia, and all thesis work must be done under supervision of a member of the Institute's Staff.

Choice of Field.

The choice of field of specialization, and of subjects elected therein, must be approved by the Committee on Graduate Students of the department in which the student is enrolled. The choice of subjects is not restricted to those offered in a single department; subjects in more than one department may be selected provided that the resultant program is approved as being integrated and well balanced.

MASTER'S DEGREES OTHER THAN THE S.M.

The requirements for the degrees M.Arch., M.C.P. differ only from those for the degree Master of Science in respect to certain prerequisites and in the number of units permitted or required for thesis. They are specified under the appropriate department hereinafter.

THE DOCTORATES

The degrees DOCTOR OF PHILOSOPHY in fields of science [Biology, Chemistry, Geology (including Crystallography), Mathematics or Physics], in Food Technology, Industrial Economics, and in Group Psychology; and

DOCTOR OF SCIENCE in fields of applied science or of engineering [Aeronautical Engineering, Biology, Ceramics, Chemistry, Chemical Engineering, Civil Engineering, Electrical Engineering, Food Technology, Geology (including Geophysics and Mineralogy), Mathematics, Mechanical Engineering, Metallurgy (including Mineral Dressing), Meteorology, Physics, and Sanitary Engineering] certify to performance of original research of high grade and to creditable completion of an approved program of advanced study.

The advanced study and research must be pursued in the Graduate School for at least two academic years, except in the case of applicants who satisfy the Faculty that they have successfully accomplished at another institution advanced work of a grade equal to that required at this Institute, in which case the period of residence may be reduced to not less than one academic year.

If at any time a Department Committee on Graduate Students is convinced that one of its applicants for a doctorate has not demonstrated those abilities necessary to meet the requirements for this degree, he may be required to change his registration to that of an applicant for a lower degree or to discontinue his registration in the Graduate School.

The four basic requirements for the award of a doctorate are as follows:

(1) Completion of a Major program of advanced work.
(2) Completion of a Minor program of advanced study.
(3) Demonstration of a proficiency in the use of scientific modern languages.
(4) Preparation of a thesis upon original research.

The MAJOR Requirement

The Major, consisting of advanced study and research may be selected in any field of science or engineering approved by the department in which the student is enrolled. The Thesis will be in this same field. The program of the Major need not necessarily be confined to subjects offered in a single department.

When the Major field involves a program made up of subjects in several departments, there may be appointed a special committee to supervise the applicant's work.

A general examination upon the field of the Major will be held for each applicant for a doctorate at such time and in such manner as his Department Committee shall approve, except that each examination shall comprise both written and oral parts.

The MINOR Requirement

The Minor requirement for the Ph.D. or Sc.D. consists of at least 25 units of credit in some field of science or of engineering other than that wherein the Major lies, more advanced in character than required in the undergraduate curriculum of the department in which the student majors. Subjects elected to satisfy this requirement will usually but not necessarily be offered in some department other than that of the Major; will be selected primarily with the purpose of broadening the student's professional information rather than of improving his proficiency in the field of his specialization; and will be comprised in part at least of "B" or "A" grade subjects.

The approval of the *field* of the Minor must be obtained from the student's Registration Officer; the *program* proposed for the Minor must have the approval of the Chairman of the Committee on Graduate Students of the department in which a plurality of the minor subjects is offered.

Subjects to be included in the Minor program must be approved in advance of enrollment therein, except that a major department may accept transfer of credit for acceptable work previously completed elsewhere, for a reasonable proportion of the Minor.

An examination upon the field of the Minor may be required, especially if credit for a Minor requirement in part is granted for work done elsewhere, but usually a record of satisfactory accomplishment in Minor subjects at the Institute satisfies this requirement.

The LANGUAGE Requirement

All candidates for a doctorate must demonstrate to the department of Modern Languages their ability to read scientific literature in English, German, and a third modern language approved by the committee in charge of the student's major work, except that the requirement of a third language may be waived upon the recommendation of that committee in the case of a candidate for the degree of Doctor of Science in a field of engineering in which the scientific literature of a third language is unimportant.

THESIS

The thesis must be carried out under the direction of a member of the Faculty. Work already accomplished elsewhere not under supervision of a member of our Faculty cannot be accepted in partial fulfilment of thesis requirement, nor can credit be granted for thesis work done in absentia.

A final oral examination upon the thesis and its field will be held after the thesis has been accepted and tentatively evaluated by the examiners.

Award of the Degree

Upon completion of the above requirements, with the approval of the candidate's supervisory committee, and upon recommendation to the Faculty by the Committee on the Graduate School, the degree may be awarded by the Corporation of the Institute.

In conferring the doctorate, the appropriate hood is presented by the Institute to each candidate who receives his degree in person at Commencement; otherwise a hood is not given.

COOPERATIVE ARRANGEMENT WITH HARVARD UNIVERSITY

A student enrolled in the Graduate School at the Massachusetts Institute of Technology who is engaged full-time in study or in a combination of study and academic staff duties together equivalent to full-time, may by permission enroll for advanced work exclusive of research at Harvard University or Radcliffe College without payment of additional tuition, provided that such exchange enrollment may not exceed one-half of his total registration. In the above category are included Fellows and full-time Special Graduate Students who are carried on the rolls of the Graduate School at M. I. T.

A student desiring to avail himself of this privilege must present to the Dean of the Graduate School at M. I. T. a written request from his Registration Officer, specifying the name and number of the Harvard subject desired, whether half-course or whole course, and whether for credit or for auditing without formal grade; the Dean's office will issue to the petitioner certain forms to be presented by him to designated officials at the other institution.

Permission will be granted for attendance at only such classes as are not so crowded that this additional registration creates an undue load on the instructors.

Requests should be confined to subjects not available in our own institution, and if there be apparent duplication of a requested subject in the two schools, acceptable reasons for the request must be presented.

I. CIVIL ENGINEERING

THE Department of Civil and Sanitary Engineering provides opportunity for study and research to satisfy the requirements for the degrees of Master of Science in Civil Engineering, or Doctor of Science in Civil Engineering.

Programs of study may be selected from the following fields:

Structural Engineering, which includes a number of advanced subjects dealing with methods of analysis and design of statically indeterminate and other complex structures

Soil Mechanics, covering both theoretical treatment and experimental technique

Hydraulics, including theoretical and experimental work in fluids, and *Water Power Engineering*

Transportation Engineering: the design, construction and economics of airports, highways and railways

Geodesy and *Photogrammetry*

The Structural Analysis Laboratory offers facilities for instruction and research in the static and dynamic behavior of structures. The Soil Mechanics Laboratory is available for instruction in experimental technique and for investigations of soils of various kinds. The Hydraulics Laboratory has facilities for investigation of problems in Hydraulics including studies involving the use of models. Camp Technology in Maine makes it possible to carry on field work in Geodesy during the latter part of the summer.

(For instruction and research in Sanitary Engineering, see Course XI.)

Departmental Requirements for Graduate Work

In addition to the general requirements as set forth on page 71, the applicant must present evidence of training in the following professional subjects considered essential for all Civil Engineers and corresponding approximately to the Institute subjects as listed:

1·00T, 1·01T	Surveying
1·21	Route and Construction Surveys
1·40, 1·41	Structures
1·43	Reinforced Concrete Design
1·441	Bridge Design
1·61, 1·62	Fluid Mechanics
2·04	Strength of Materials

He must also present evidence of having had in addition to the subjects listed above, sufficient undergraduate training to prepare him for the advanced work at graduate level.

Further specific professional requirements prerequisite for graduate study in the various branches of Civil Engineering, are as indicated below:

For *Structural Engineering, Soil Mechanics, Hydraulics:*
No additional requirements.
For *Geodesy:*
1·03 Advanced Surveying.
For *Transportation Engineering:*
1·271, 1·272 Transportation Engineering.
For *Water Power Engineering:*
1·70 Hydrology and Flood Control.
1·71 Water Power Engineering.

Deficiencies in prerequisites may be removed while pursuing a program of graduate work but before proceeding with advanced subjects dependent upon them.

The Degree, Master of Science in Civil Engineering

In meeting the requirements for the degree Master of Science, those subjects given above under Departmental Requirements for Graduate Work which are listed as "B" in the catalogue may, to the extent of not over 24 units, be presented in partial fulfillment of degree requirements.

II. MECHANICAL ENGINEERING

The Department of Mechanical Engineering is equipped to provide opportunities for graduate work leading to the degrees of Master of Science or Doctor of Science in Mechanical Engineering, and the degree of Master of Science in Textile Technology.

Laboratory facilities for experimental work are available in Photoelasticity and Experimental Stress Analysis, Materials Testing and Plasticity, Vibrations, Instrumentation, Control Phenomena, Fluid Mechanics, Temperature Measurements, and Heat Transfer. Through the Sloan Automotive Laboratory and the new Gas Turbine Laboratory special facilities are available for design and research activities in Internal Combustion Engines and Gas Turbines with particular emphasis on flow and combustion phenomena.

The Institute also offers opportunity for advanced study and research in the field of textiles.

Departmental Requirements for Graduate Work

The general admission requirements are those set forth on page 71. A statement concerning transfers from other colleges is given below.

The Degree, Master of Science in Mechanical Engineering

The principal object of the study program leading to the degree of Master of Science in Mechanical Engineering is to broaden the student's background of engineering science in order to enable him to approach rationally any problem that may arise in the mechanical engineering field.

This object precludes specialization in any one narrow field as well as the development of general practical skills. To reach this objective within the present limit of 96 units, it is necessary to place certain limitations on the freedom of the student to select his program. With this purpose in mind, the subjects available to graduate students in the Mechanical Engineering Department have been grouped under seven major categories, including the Thesis, as shown below. Minimum requirements of units are prescribed for four of these categories. Since the prescribed number of units makes a total of 65, the student may have complete freedom of choice for a maximum of 31 units within the standard program of 96 units.

Subject Group	*Minimum Number of Units*
1. Mathematics	18 (Two Terms)
2. Applied Mechanics and Fluid Mechanics	18 (Two Terms)
3. Thermodynamics and Heat Engineering	9 (One Term)
4. Design	..
5. Materials Testing, Processing, and Metallurgy	..
6. Manufacturing and Production	..
7. Thesis	20
	65

The choice of subjects within any one subject group is intended to be as free as possible but must be made so as to insure a logical program.

The programs for transfer students must necessarily differ from those of graduates of the Mechanical Engineering Department. In general, a transfer student is required to take undergraduate subjects in those fields where this is necessary to bring his background up to the level required for graduates of the Mechanical Engineering Department in Options 2 or 3. However, the student is encouraged to take the most advanced subject which his previous train-

II. Mechanical Engineering Continued

ing justifies. Satisfactory grades in a graduate subject will permit the elimination of undergraduate deficiencies in subjects which cover the corresponding field at the undergraduate level. Experience shows that the majority of transfer students without previous graduate training should take 2·081, 2·082, 2·257, and 2·43, or their equivalents.

The Degree, Master of Science in Textile Technology

Graduates of the Institute, or of other institutions which award the Bachelor's degree on the basis of a course essentially equivalent in breadth and training to that offered by the Institute in the fields of Chemical Engineering, Chemistry, Mechanical Engineering, Business and Engineering Administration, Industrial Physics, or General Science and Engineering may obtain the Master's degree in Textile Technology in from one to two years depending upon preparation. Graduates of high standing, of technical schools or textile schools offering less extensive preparation in science or engineering, will, in general require a minimum of two years to fulfill the requirements for the degree.

The Degree, Doctor of Science in Mechanical Engineering

The objective to be followed in planning the Major program of study towards the Doctorate is exactly the same as that outlined for the Degree of S.M., but after the attainment of the proficiency embodied in the requirements for the degree of S.M., further and more mature specialization is required in at least one subject group selected from 2, 3, 4, or 5. Completion of this Major program is verified by a General Examination. Experience indicates that no rigid rules for the number of units involved in the Major program are desirable, but for the average candidate without previous graduate training, the equivalent of about 200 units is usually required. This also includes the established minimum of 25 units for the Minor requirement.

The General Examination includes all subject matter covered in the requirements for the Master's degree and the additional graduate subjects for which the candidate has registered as a part of his Major program. The Oral part of the General Examination may not be taken until the written part is passed.

The Minor program for Doctor of Science in Mechanical Engineering may be selected from some field of science or Engineering other than Subject Groups 2, 3, and 4. Mathematics is now the most common field for the Minor, but whenever possible the Minor may be chosen from the fields of Physics, Chemistry, Metallurgy, Chemical Engineering, Civil Engineering, Naval Architecture, and Aeronautical Engineering.

The principal research program, its results embodied in a Thesis and verified by a Final Examination, should be selected within the field previously chosen for the Major program. Depending upon the degree of coördination between the research program and the Major program, this part of the doctorate program usually covers about 100 units.

Unless specifically approved by the Chairman of the Committee on Graduate Students of the Mechanical Engineering Department, the General Examination and the Language Requirement must be completed before the program of research is undertaken. Whenever possible, the Language Requirement should be fulfilled in the first or second terms of the graduate program so that scientific literature in at least one important foreign language may be available to the candidate for the Major program of study.

III. METALLURGY

(Including Mineral Dressing and Ceramics)

The Department of Metallurgy offers graduate work leading to the degrees of Master of Science or Doctor of Science in Metallurgy or Ceramics which may be pursued along a number of lines. The major divisions are Process Metallurgy, Physical Metallurgy, Mineral Dressing, and Ceramics.

Process Metallurgy deals with the production of metals and alloys from ores or concentrates; Physical Metallurgy with the study of physical properties of metals and their alloys. Mineral Dressing deals with mechanical, physical, and chemical purification and preparation of ores, solid fuels, ceramic raw materials, and other minerals. Ceramics covers pottery, structural clay products, refractories, abrasives, glass, and enamels.

In the Metallurgy laboratories facilities are provided for the roasting and special treatment of ores, the extraction of the metals by wet methods or by furnace smelting, including the electrometallurgical processes, and the study of high temperature equilibria. In addition to various types of smelting furnaces the laboratories are equipped with gas and electric furnaces for the making of alloys in small quantities. A coreless induction furnace with a melting capacity of one hundred and fifty pounds makes possible the production of steel and other alloys on a semi-commercial scale. Equipment is available for detailed metallographic investigation, for heat treatment study and research, as well as for X-ray examination. The latter field is provided for by a lead room in which radiographic studies may be made and by facilities for research in the atomic arrangement in metals. Facilities are available for advanced research in the field of magnetism. Through coöperation with the Department of Mechanical Engineering, physical testing of all sorts is possible.

Opportunity is given for study and research in more specialized subjects such as heat and corrosion resisting alloys, the light alloys, and nitriding. Facilities are also available for the study of many of the fundamental physical properties of metallic systems such as electrical and thermal conductivities, magnetic properties and similar topics.

In the Mineral Dressing laboratories facilities are available for the study of crushing, grinding, screening, classification, thickening, filtration, tabling, jigging, electrostatic and magnetic separation of ores, fuels, and minerals. In addition, complete microscope equipment is available for the study of mill products. Special attention has been given to flotation for the study of which a modern laboratory is available. The equipment is designed not only for the study of batch or continuous operations of the various process, but also for the analysis of the basic physical and chemical phenomena on which the processes rest. Opportunity, also, is given to explore new fields in mineral identification and in mineral synthesis.

The field of Ceramics, covering as it does pottery, structural clay products, refractories, abrasives, glass and enamels, is a very broad one, but a sound training in the fundamentals of the subject gives a basis for later specialization. The laboratories are equipped with testing apparatus and with machines and kilns for carrying out regular plant processes.

Departmental Requirements for Graduate Work

The general admission requirements are those set forth on page 71 with no exceptions.

III. Metallurgy Continued

Professional subjects prerequisite for graduate study in the Department of Metallurgy are given below.

For students in *Process and Physical Metallurgy:*

3·01	Non-Ferrous Metallurgy
3·12	Metallurgy: Iron and Steel
3·31, 3·32	Physical Metallurgy
5·61, 5·62	Physical Chemistry
6·18, 6·19	Electrical Engineering Fund.

For students in *Mineral Dressing:*

3·81, 3·82	Mineral Dressing
3·86	Quantitative Mineragraphy
5·41	Organic Chemistry
5·61, 5·62	Physical Chemistry
12·011	Mineralogy
12·20	Elementary Crystallography

For students in *Ceramics:*

2·50	Heat Measurements
3·70	Ceramics
5·61	Physical Chemistry

A number of "A" subjects listed in other Courses may be taken for credit in the field of Ceramics. Such, for example, are:

8·28	X-ray Diffraction	3–6
8·29	Theory of the Solid State	3–6
10·70	Principles of Combustion	4–8
10·74	Furnace Design	3–6

The above professional subjects may be taken along with advanced work.

The Degree, Master of Science

The specifications for the degrees Master of Science in Metallurgy and Master of Science in Ceramics are as set forth on page 71.

The Degree, Doctor of Science

The specifications for the degree of Doctor of Science in Metallurgy or Ceramics are as set forth on pages 71 and 72.

IV. ARCHITECTURE AND PLANNING

The School of Architecture and Planning offers work leading to the degrees of Master in Architecture and Master in City Planning.

Graduate study in Architecture affords students who have demonstrated professional promise an opportunity for advanced work in the further application to creative design of the contributing fields of study that formed part of their undergraduate curriculum. There is also an opportunity for participation with students of related disciplines in the exploration of important problems whose solution appears to require the contributions of more than one profession. The work is arranged to enable the student to devote large units of time to research and design under the guidance of the School and with the assistance of Institute specialists in the related fields. This activity is enriched by the availability of unusual laboratory and library facilities and by the association with graduate students from other backgrounds.

The Graduate Course in City Planning is designed to train practitioners or staff men in the fields of city and regional planning. It offers to the advanced student a broad survey of the entire field of planning, and practice work in the library, drafting room, and field. It is intended primarily for students with undergraduate training in city planning, architecture, landscape architecture, civil engineering, or one of the social sciences; but those whose undergraduate preparation has been in other fields may also be admitted provided that they make up certain deficiencies ordinarily required in undergraduate courses.

Departmental Requirements for Graduate Work

Undergraduate preparation in Architecture and Planning usually differs from that required for the scientific degrees, and in place of the requirements on page 71, the following are set up as prerequisites for graduate study.

Architecture. Bachelor in Architecture or equivalent degree with high academic standing from a professional undergraduate course in architecture at an institution of recognized standing, or S.B. or A.B. degree with high standing and enough professional work in a school of architecture of recognized standing to indicate promise of competence in the profession.

Planning. The degree, Bachelor in City Planning, from the Institute or other approvable college, or the S.B. or A.B. degree together with academic records and background considered satisfactory as preparation for graduate study in the field of city planning.

Evidence of satisfactory preparation in the following undergraduate subjects will be required for all Graduate students in Architecture and Planning.

Mathematics. One full year of college mathematics, including at least one term of calculus.

Physics: One full year of college work in physics.

Humanities. Training in English, history, the humanities and social science substantially equivalent in kind and amount to such subjects included in the undergraduate curricula of the Institute.

Professional Subjects in Architecture. Two full years of subjects in mechanics and structural design and one full year of subjects in other technical aspects of building; a completed program of work in history of architecture, freehand drawing, and architectural design equivalent to these subjects as required in the Institute's curriculum for the Bachelor in Architecture.

Professional Subjects in City Planning. Acceptable courses of at least one term's credit each in surveying, urban sociology, municipal engineering, and city planning principles. At least twelve weeks of practical experience in a planning office are ordinarily required.

Deficiencies in mathematics and physics may be removed by the enrollment in special sections in subjects offered by the Institute. A student whose deficiencies are of minor extent will be permitted graduate registration while taking the appropriate subjects at the Institute to remove them. Where such subjects are of "B" rating they will contribute, up to the 24 units described below, toward the requirements for the Master's degree.

The Degree, Master in Architecture

The degree of Master in Architecture is awarded upon completion with a satisfactory academic rating, of a program of advanced study and research approved by the School's Committee on graduate students, and comprising at least

(1) 72 units of "A" subjects including a minimum of 30 units of graduate architectural design and a minimum of 20 and a maximum of 40 units of thesis done in residence, and
(2) 24 units of "B" or "A" subjects.

The Degree, Master in City Planning

The degree of Master in City Planning will be awarded upon satisfactory completion of a course with a minimum of 96 units of advanced study, subdivided as set forth on page 71, including at least three terms of city and regional planning design and a thesis of from 20 to 40 units.

V. CHEMISTRY

Modern developments in chemistry and the present position of the American chemical industry have combined to make desirable a program of study beyond the traditional four-year period required for a Bachelor's degree.

The Department of Chemistry offers graduate programs leading to the degrees of Master of Science, Doctor of Philosophy, or Doctor of Science in Chemistry. Details of these programs, which differ according to whether the candidate chooses to specialize in Inorganic (including Analytical Chemistry), Organic, or Physical Chemistry are recorded below. Students working toward the Doctorate are expected to choose one of these three fields of specialization; students working toward the Master's degree may make a similar selection, or may take a program in chemistry including study in an approved combination of these fields.

Attainment of the Master's degree is not prerequisite to a program of study leading to a Doctorate. Master's candidates may, by permission, change to the corresponding Doctorate without loss of credit.

Chemical research and development work in industrial laboratories has continued at an accelerated pace during the war, while few graduate students were able to remain in residence in the universities. Consequently there exists a shortage of chemists in all branches of the science.

There is a demand for men of mature scientific education to serve as investigators and to direct investigational work in industry, in endowed research institutions, in government bureaus and in academic institutions. The numerous industries in particular have nearly all come to realize the desirability and even necessity of supporting fundamental scientific investigations relative to their processes as a basis for future development. It is universally agreed that graduate work is an essential preparation for positions in connection with these divisions.

Teaching Fellows

The Department appoints a limited number of Teaching Fellows who are candidates for the degree of Doctor of Philosophy in Chemistry. Teaching Fellows serve in the laboratories of the Department, and, if qualified, in the classroom, on a part time regular schedule throughout the academic year. For information in regard to appointments, address correspondence to the Head of the Department.

Physical Chemistry

A considerable portion of the more recent advance in science has been in fields lying between the divisions of science as they were originally established. One of the most important of these developments is physical chemistry, which has come into existence as a result of investigations lying between the previously loosely defined borders of the sciences of physics and chemistry.

Recent research in Physical Chemistry, other than war research, has been concentrated on the following subjects, and the laboratory is especially well, often uniquely, equipped for such research:

Pressure-volume-temperature relations of gases and liquids.
The absolute temperature scale.
Molecular weights of gases by limiting densities.
Heat capacities and latent heats at low temperatures.
Properties of gases at low pressures.
Scattering and other properties of molecular beams.
Electromotive force in concentration cells, and oxidation-reduction potentials.
Freezing points of liquid solutions.
Vapor pressures of liquid solutions.
Infra-red spectroscopy.
Precision photometry.
Kinetics of thermal and photochemical reactions.
Properties of high polymers.
Properties of protein solutions.

Organic Chemistry

In the graduate program, subjects are offered which aim to develop in the student a sound knowledge of fundamentals and familiarity with current progress in the most active and important branches of Organic Chemistry. Each student undertakes a research problem which forms the nucleus of his graduate work, and through the experience of conducting an experimental investigation leading to the Ph.D. or S.M. thesis, acquires the research attitude and method of approach, and training in the specialized techniques of organic research. Basic graduate subjects in Organic Chemistry cover quite broadly organic reactions and their application to synthetic problems; theoretical organic chemistry; characterization or identification of organic compounds by the methods of qualitative organic analysis (including a survey of functional groups and their reactions); modern experimental techniques in Organic Chemistry. Advanced laboratory work which provides a background for research is an important part of the last two of these courses. The Institute pioneered in developing both of these subjects.

Fields of research in Organic Chemistry which are being investigated actively in the department include carbohydrates; heterocyclic compounds; identification and analytical methods; organic peroxides; organometallic compounds; polymerization; reactions of active methylene compounds; reaction mechanisms; synthetic methods; vitamins; other natural products and physiologically active compounds. The courses in recent advances in organic chemistry, conducted by the staff and required of all candidates for the degree of Doctor of Philosophy in this field, include chemistry related to these topics and others of current interest and importance.

Inorganic Chemistry

The progress which has been made in the utilization of certain of the less familiar elements, such as zirconium, columbium, tantalum, molybdenum, indium, rhenium — to mention but a few — is but one indication of the need for scientific investigation of the chemistry of such elements and of their compounds.

The preparative side of the science has been stressed from the beginning, as it has been felt that a primary function of the inorganic chemist is the study of methods of preparation of substances in a reasonably high state of purity. To this end, his work is closely associated with that of the analytical chemist

In addition to the preparation of pure substances, the inorganic research chemist is naturally interested in the study of the physical properties and the interactions of various substances under fixed experimental conditions, and this may be said to constitute his second objective. The contributions of the laboratory, therefore, will be found to include a number of analytical researches, the isolation and study of numerous inorganic compounds, and investigations of theoretical and factual aspects of inorganic reactions.

Particular attention has been given to the chemistry of the less familiar metallic and non-metallic elements, as well as to the elaboration of the chemistry of some of the common elements.

V. Chemistry Continued

DEPARTMENTAL REQUIREMENTS FOR GRADUATE WORK

The general admission requirements are those set forth on page 71, with the following exceptions:

MATHEMATICS. For degree applicants in Physical Chemistry, M22; for others, M21.

PROFESSIONAL SUBJECTS. All candidates for admission to graduate work in this department must present equivalents of the following subjects:

Analytical Chemistry:	5·10, 5·12, 5·13
Organic Chemistry:	5·41, 5·42, 5·414, 5·424
Physical Chemistry:	5·61, 5·62, 5·63

Students specializing in one of the following fields of chemistry must include in their program of graduate study the subjects indicated, unless they have already received credit for them.

In *Inorganic Chemistry*
5·061, 5·062, 5·071, 5·072, 5·08

In *Organic Chemistry*
5·43, 5·44, 5·51T, 5·52T, 5·53, 5·581T, 5·582T

In *Physical Chemistry*
5·65, 5·66, 5·72T

THE DEGREE, MASTER OF SCIENCE

For the degree, Master of Science in Chemistry, in addition to the subjects listed above, two Elementary Foreign Languages are required equivalent to L11, L12 (German) and L51, L52 (French).

THE DOCTORATES

For the degree, Doctor of Philosophy in a field of chemical science or Doctor of Science in a field of applied chemistry each candidate must fulfill the requirements listed below, in addition to the general Departmental requirements. He must also complete a program the content of which varies according to the major field: Inorganic, Organic, or Physical Chemistry.

In order to complete the Language requirement, he must pass written examinations in scientific French and German.

To fulfill the Minor requirement he must take at least 25 units of subjects in some department other than Chemistry. Candidates majoring in Physical Chemistry must take the Minor in Mathematics or Physics.

He must complete or be certified in the equivalent of all starred subjects in the Course V undergraduate curriculum with certain exceptions: *viz.*, majors in Inorganic Chemistry need not present 5·417; majors in Organic Chemistry need not present 5·611 and 5·621 and should substitute 5·72T for 5·64; majors in Physical Chemistry need not present 5·417, 5·43, and 5·44.

In addition to the general requirements indicated above, candidates for the Doctor's degree must also pursue a program of graduate subjects. The specific content of these programs varies according to the major field in which the candidate is registered, but is expected to include the following subjects:

Inorganic Chemistry: 5·71, 5·911, 5·912, together with 14 to 18 hours in either X-rays and Crystal Physics, Nuclear Physics, Radiochemistry, X-ray Metallography, or Crystallography, and during each year of residence 5·941 and 5·942.

Organic Chemistry: During each year of residence 5·913, 5·914, 5·591T, and 5·592T.

Physical Chemistry: 5·73, 5·74, 5·75, 5·76, 5·77, and during each year of residence 5·931, 5·932, and the Departmental Colloquium.

In the interpretation of these requirements, the Department will consider the candidate's previous academic record and professional experience together with his particular aims and objectives, and will take a liberal attitude toward substitution of other subjects of equivalent educational and scientific value.

Inquiries should be addressed to the Chairman, Committee on Graduate Study, Department of Chemistry.

VI. ELECTRICAL ENGINEERING

The Department of Electrical Engineering offers advanced work leading to the degrees of Master of Science or Doctor of Science in Electrical Engineering.

There are no fixed programs of study toward these degrees. Particular effort is made with each student to develop his program of graduate study along the lines of his individual special interest. Such a program provides him with a strong incentive to a high level of accomplishment and gives him a specialized ability that is immediately useful. This specialized ability, however, is deemed a less significant result of graduate study than is the clearer insight into and better integration of fundamental principles so generally gained by the graduate student. Soundly conceived advanced work rarely fails to send the student back to deepen his understanding of elementary but basic principles. These ideas influence both the methods of approach used in graduate engineering subjects and the counsel given to students to include in their programs further formal study of mathematics and physics.

At the graduate level the Department offers a wide choice among a number of areas of activity. Several of these are interdepartmental in scope, representing a trend emphasized by the war and regarded most desirable. The Department regards active research projects as a dominant influence in its graduate program provided each is so conceived and administered that the graduate student can and does have full opportunity to associate himself with it while retaining his scientific individuality and initiative. This educational principle is vigorously enforced.

Graduate work tends to center about a number of especially active areas in the broad field associated with electrical engineering. Each of these areas is characterized by an active research program, and in general by graduate class and laboratory programs. Some of these are mentioned in the following paragraphs.

In servomechanisms and automatic control a large research and development program is closely coupled with extended graduate study covering numerous and varied phases of this subject. Close integration of electronic and electric circuits, electromechanical, hydraulic, and mechanical elements in single dynamical systems provides excellent educational breadth in a currently active field.

In the Research Laboratory of Electronics sponsored jointly by the Departments of Electrical Engineering and Physics particular attention is currently given to microwave techniques and their applications in such fields as communications, television, acoustics, generation of high-energy radiation, electronic computation, gaseous conduction, and atomic structure.

Advanced network theory is an important area in its own right and contributes to several other areas, for example, servo theory, communications, and power transmission.

A group is concerned with advanced topics in the electric power field and uses the Network Analyzer in power

VI. Electrical Engineering Continued

system studies ranging from those of large public utility systems to those of multimotored airplanes.

The development and application of mechanical methods of mathematical analysis is a major activity consolidated in the Center of Analysis. The Center of Analysis has two Differential Analyzers, the original unit and the most modern unit. In addition, there are other extensive computational facilities.

The Departments of Architecture, Physics and Electrical Engineering are engaged in an extensive program of research and development in the field of acoustics, both fundamental and applied.

In the Laboratory for Insulation Research the fundamental subjects of electric conduction and displacement with their applications in the fields of insulation, semiconductors and dielectrics are the basis of research utilizing the concepts of atomic physics, and are approached from the points of view of physics and chemistry as well as of electrical engineering.

The development of generators in the several-megavolt range and their use in the generation of high-energy particles and radiation are subjects both of research and development and of graduate study. High-precision measurements of the properties and effects of such radiations, the problems of very-high-voltage insulation, and therapeutic applications in coöperation with medical research groups are emphasized.

Certain aspects of nuclear energy and machines for producing extremely high-energy particles constitute another focus of activity as a part of the Laboratory of Nuclear Science and Engineering. This laboratory is another project in which several departments coöperate.

A facility differing in kind from the centers of new development but equally essential in the Department's educational program is the Vail Library. This Library is one of three great electrical libraries of the world. The original Vail Collection (30,000 volumes), presented to the Department in 1912 through the interest of the late Theodore N. Vail, was combined with other electrical literature in the Institute Library to form the Vail Library which now comprises some 43,000 volumes. It contains the works of all writers who have made significant contributions to electrical science and engineering since the time of William Gilbert (1600). The Vail Library staff gives instruction in library usage and bibliographic research, maintains unusual files of current industrial catalogues and other current material in addition to providing the usual library services.

From the emphasis given to the graduate student's association with active projects it is evident that his graduate study is considered to include much more than class exercises and assignments pursued in a routine manner. He is expected to conceive of his program as a coördinated whole, having as its objective the advancement of his professional preparation and providing for a substantial amount of independent and correlative study in current literature and independent investigation in the laboratories. Such study and investigation are essential parts of the seminar and thesis research, affording the student an opportunity to develop his ability to do sound constructive reasoning, and to contribute to the advancement of engineering.

Assistantships. Each year a limited number of appointments to assistantships are available to men especially qualified by training and natural endowment for teaching and research. Every effort is made to arrange the assigned work of an assistant so that he may carry approximately forty per cent of a full-time program of study toward an advanced degree. Should his research assignment result in material appropriate for a graduate thesis, a research assistant is permitted to make use of it.

Departmental Requirements for Admission to Graduate Work

The general requirements are as set forth on page 71, without exceptions.

In addition to the general requirements for all graduate students, a candidate for the degree of Master of Science in Electrical Engineering or Doctor of Science in Electrical Engineering must present evidence of training in certain professional subjects considered essential for all Electrical Engineers, and which correspond approximately to the following Institute subjects:

M31	Differential Equations
2·00, 2·01	Statics, Dynamics
2·04	Strength of Materials
6·00, 6·01, 6·02, 6·03	Electrical Engineering, Principles
6·75	Electrical Measurements Laboratory
6·76	Electronics Laboratory
6·77	Elec. Eng. Lab.

He must also present evidence of having had sufficient undergraduate training to prepare him for the advanced subjects he wishes to take, and to give him a certain professional breadth. For each of the following fields, the amount of such training should be approximately equivalent to that included in the Institute subjects indicated:

Electric Power

2·07	Dynamics
2·40	Heat Engineering
6·04	Electrical Engineering, Principles
6·78, 6·79	Elec. Eng. Lab.

Communications

6·30, 6·311, 6·321	Elec. Communications Principles
6·331, 6·332	Elec. Communications Laboratory
6·781	Elec. Eng. Lab.
8·05	Vibrations and Sound
8·061, 8·062	Intermediate Physics

Electronics Applications and Automatic Control

2·07	Dynamics
2·251	Fluid Mechanics
6·20	Electronic Control and Measurement
6·781	Elec. Eng. Lab.
6·83	Electronic Eng. Laboratory
8·061, 8·062	Intermediate Physics

When the student's interest in graduate work does not fall in one of these distinct fields, he must present comparable evidence both of adequate preparation for advanced work in his chosen field and of reasonable competence in collateral fields.

Credit is not usually allowed for undergraduate subjects in which the applicant's grades are low. High-grade work in undergraduate mathematics and physics is considered to be particularly important.

If the student has not completed, before entering the Institute, the undergraduate subjects deemed important preparation for the graduate study and research that he desires to undertake, he may make up these subjects as deficiencies while in attendance at the Institute. Those subjects having a "B" classification may be counted up to a total of 24 units for credit toward the Master's degree.

The Degree, Master of Science

In addition to general requirements set forth on page 71, the Department of Electrical Engineering requires the following:

Modern Languages. A reading knowledge of technical German, Russian, or French, along lines of the student's

VI. Electrical Engineering Continued

professional interest. When a choice can be made, German is preferred, since German literature in the field of Electrical Engineering is at present the most extensive of the three, with Russian as a second choice. This requirement may be satisfied by: a certificate grade in three years of preparatory-school German or French; or a certificate grade in two years of preparatory-school German, and two years of French; or two years of German or French taken at the Institute; or passing a reading test in German, Russian, or French; or passing an intensive one-semester subject in German, Russian, or French given at the Institute to prepare students to meet the Modern Language reading requirements.

Seminar. All graduate students in the Department who have not had equivalent experience in the preparation and oral presentation of technical papers are required to take Seminar, 6·501 and 6·502. In the Seminar meetings, papers dealing with the history of the development of various phases of electrical engineering and the influence of these developments upon present practices, are presented and discussed. The student may select his seminar topic so as to utilize the seminar time for examination of the literature relating to the general field of his thesis.

Students working for the Master's degree are expected to devote themselves to a few subjects, not more than three each term, in addition to their Seminar and research. The subjects of study are wholly elective, with the exception of Electrical Engineering Seminar and Thesis, and not restricted to those given by the Department of Electrical Engineering; however, the program of study must be well balanced, emphasizing one or more of the mathematical, economic, and experimental aspects of electrical engineering.

The Degree, Doctor of Science

Only students who have shown promise of outstanding performance in work of a creative nature are encouraged to study for the doctorate. Where the records of students entering on graduate work do not yield evidence of this ability, they are usually advised to qualify first for the Master's degree. The thesis research for the doctorate is expected to make a substantial and noteworthy contribution in Electrical Engineering or a related field.

The general requirements for the doctor's degree are given on pages 71 and 72.

Each applicant for the doctorate in Electrical Engineering is required to demonstrate his ability to read scientific literature in English and in two other modern languages selected from German, Russian, and French. Ordinarily this requirement should be satisfied by the time the general examination is taken, and before undertaking the thesis research.

The field of the Minor is not prescribed by the Department, but usually Mathematics, Physics, or Economics is chosen. The Minor requirement should be satisfied by the time the general examination is taken.

Doctorate students who have not previously satisfied the Seminar requirement listed above are required to take Seminar, 6·501 and 6·502.

VII. BIOLOGY

Graduate study and research in this Department may be selected in one of the following fields: Basic Biological Sciences, Biochemistry, Biophysics, General Physiology, Microbiology. Advanced work in these fields leads to the degrees of Master of Science in Biology, and Doctor of Philosophy or Doctor of Science in the field of specialization. Course VII-A, listed under the undergraduate course schedules, leads to the degree of Master of Science in Physical Biology and Bachelor of Science in Quantitative Biology.

The Biological Research Laboratories

The Biological Laboratories offer facilities for advanced work in biochemistry, biophysics, cytology, enzymology, general physiology, and microbiology. Properly prepared graduate students may elect to undertake research in one or more of these fields under guidance of staff members. Included in the program of research in which staff members have an interest, and with which advanced graduate students may hope to become affiliated, are the following:

In bacteriology particular emphasis is laid on physiological and biochemical studies and on the development of quantitative methods of dealing with bacterial processes.

Biochemical studies are concerned with the purification and chemical characterization of substances important in plant and animal growth and metabolism. Among specific problems under investigation may be mentioned the mechanism of fermentation, antibacterial substances, and the purification and chemical characterization of the protein, collagen.

Equipment is available for research in a wide variety of fields of physical biology. Exceptional instrumentation has been assembled for an investigation of the molecular organization of cells, tissues, and their products. Included are X-ray diffraction units, an electron microscope, and polarization optical equipment. These techniques are being applied at the present time especially to collagen, insulin and the proteins of muscle. For identification of biological substances there is equipment for investigating ultraviolet and visible absorption spectra, Raman, emission, and fluorescence spectra. Studies employing these methods bear importantly on the problem of the mechanism of inflammatory processes, proliferation and neoplasia. There is a well-equipped laboratory for the study of the properties of mono- and poly-molecular films. Electrical instrumentation is provided for a study of the biological action of high-frequency electric fields, and ultrasonic radiation. Equipment and laboratories are available for the study of the instruments used in physical medicine.

Physiological investigations include studies of nerve action with the cathode ray oscillograph, of permeability processes by the radioactive tracer method, of cellular metabolism by manometric and volumetric methods, of the action of enzymes, with special reference to their kinetics as related to temperature and oxidation-reduction potential. Studies are also in progress to determine the active groups of enzymes, their distribution in cells and tissue and the relationship of enzyme concentration to the nutrition of living organisms.

Departmental Requirements for Graduate Work

Only students with a bachelor's degree and superior credentials, who have had excellent training in biology and chemistry, may be accepted as applicants for advanced degrees in the Department. Previous award of the Master's degree in an appropriate field by an accredited institution will usually be adequate for acceptance of an applicant for a doctorate.

For admission to graduate work in this department, the general requirements as set forth on page 71 are modified with the following exceptions:

VII. Biology Continued

MATHEMATICS. Through calculus equivalent to M11 and M12.

PHYSICS. One year of satisfactory college physics.

CHEMISTRY. Equivalents of 5·01, 5·02, 5·12, 5·61, 5·62, 5·41, 5·428.

PROFESSIONAL SUBJECTS. Two years of college biological subjects, and the equivalent of 7·19, 7·20, and 7·80. Other prerequisites may be required depending upon field of specialization.

Deficiencies in subjects listed above may be removed, if not too extensive, while pursuing a graduate program but before entering upon advanced work which is dependent upon them.

THE DEGREE, MASTER OF SCIENCE

The degree Master of Science in Physical Biology is awarded upon completion of the special curriculum designated as VII-A, only. Other candidates may attain the degree Master of Science in Biology, or Master of Science (without specification).

THE DOCTORATES

The degrees Doctor of Philosophy in a field of biological science, or Doctor of Science in a field of applied biology, require a reading knowledge of scientific literature in two modern languages other than English acceptable to the department selected from French, German, Russian.

General examinations for a doctorate in this department are held in two groups, each partly written and partly oral. The preliminary examinations include fundamentals of general biology, microbiology, physiology, and biochemistry: the final general examinations deal particularly with the field of specialization.

VIII. PHYSICS

The Department of Physics offers work leading to the degrees of Master of Science, Doctor of Philosophy, or Doctor of Science in Physics. No stated curriculum of subjects is required for any of these degrees, but they are to be chosen in consultation with the registration officer, subject to certain broad principles.

GRADUATE STUDY AND RESEARCH FACILITIES

Physics is the fundamental science underlying almost all branches of engineering. During the last fifty years of extraordinary progress it has advanced far beyond its conventional fields of mechanics, sound, heat, light, and electricity and magnetism, and has led to very complete understanding of the structure of atoms, molecules, and matter in bulk, of electronics and gas discharges, of atomic spectra and the nature of light. The discovery of radioactivity, of induced radioactivity, of nuclear fission and of cosmic rays, has led to an understanding of the nature of the atomic nucleus, and of high energy particles, which is far from complete, but which is bound to lead to further far-reaching discoveries. The fundamental laws governing the nature of matter and energy are partly understood as a result of recent work, almost certainly within reach in the near future.

Along with this remarkable advance in basic knowledge has come very widespread application of new principles and methods to practical problems. The methods of electronics have revolutionized communications and instrumentation. Relatively old fields like acoustics have become revitalized. Physical tools like X-ray diffraction, electron diffraction, the electron microscope, and modern spectroscopy, throw completely new light on problems of chemistry, metallurgy, and biology. Applied nuclear physics, with its use of induced radioactive tracers, brings a tool of the greatest power to bear on biological, chemical, and geological problems. The great energy released in nuclear reactions suggests that even the hopes of atomic power may not be without foundation. The day has passed when any branch of physics could be considered as merely of academic interest. The physicist, with his broad knowledge of principles and methods, has shown himself particularly able to undertake new problems in the industrial laboratory, to apply his science to practical ends.

The Physics Department recognizes the importance both of the development of fundamental knowledge, and of the applications of physics. The laboratory is equipped with excellent research facilities, and carries out extensive research programs, in practically all fields of active interest. Three interdepartmental research laboratories, the Laboratory of Nuclear Science and Engineering, the Research Laboratory of Electronics, and the Acoustics Laboratory, serve to correlate the research of the various departments in these fields, and their facilities are available to graduate students in physics. In nuclear physics, equipment includes a large cyclotron, and high voltage electrostatic generators. Further electronuclear machines of very high voltage are under construction in connection with the Laboratory of Nuclear Science and Engineering. There are active research programs in nuclear structure, applied radioactivity, and in cosmic rays and high energy particles. The Research Laboratory of Electronics provides unequalled facilities for research in microwave electronics, and related branches of physics. The Magnet Laboratory has equipment for the production of very high magnetic fields, and of very low temperatures. The Acoustics Laboratory works both in low frequency acoustics, including architectural acoustics, and in ultrasonics. The Spectroscopy Laboratory is unique in the field of spectroscopic measurement and analysis, and the Optics Laboratory specializes in the field of color measurements. Work in X-ray diffraction and crystal structure, electron microscopy, and the structure of dielectrics, is actively carried on.

Courses of study include work in almost all of these experimental fields, and in the various branches of theoretical physics as well. It is expected that the graduate student will gain real familiarity with several of the branches of physics, not merely with one specialty. Whether he plans to go into academic work, or into industrial research, the training includes a broad and thorough understanding of the fundamentals of physics, as well as of its more advanced applications.

DEPARTMENTAL REQUIREMENTS FOR GRADUATE WORK

General requirements are those set forth on page 71 with the following additions:

PROFESSIONAL SUBJECTS. The equivalents of the following subjects, which are not credited in fulfillment of degree requirements:

8·061, 8·062	Intermediate Physics
8·161	Optics
8·311	Atomic Structure

The following advanced undergraduate subjects, of "B" listing, may be credited (to the extent of 24 units) toward and are required for advanced degrees:

8·11	Experimental Physics
8·461, 8·462	Introduction to Theoretical Physics

Deficiencies in subjects required for admission or for advanced degrees may be removed while engaged in graduate work before undertaking advanced subjects dependent upon them.

VIII. Physics Continued

THE DEGREE, MASTER OF SCIENCE

In addition to general requirements set forth on page 71 a reading examination in either scientific French or German is required.

THE DOCTORATES

The degrees Doctor of Philosophy in a field of pure physics or Doctor of Science in a field of applied physics require examination for reading knowledge of scientific literature in either German and French or German and Russian.

The student is expected to take graduate subjects to prepare himself for the general examination but there are no stated required subjects.

X. CHEMICAL ENGINEERING

Graduate study in this Department leads to the degrees of Master of Science in Chemical Engineering or Chemical Engineering Practice or Doctor of Science in Chemical Engineering.

Because of the breadth of the field of Chemical Engineering the undergraduate Course must be devoted to training in fundamentals, and strictly professional subjects must be elementary in character. Postgraduate work is therefore of peculiar importance and value to the chemical engineer.

The program for the S.M. degree, particularly in Chemical Engineering Practice, is usually arranged as a continuation of the broad professional training, although individual schedules may be planned to specialize in a given field. Work for the Sc.D. degree is more specific in character and the Department offers coördinated programs in three fields: Engineering Operations of Chemical Engineering, Applied Chemistry, and Fuel Engineering. Special programs are developed for individual cases.

SCHOOL OF CHEMICAL ENGINEERING PRACTICE

The Department of Chemical Engineering offers a Course leading to the degree of Master of Science in Chemical Engineering Practice (designated as X-A).

In the School of Chemical Engineering Practice a selected group of graduate students who have completed at least four years of undergraduate study at the Institute or elsewhere spend six months at three field stations located at Bangor, Me., Parlin, N. J., and Buffalo, N. Y. At these stations four different concerns open their plants for the instruction of students who at each station are under the direct charge of two members of the Institute staff. Since the time is devoted wholly to their education, students receive no compensation. Their attention is directed chiefly to the application of theory to practice and to the cultivation of resourcefulness and of effectiveness in coöperative effort under industrial conditions.

The quantitative aspects of Chemical Engineering are intensively studied in the Practice School. In addition to tests on industrial equipment, plant investigations are carried out by the students at each of the stations, this work covering two fields: first, investigation of some special phase of one of the unit operations; or second, investigation of some problem of industrial chemistry particularly important at the station in question.

Finally, the School of Chemical Engineering Practice offers exceptional opportunity for graduate engineering research, first by affording an opportunity for comparing laboratory data, formulae, and conclusions with observations on plant apparatus operating under practical working conditions; and second, by extending, from laboratory scale at the Institute to commercial scale in the various plants, the range of investigations possible.

The following program will be taken by men graduating in Chemical Engineering from the Institute. For twenty-four weeks, starting in July following graduation, students are at the field stations (10·81, 10·82 and 10·83). They then return to the Institute for intensive work in Chemical Engineering Plant Design (10·53) during January. The program for the Master's degree is completed by graduate professional subjects and thesis at the Institute during the spring term.

For graduates in Chemical Engineering from other institutions the usual program of study for the Master's degree in Chemical Engineering Practice involves two terms at the Institute plus the field station work in the Practice School and the Design Course (10·53). Graduates in chemistry from other institutions usually require an additional term. Students are usually not admitted to the Practice School until they have spent at least one term at the Institute.

FIELDS OF STUDY

Engineering Operations. Graduate subjects in the several important unit operations such as heat transmission, distillation, and absorption are offered, emphasizing the engineering phases of the students' professional training.

Applied Chemistry. A group of subjects in Applied Chemistry, such as colloidal chemistry, catalysis and high pressure processes, comprise an integrated program for students whose primary interests are on the side of Industrial Chemistry.

Fuel Engineering. While the important group of industries involving the processing and utilization of fuels demand the training and viewpoint of the chemical engineer, many of their problems can be handled by men who have majored in non-chemical branches of engineering, provided they prepare themselves adequately for fuel engineering work by graduate study. The Department offers a group of subjects on fuel processing and utilization as the core of a program of graduate study in Fuel Engineering, the balance of the work being in science, engineering or economics. The facilities of the Buffalo Station of the Practice School can be utilized for advanced investigations in fuel engineering practice.

Since the program in any of these fields will depend on undergraduate training and industrial experience, any one interested is requested to furnish information permitting individual consideration.

DEPARTMENTAL REQUIREMENTS FOR GRADUATE WORK

The requirements for graduate study are dependent on the degree to which the student wishes to specialize. The broadest training is required in Chemical Engineering and in Chemical Engineering Practice as it is assumed that the student is preparing himself for any phase of chemical engineering. Students who plan definitely to major in Applied Chemistry or in Fuel Engineering will be expected to meet requirements in chemistry and in engineering to an extent justified by the field of specialization.

The general requirements are as set forth on page 71, with the following additions:

CHEMISTRY: the substantial equivalent of the undergraduate subjects in Course X.

ENGINEERING: (*a*) a one-year problem course in heat engineering or chemical engineering thermodynamics, and (*b*) preparation in applied mechanics or elements of electrical engineering.

CHEMICAL ENGINEERING: problem courses in industrial chemistry and in unit operations.

X. Chemical Engineering Continued

THE DEGREE, MASTER OF SCIENCE

A prerequisite for the award of the Master's degree is elementary French or German.

XI. SANITARY ENGINEERING

The Department of Civil and Sanitary Engineering provides opportunities for study and research in sanitary engineering to satisfy the requirements for the degrees of Master of Science in Sanitary Engineering or Doctor of Science in Sanitary Engineering.

Programs of study may be selected from subjects dealing with:

Principles and practice in water supply, sewerage, the treatment of water and the treatment and disposal of sewage and industrial wastes;

Sanitary chemistry and chemical examination of water, sewage and industrial wastes;

Sanitary biology, bacteriological examination of water and sewage, and other aspects of sanitary bacteriology.

Principles and practices in sanitation and public health.

Students who enter with preliminary training in sanitary engineering will find opportunities for advanced studies in the design phases of sanitary engineering, in the operation of sanitary works, in sanitary research, or in environmental sanitation and public health.

The William Thompson Sedgwick Laboratories of Sanitary Science provide facilities for instruction and research in sanitary chemistry, sanitary biology, sanitary bacteriology, environmental sanitation, and in engineering processes for water and sewage treatment.

DEPARTMENTAL REQUIREMENTS FOR GRADUATE WORK

In addition to the general requirements as set forth on page 71 the applicant must present evidence of training considered essential for all Sanitary Engineers, corresponding approximately to the Institute subjects as listed:

1·00T, 1·01T	Surveying
1·40, 1·41	Structures
1·61, 1·62	Fluid Mechanics
1·75, 1·76	Water Supply & Sewerage
2·04	Strength of Materials

Deficiencies in any of the foregoing subjects may be removed while pursuing a program of graduate work, but before proceeding with advanced work dependent upon them.

THE DEGREE, MASTER OF SCIENCE IN SANITARY ENGINEERING

In meeting the requirements for the degree Master of Science, these subjects given above under Departmental Requirements for Graduate Work which have a "B" listing in the catalogue may, to the extent of not over 24 units, be presented in partial fulfillment of degree requirements.

In general, students with proper preparation and high scholastic ability may expect to complete the requirements for the degree Master of Science in Sanitary Engineering in one academic year.

XII. GEOLOGY

Many opportunities are available for the pursuit of advanced study leading to the degrees of Master of Science. Doctor of Philosophy, or Doctor of Science in Geology, Specialization in the more theoretical aspects of geology, mineralogy, petrology and geophysics may be chosen as preparation for teaching and research. Important lines of specialization lie in the field of applied geology. One of these is economic geology in which the student may choose mining geology or petroleum geology. If a student is interested in the administrative and financial phases of the mineral industry, he may pursue studies in the field of mineral economics and evaluation of mineral properties. Geology, as applied to engineering problems, offers an interesting field of specialization which is growing in importance. The Department offers an opportunity for specialization in geophysics with a view to professional work in the combined application of geology and geophysics to the problems of mineral exploration. X-ray crystallography, which is finding rapidly expanding applications in many industries, may be selected as a field of specialization.

Advanced work in the Department is facilitated by laboratories with modern appliances for research in the several phases of geology, mineralogy, crystallography, petrography, geophysics and paleontology. The Department also has a variety of collections of specimens and materials available for study by qualified graduate students.

DEPARTMENTAL REQUIREMENTS FOR GRADUATE WORK

The general admission requirements are those given on page 71, with the following exceptions: MATHEMATICS, M22 is not required as a prerequisite.

In addition, the student may be required to take certain additional subjects which will be decided upon by the Graduate Committee of the Department after evaluation of the student's preparation and study of his proposed program of advanced work. The Department further requires preparation in the following subjects or their approved equivalents:

For *all* students in the Department of Geology:

5·11	Qualitative Analysis
5·12	Quantitative Analysis
5·61, 5·62	Physical Chemistry
12·20	Elementary Crystallography
12·23	Optical Crystallography

For students in the fields of *Geology*, *Mineralogy*, *Geophysics*, or *Mineral Industry*, the following additional subjects:

12·011, 12·012	Mineralogy
12·15	Petrography
12·301, 12·302	General Geology
12·38	Geomorphology
12·40	Economic Geology
12·41	Economic Geology Lab.
12·581	Sedimentation
12·701, 12·702	Structural Geology

For students in the field of *Crystallography* the following additional subjects:

12·24	Theoretical Crystallography
M77	Vector Analysis
8·27	X-ray and Crystal Physics, or
3·50	X-ray Metallography

THE DEGREE, MASTER OF SCIENCE

In addition to the general requirements for the degree, Master of Science, the candidate is required to pursue a course of study, within the field of his choice, which is satisfactory to the Department Committee on Graduate Students. The field may be selected from general geology, economic geology, structural geology, petrology, mineralogy, crystallography, geophysics, mineral industry, or other approved fields.

THE DOCTORATES

The general requirements for the degrees, Doctor of Philosophy and Doctor of Science, are given on pages 71

XII. Geology Continued

and 72. In the Department of Geology, the field may be selected from geology, petrology, mineralogy, crystallography, geophysics, mineral industry, or other approved fields. The preparation of the candidate for the Doctorate must be such as to satisfy the Department Committee on Graduate Students that he is qualified to undertake courses of advanced study and research.

Soon after entering the Department, the candidate may be given an informal preliminary examination, which will be partly oral and partly written, to survey his training and attainments and to serve as a basis for directing his graduate program.

In order to complete the language requirement the candidate must demonstrate to the satisfaction of the Department of Modern Languages that he can read scientific literature in the field of his Major in two of the following languages: French, German, and Russian, or in such other approved languages as are appropriate for his chosen field of specialization.

Subjects satisfying the 25 units for the Minor requirement must be taken from the lists of subjects offered by another department and approved by the Committee on Graduate Students of the Department of Geology.

Subject to the approval of the Department Committee on Graduate Students, other subjects for which a student has adequate preparation may be elected from the subjects primarily for graduates offered by related departments. A number of advanced subjects in geology and mineralogy, given at Harvard University, are also open to the student.

XIII. NAVAL ARCHITECTURE AND MARINE ENGINEERING

The Department of Naval Architecture and Marine Engineering offers courses leading to the following advanced degrees: Master of Science in Naval Architecture, Master of Science in Marine Engineering, Master of Science (without specification), and Master of Science in Naval Construction and Engineering (restricted to commissioned officers of the United States Navy and United States Coast Guard).

The Degree, Master of Science in Naval Architecture

The undergraduate preparation in mathematics, chemistry, physics and the humanities should be that given on page 71. Undergraduate preparation in professional subjects should in general be equal in quality and quantity to that contained in the Institute's undergraduate curriculum in Naval Architecture and Marine Engineering. Satisfactory grades in the following undergraduate Institute subjects or their equivalent must be shown before the candidate will be admitted as a candidate for the Master's degree.

2·01, 2·04, 2·062	Strength of Materials and Dynamics
2·251	Fluid Mechanics
2·40, 2·42	Heat Engineering
2·683	Engineering Laboratory
2·851	Machine Tool Laboratory
6·18	Electrical Eng. Fund.
13·01, 13·02	Naval Architecture
13·34	Ship Construction
13·42	Ship Drawing
13·45, 13·46	Ship Design
13·52, 13·54	Marine Engineering

Work in the graduate school should include 13·03 and 13·04 Naval Architecture and Ship Design and other graduate subjects in the field of Naval Architecture offered in the Department, such as 13·73, 13·74 and 13·791. The major part of the program of study must be in the field of Naval Architecture but may include advanced mathematics and physics, related subjects or those having applications to hull design and construction which are taught in other Departments, such as applied mechanics, hydrodynamics, metallurgy and metallography.

The Degree, Master of Science in Marine Engineering

The undergraduate preparation should, in general, be the equivalent of the Institute's course in Naval Architecture and Marine Engineering. Satisfactory grades in the following undergraduate subjects or their equivalents must be shown before the candidate will be admitted as a candidate for the Master's degree.

2·251	Fluid Mechanics
2·01, 2·04, 2·06	Applied Mechanics
2·40, 2·42	Heat Engineering
2·683	Engineering Laboratory
2·851	Machine Tool Laboratory
6·40, 6·89	Electrical Engineering
13·01, 13·02	Naval Architecture
13·52, 13·55	Marine Engineering
13·62	Marine Engineering Design

Work in the graduate school should include graduate subjects in the field of Marine Engineering offered in the Department, such as 13·71, 13·72, 13·73, 13·74, 13·78 and 13·791 but part of the program may consist of subjects given in other Departments which have applications in the field of Marine Engineering such as applied mechanics, hydrodynamics, thermodynamics, machine design, refrigeration, internal combustion engineering, gas or steam turbine design, power plant engineering, heat transmission, metallurgy and metallography, advanced mathematics, advanced physics.

The Degree, Master of Science (Without Specification)

The undergraduate preparation should in general be the equivalent of the Institute's course in Naval Architecture and Marine Engineering.

Work in the Graduate School should include some of the graduate subjects given in the Department but the major part of the program may consist of subjects given in other Departments which have applications in the fields of Naval Architecture, Marine Engineering or the business of shipbuilding.

The Degree, Master of Science in Naval Construction and Engineering

The course of study leading to this degree, designated Course XIII-A, is restricted to commissioned officers of the United States Navy and United States Coast Guard. They must have completed the prescribed course of studies at the United States Naval Academy, United States Coast Guard Academy or their equivalent.

The curriculum of Course XIII-A is a fully prescribed curriculum requiring three years for its completion, and is given below.

XIII-A. Naval Construction and Engineering

Prior to First Term of Senior Year

M73	Review of Mathematics	20–0
2·851	Machine Tool Lab	4–0
2·852	Machine Tool Practice	4–0

XIII. Naval Architecture and Marine Engineering Continued

Senior Year

First Term	2·046	Strength of Mat. & Dynamics	4–5
	2·402	Heat Engineering	6–7
	3·391	Properties of Metals	3–3
	13·01	Naval Architecture	3–6
	13·21	Warship Design	5–0
	M36	Advanced Calculus	3–6
			24–27
Second Term	2·256	Fluid Mechanics	3–6
	2·422	Heat Engineering	2–4
	3·392	Properties of Metals	3–3
	13·02	Naval Architecture	3–6
	13·12	Theory of Warship Design	2–4
	13·22	Warship Design	5–0
	M37	Advanced Calculus	3–6
			21–29

First Graduate Year

First Term	2·081	Strength of Materials	3–6
	6·43	Electrical Engineering	3–6
	10·311	Heat Transfer	3–3
	13·13	Theory of Warship Design	4–8
	13·75	Naval Engineering	5–6
	13·79	Propeller Design	2–2
			20–31
Second Term	2·805	Diesel Engines	3–6
	6·44	Electrical Engineering	4–7
	13·24	Warship Design	5–0
	13·73	Mechanical Vibration	3–6
	13·76	Naval Engineering	6–4
	Ec15	Economics & Labor Rel., Prin.	4–8
			25–31

Second Graduate Year

First Term	2·211	Mech. Eng. Prob., Adv.	3–9
	2·72	Machine Design	3–6
	6·45	Electrical Engineering	4–7
	13·15	Theory of Warship Design	3–6
	13·25	Warship Design	5–0
	13·74	Mechanical Vibration	3–6
		Thesis	4
			59
Second Term	2·213	Gas Turbine Prob., Adv.	3–9
	6·46	Electrical Engineering	4–7
	13·16	Theory of Warship Design	3–6
	13·26	Warship Design	8–0
		Thesis	15
			55

XV. BUSINESS AND ENGINEERING ADMINISTRATION

Designed to prepare the technical graduate for ultimate executive responsibilities of an important nature, the course leading to the degree of Master of Science in Business and Engineering Administration has for its three primary objectives an appreciation of the social implications of industry, an understanding of the interrelations of business and economics, and a familiarity with managerial as well as technical problems.

Breadth of viewpoint is developed by foundation subjects dealing with the economic, social and political background of business. Facility is stimulated through the study of actual problems encountered in the major fields of management: production, marketing, finance, accounting, law and labor relations. The professional point of view is encouraged by original investigations of contemporary industrial situations, selected because of their unusual interest and value to the individual student. Finally, through the privilege of electing subjects in other departments of the Institute, opportunity is offered for further advance in allied technical areas which have especial bearing upon the student's subsequent industrial activities.

Graduate study in this department presupposes preparation equivalent to that of a graduate of the Courses in Business and Engineering Administration. With this preparation the candidate may reasonably expect to complete the requirements for the Master's degree in one year. Without it, graduates from other courses at the Massachusetts Institute of Technology or from non-business courses in other accredited technical schools will undertake a two-year program. The first year of residence is devoted to the satisfying of prerequisites, and any remaining time during that year is assigned to additional subjects chosen from undergraduate electives. The second year is given wholly to graduate work, in accordance with the general requirements for the Master's degree.

Departmental Requirements for Graduate Work

The general admission requirements are those set forth on page 71, with the following exceptions:

Mathematics. M22 Differential Equations is not a prerequisite.

Physics. The department requires a complete college course in Physics of at least one year.

Engineering Subjects. A substantial number of engineering units similar to those prescribed in XV-A or XV-B, the undergraduate Courses in Business and Engineering Administration.

Professional Subjects. The following subjects are prerequisite for the receipt of an advanced degree.

15·30	Personnel Management	Ec11	Economic Principles and the equivalent of *any three* additional subjects in Business or Economics to be selected from "B" subjects (other than those listed in the previous group).
15·41	Finance		
15·50	Accounting		
15·61	Law of Contracts		
15·70	Production		
15·81	Marketing and Reports		
15·92	Industrial Problems		

Deficiencies in prerequisites for admission or for the receipt of the degree may be taken along with graduate work.

XVI. AERONAUTICAL ENGINEERING

Advanced study in this Department leads to the degrees of Master of Science or Doctor of Science in Aeronautical Engineering.

Emphasis is laid on individual study and research. Each student must follow a consistent program of work directed toward some particular part of the aeronautical field, such as aerodynamics, design, instrumentation, structures or power plants. Since most phases of the graduate work in Aeronautical Engineering rest heavily upon mathematics and mechanics, aptitude in these subjects is required.

Students may also elect subjects given in other departments, but bearing a useful relation to their program of aeronautical studies. The selection of such subjects must be approved by the registration officer.

For aerodynamical research several wind tunnels are available. The largest, the Wright Brothers Wind Tunnel, with an elliptical throat 7½ by 10 feet, is a pressure tunnel. Operating pressures are from ¼ to 4 atmospheres and the maximum speeds vary up to 350 miles per hour at ¼ atmosphere. Other tunnels include: 5 by 7½ foot rectangular throat closed return fitted with instruments and

XVI. Aeronautical Engineering Continued

apparatus for the study of flutter, 5 foot diameter Venturi type, an instrument tunnel arranged with multi-stage throats.

The Instrumentation Section is equipped with three laboratories. One supplies instruction in the fundamentals of instrumentation with particular emphasis on the behavior of measuring systems under rapidly changing conditions. In this laboratory there is apparatus for studying aircraft instruments including a testing chamber in which flight conditions can be reproduced. A second laboratory is concerned with vibration measurements and is equipped with instruments of many types for measuring vibratory displacement, acceleration and strain. Calibration apparatus and a vibration-testing machine are included in this laboratory. The third laboratory contains equipment for studying the performance of fire control equipment and is restricted to selected Army and Navy students.

The Structures Laboratory is equipped for supporting various types of structures not readily adaptable to testing in ordinary testing machines. Loading devices and electrical and mechanical strain gauges are available so that studies of strain distribution under static loadings can be made on structures of types commonly employed in aircraft. By using some of the equipment available in the Vibrations Measurement Laboratory, stress distributions in structures subjected to dynamic loadings can also be investigated. The Structures Laboratory and the Vibrations Measurements Laboratory are operated in close coöperation.

Departmental Requirements for Graduate Work

The general requirements are those set forth on page 71 with the following additions:

Professional Subjects. Equivalents of the following Institute subjects:

2·30	Engineering Materials
2·40	Heat Engineering
2·701	Machine Drawing
16·02	Aeronautical Mechanics, Int.
16·10	Aerodynamics, Applied
16·21	Structures

Applicants must also present evidence of preparation for the advanced subjects they wish to take. The amount of such preparation should be equivalent to the following:

For *Aerodynamics:* 16·13, 16·17, 16·62
For *Aeronautical Design:* 16·13, 16·14, 16·17, 16·22, 16·62, 16·75
For *Aeronautical Structures:* 16·13, 16·17, 16·22
For *Instrumentation:* 6·18, 6·19, 16·13,
For *Aeronautical Power Plants:* 2·792, 2·794, 16·16

If applicants have not had the specified undergraduate preparation before entrance, they may remove deficiencies while engaged in graduate work, provided that advanced work may not be undertaken until prerequisites therefor have been satisfied. Many of these subjects listed are "B" subjects. (See Subjects of Instruction Tabulated.)

Attention is called to the five-year program leading to S.B. and S.M. degrees described under Course XVI Undergraduate schedules.

The Degree, Master of Science

Requirements for the degree Master of Science in Aeronautical Engineering include two terms of Advanced Mathematics (beyond M22) unless such work has been included in undergraduate preparation.

For the above degree, closely related subjects taken in another department may with permission of the Aeronautical Engineering Department Committee on Graduate Students be interpreted as within the Aeronautical Engineering field.

The Doctorate

The applicant for the degree Doctor of Science is expected to take graduate subjects in preparing himself for the general examination and for thesis research: no specific subjects are prescribed.

The general examination for the doctorate consists of two parts. The first is a written examination, consisting normally of six questions which require, on the average, one day each to complete and are to be answered with the aid of the student's notes and the library within one week from the date of issue.

The second is a three-hour oral examination following the successful completion of the first. The general examination, Minor and Language requirements must be completed before the student is admitted to candidacy for the degree.

XVIII. MATHEMATICS

This Department offers courses leading to the degrees of Master of Science, Doctor of Philosophy, or Doctor of Science in Mathematics.

Candidates for advanced degrees who work in the field of applied mathematics will be required to follow a course of study covering important aspects of one or more engineering and scientific fields together with a selected sequence of mathematics subjects. Assistance or even collaboration in practical problems in applied mathematics being investigated by members of the staff will constitute an important part of graduate programs. The student working for an advanced degree in applied mathematics thus will be enabled to carry on his research work with any of the members of the staff working in his field in any department of the Institute. His thesis advisers may include experts familiar with these practical problems as well as experts familiar with advanced mathematical techniques.

Departmental Requirements for Graduate Work

In addition to general requirements as set forth on page 71, the applicant must present evidence of preparation equivalent to that of Course XVIII, option 1, undergraduate schedule.

Certain deficiencies in prerequisites may be removed by the student while pursuing graduate work, provided that advanced work may be undertaken only after prerequisites upon which it depends have been satisfied.

The Degree, Master of Science

For the Master's degree the student must take in each term at least three subjects of advanced mathematics or allied subjects and fill the remaining time with electives or thesis.

The Doctorate

For the degree Doctor of Philosophy, each candidate must select a major field of interest — analysis, geometry or applied mathematics — and complete the program of subjects prescribed by the Department as appropriate to this major field. Ordinarily the last year will be spent on research and the completion of the thesis.

XIX. METEOROLOGY

The purpose of this course is to prepare students for practical work and for research in the field of meteorology. Instruction is offered leading to the degrees of Master of Science and Doctor of Science in Meteorology. Emphasis is placed on the application of physical principles and mathematical techniques to atmospheric processes as well as on observational, empirical, and statistical methods. With the inauguration of the undergraduate program in meteorology, the graduate courses have been revised to meet the need of students who have had either the equivalent of the undergraduate curriculum or adequate training in mathematics and physics. Students may be admitted for graduate study without previous training or experience in the field of meteorology provided that they satisfy the general requirements and have a good background in the physical sciences. Students with no previous training in meteorology in general, will have to spend four semesters in residence to qualify for the Master's degree.

Weather data are collected by means of teletypes so that all students may have access to the latest weather reports from North America and the neighboring oceans. This extensive coverage of current information together with a file of past data provides an excellent opportunity for research on problems of weather forecasting. The instruction in long-range weather forecasting is based on theories and results obtained at the Institute and the Weather Bureau during the last few years. The application of statistical methods to meteorology is undertaken in coöperation with the staff of the Department of Mathematics. Staff and facilities are available for the study of advanced dynamics of atmospheric motion.

The Meteorological Instrument Laboratory contains standard instruments for the measurement and recording of atmospheric phenomena, including instrumentation for pilot balloon, airplane meteorograph, and radio meteorograph soundings. Calibration chambers for use over a wide range of pressure, temperature, and humidity are available, as well as other special laboratory apparatus. Laboratory facilities for research in atmospheric condensation and precipitation processes are also available and equipment is at hand for experimental research in other fields of meteorology.

Meteorological Seminars sponsored jointly by Technology, Harvard University, and the American Meteorological Society are held at regular intervals during the academic year. At these meetings, recent developments in meteorology and allied sciences are discussed by guest speakers, members of the staff, and students. Close coöperation is maintained with the Blue Hill Observatory of Harvard University, the Mount Washington Observatory, the Woods Hole Oceanographic Institution, the United States Weather Bureau, the United States Navy, and the United States Army.

Departmental Requirements for Graduate Work

The general requirements for admission to graduate work in Meteorology are those set forth on page 71.

Candidates for advanced degrees in Meteorology must present evidence that they have had the equivalent of the following undergraduate professional subjects:

19·01, 19·02	Descriptive Meteorology
19·60	Thermodynamics of the Atmosphere

Deficiencies in the above subjects may be removed while pursuing a program of graduate study.

The Degree, Master of Science

For the degree Master of Science in Meteorology, "A" subjects may be chosen from those offered in synoptic laboratory, synoptic meteorology, dynamic meteorology, long-range weather forecasting, physical meteorology, and graphical analysis. All candidates will be expected to take the meteorological seminar. There are no foreign language requirements for the Master's degree.

The Doctorate

Students are accepted as candidates for the degree of Doctor of Science provided that they can satisfy the Department Committee on Graduate Students that they are qualified to undertake an extensive course of advanced study and to complete a thesis of high calibre.

Candidates for the Doctorate in Meteorology shall be required to demonstrate their ability to read scientific literature in English and in two other modern languages, at least one of which shall be German or Russian. Wide latitude is permitted in the choice of the second modern language, but the following are considered to be particularly suitable: German or Russian (if not chosen as the first language), French, Norwegian, Spanish, and Portuguese.

XX. FOOD TECHNOLOGY

The Department of Food Technology offers advanced courses leading to the degrees of Master of Science and Doctor of Philosophy or Doctor of Science in Food Technology.

Graduate work in food technology for the doctorate offers opportunity for advanced study and experimental work in the chemical, biological, engineering or economic aspects of food production, and development or control of new processes relating to product improvement or conservation of nutritive quality. Such work may be combined with subjects in chemical engineering, chemistry, mechanical engineering, physics, business administration, or others.

The Food Technology Laboratories provide facilities for research in the investigation of food processes, packaging, heat treatment, and the development of new food products. Numerous phases of the problems of food refrigeration, including quick freezing, have constituted a part of the food technology research program for several years. An extension of this program has been made possible through the generous coöperation of the Dewey & Almy Chemical Company in making available for joint use their conveniently located, modern and complete food-freezing laboratory, where students may conduct semi-plant scale research on frozen foods.

Research in food technology includes the following: various aspects of food processing, plant design, and product control; instrumentation; objective measurements for quality evaluation; packaging research with new materials; electronic applications in food industries; by-products utilization; detergents in food industries; unit-process methods in food manufacture. The evaluation of food flavors and the relation of processing methods to flavor development and conservation are fields of research of primary interest to the Department of Food Technology. Another basic field of research is that of low temperature food dehydration, including drying from the frozen state, which presents interesting possibilities applicable to numerous food industries.

Departmental Requirements for Graduate Work

The general requirements for admission are those set forth on page 71.

Applicants for admission to graduate work in food technology are required to meet as prerequisites the general

XX. Food Technology Continued

equivalent of the undergraduate program in food technology. Graduates from accredited institutions presenting evidence of scholarship of high order in contiguous professional fields may be permitted equivalent substitutions for such prerequisites, or the privilege of advanced standing examinations in the case of deficiencies.

The Degree, Master of Science

A five-year course leading to the degree of Master of Science in Food Technology is outlined under the Undergraduate Course Schedules. This course, combining the undergraduate four-year course with a fifth year of instruction following a six-month period in industry, presents opportunities for those desiring actual experience in food industries before starting their graduate year of advanced work.

The Doctorates

For students working toward the degree Doctor of Science in Food Technology, graduate subjects should be taken in preparation for the general examinations, but no specific subjects are prescribed. The choice of subjects is determined by the preparation and field of interest of the individual in consultation with his graduate registration officer.

Requirements for the doctorate include the satisfactory completion of oral and written examinations prescribed by the Department which demonstrate the competence and thorough understanding of the basic scientific phases of food technology and their application in certain specified fields.

ECONOMICS AND SOCIAL SCIENCE

The Department of Economics and Social Science offers work leading to the degrees of Doctor of Philosophy in Industrial Economics and of Doctor of Philosophy in Group Psychology. The Department also coöperates with other departments of the Institute in the five-year course, combining undergraduate and graduate work, leading to the degree of Master of Science either in Economics and Engineering or in Economics and Natural Science.

There is available at the Institute a wide variety of subjects in the fields comprising this area. There are also available for advanced students the facilities of the Industrial Relations Section and of the Research Center for Group Dynamics.

Departmental Requirements for Graduate Work

In place of the general requirements for admission set forth on page 71, the following requirements have been established as prerequisites for graduate study in the Department of Economics and Social Science:

Mathematics. One full year of college mathematics, including at least one term of calculus.

Physics. One full year of college work in physics.

Humanities. Training in English, history, and the humanities substantially equivalent in kind and amount to such subjects included in the undergraduate curriculum of the Institute.

Professional Subjects Prerequisite for Degree in Industrial Economics. Three full-year subjects in social science chosen from the following: economics, psychology, sociology, and history. (One of these subjects must have been economics, and history subjects to be acceptable must have stressed economic and technological developments.)

Professional Subjects Prerequisite for Degree in Group Psychology. Three full-year subjects in social science (psychology, sociology, anthropology, economics), of which at least one must have been in psychology.

Deficiencies in mathematics and physics may be removed by enrollment in special sections in subjects offered by the Institute. A student whose deficiencies are of minor extent will be permitted graduate registration while taking the appropriate subjects at the Institute to remove them.

The Doctorate in Industrial Economics

In the field of the Major, the candidate for the Ph.D. degree will be expected to have some understanding of all the fields listed below. The candidate will take a general examination covering four fields ordinarily chosen from: Economic Theory, Socio-psychological Theory, Industrial Relations, Industrial Organization and Price Policy, Economics of Technological Change, Statistical Method and Theory, Economic History, the State in Relation to Industry.

Following the Institute rules, the candidate for the Ph.D. degree will be required to take a Minor in a field other than economics. Possibilities include: Business Administration, Mathematics, Biology, or any of the scientific or technical fields in which the student is qualified to participate.

The candidate will be required to demonstrate his ability to read professional literature in two modern foreign languages. Ordinarily these languages will be German and French, but substitutions may be permitted in appropriate cases.

The Doctorate in Group Psychology

Only students who have received the equivalent of the Institute's cumulative rating of 4·00 as undergraduates will be admitted.

In the field of the Major, the candidate for the Ph.D. degree will be expected to have some understanding of all of the following subjects, and is required to take general examinations in four of them: Social Research Methods; Group Behavior; Systematic Individual Psychology; Applied Group Psychology in Industry, Government, Education, Community Life or Social Agencies; Statistical Methods; Selected Areas in Social Anthropology or in Sociology. He must take the examinations in Social Research Methods and Group Behavior.

Following the Institute rules, the candidate for the Ph.D. degree will be required to take a Minor in a field other than psychology. Students will ordinarily take their Minor outside the Department of Economics and Social Science.

The candidate will be required to demonstrate his ability to read professional literature in two modern foreign languages. Ordinarily these languages will be German and French, but substitutions may be permitted in appropriate cases.

It is expected that the work leading to the doctorate will normally require three years of full-time graduate study and research. Thesis research will be carried on in close collaboration with one or more members of the staff. The number of students accepted will be limited to the few who can be given an individual type of instruction.

The Degree, Master of Science: Five-Year Course

The five-year course, combining undergraduate and graduate work, leads to the degree of Master of Science either in Economics and Engineering or in Economics and Natural Science. The degree is conferred at the end of the

Economics and Social Science Continued

fifth year together with the degree of Bachelor of Science in the professional course in which the student has completed his undergraduate work. The student during the first four years completes his undergraduate requirements and at the same time takes one additional economics or business subject in each term of the third and fourth years. These additional subjects are made possible by omission of the senior thesis, and by means of electives available in the professional course, or by substitution, or by postponement of one or more professional subjects to the fifth year. The major part of the fifth year is devoted to social science subjects, including a thesis which should have an economic as well as an engineering aspect. The usual requirements as to "A" and "B" subjects for the Master's degree apply to this curriculum.

This five-year course is open to graduates of the Institute who may be admitted to the Graduate School and who meet the requirements of the Master's degree based on a program of advanced work as outlined above. It is not open to students in the Course in Architecture or in Business and Engineering Administration, or to graduates of other colleges who come to the Institute to specialize in Economics unless, in addition to the advanced work in Economics, they complete in residence a program of work in one of the departments of engineering or science approved by the Committee on the Graduate School.

DESCRIPTION OF SUBJECTS

The list below is necessarily subject to change due to present conditions

The prerequisites, units of exercise and preparation, and instructors in charge of each subject will be found under "Subjects of Instruction Tabulated"

CIVIL AND SANITARY ENGINEERING

SUBJECTS 1·00 TO 1·99

1·00. SURVEYING. Elementary theory and methods of plane and topographical surveying. Breed, *Surveying.*

1·00T. SURVEYING FIELDWORK. At Camp Technology. Theory and practice of plane and topographic surveying. Introductory exercises in the use of the tape, transit and level; a complete topographic survey of a given area using the stadia method and plane table; and engineering astronomy for the determination of azimuth, time and latitude. Drafting room work on preparation of maps and plans from original field notes. Class room work on description of methods and theoretical background of the fieldwork.

1·01. TOPOGRAPHICAL DRAWING. Scale drawings, profiles, contour maps, and conventional signs for topography. Application to solution of engineering problems. Brief treatment of photogrammetry. Breed, *Surveying.*

1·01T. ADVANCED SURVEYING FIELDWORK. At Camp Technology. Continuation of 1·00T. Methods and fieldwork of the more precise surveys. Triangulation by use of repeating and direction instruments. Measurement of base lines with both invar and steel tapes. Measurement of a precise traverse by "buck-chaining" methods. Precise leveling with micrometer tilting levels. Hydrographic surveying including soundings and use of current meter.

1·03. ADVANCED SURVEYING. Detailed discussion of methods of conducting advanced surveys. Principles of triangulation, base line and leveling, treated from a practical standpoint. Engineering astronomy including the determination of latitude, time and azimuth with the engineer's transit. Aerial surveying and photogrammetry including a study of the methods of preparing planimetric and topographic maps from aerial photographs. (Not offered 1946–47.)

1·04. CONSTRUCTION SURVEYING FIELDWORK. At Camp Technology. Fieldwork problems pertinent to construction surveys. Determination of quantities, proper location of structures relative to the terrain and the layout of building lines before and during construction. Designed for Course XVII.

1·05. SURVEYING. Elementary surveying, including theory and fieldwork. Breed, *Surveying.*

1·054. SURVEYING FIELDWORK. Use of tape, transit and level; complete topographic survey using the stadia method and plane table; astronomical observations for azimuth, time and latitude. Drafting of topographic map from field notes. Breed, *Surveying.*

1·06. PHOTOGRAMMETRY (B). Various methods of constructing maps from photographs for engineering purposes; methods of making topographic maps from vertical and from oblique photographs; methods of control of aerial surveys. Does not include the technical work of photography or of flying.

1·07. GEODETIC SURVEYING (B). Fieldwork, class work and computation at Camp Technology. Fieldwork including measuring a base line with invar tapes; triangulation with repeating and with direction instruments; precise leveling; astronomical observations.

1·08. NAVIGATION. Principles underlying piloting and celestial navigation. Study of piloting including use of compass, log and fathometer; various plane and great circle sailings; aids to navigation such as charts, tide tables and light lists. Celestial navigation comprising the use of chronometer and sextant; systems of spherical coördinates; correction to altitudes; use of Greenwich Hour Angle for time data; latitude sights; line of position sights; navigator's day's work at sea.

1·13T. ADVANCED SURVEYING. Abridgement of 1·03 to meet the needs of students who have taken 1·054.

1·141, 1·142. ADVANCED GEODESY (A). Methods of developing the higher formulas for computing geodetic positions; theories of potential and the earth's figure; theories of astronomical, magnetic and gravity observations; and application of least squares to the adjustment of geodetic surveys.

1·15. INTRODUCTION TO VIBRATION THEORY (A). Free and forced vibrations with and without solid and fluid friction. Emphasis upon the analysis of various vibration measuring devices, accelerographs, frequency meters, etc. Proper interpretation of the results; principles of design of instruments and recording systems. Practical problems of mechanical vibration and of vibration prevention. (Not offered 1946–47.)

1·16. VIBRATION PROBLEMS (A). Available methods of solving the more complex problems in vibrations-step-by-step integration, the differential analyzer, model study, electrical network solutions, Rayleigh and Rayleigh-Ritz methods, Lagrange's equations, and the general solution of nth order vibration equations, including non-harmonic vibrations. Analysis of complex mechanical systems under transient and periodic forces and displacements. Practical problems illustrating the application of the various methods and principles. (Not offered 1946–47.)

1·20. ROUTE SURVEYING FIELDWORK. Location survey for a railway or highway project; systematic drill in laying out curves, setting slope stakes for earthwork and staking out masonry structures. A limited amount of class work and drafting supplementing fieldwork. Allen, *Railroad Curves and Earthwork;* Allen, *Field and Office Tables.*

1·21. ROUTE AND CONSTRUCTION SURVEYS. Continuation of 1·20. Application of curves to location and property lines of railways, highways and other route surveys. Simple, compound, reversed, spiral and vertical (parabolic) curves. Horizontal and vertical control, lines and grades, and quantity surveys of earthwork and masonry for civil engineering construction.

1·24. MUNICIPAL ENGINEERING. Location, design, layout, drainage, construction and maintenance of highways and streets; urban problems of highway traffic control and public transportation; railroad problems in City Planning; and a consideration of airport location, design and operation.

1·26. RAILWAY SIGNALING (B). Interlocking and block signals; and remote, centralized and automatic train control. Development of modern signaling practices with reference to the economics of train operation. Inspections of railway signal installations.

1·271, 1·272. TRANSPORTATION ENGINEERING (B). Transportation by railway, highway, and air with some attention to inland waterways. Subjects in the highway field include traffic surveys and traffic control, highway pavement design, construction methods, characteristics of motor vehicles, cost of highway transportation, and economics of highway design, finance regulation and taxation. Railroad subjects include maintenance of way, signals, motive power and cars, train resistance and tonnage rating, I. C. C. accounting and regula-

Civil and Sanitary Engineering Continued

tion, and economics of location and operation. Coördination of the different forms of inland transportation. Design problems in highway, railway and airport location.

1·28. Highways and Airports (B). Principles and practice in the location, design, construction and maintenance of highways, streets and airports.

1·29. Transportation (B). Transportation by rail, highway and air, with some attention to inland waterways and pipe lines. Physical plant such as tracks, roads, airways, rail and motor terminals and airports; transportation equipment; organization and operational methods; Government regulation; operating costs and bases for rates and fares; economic field of operation and coördination.

1·301, 1·302. Advanced Railway Transportation (A). A continuation of 1·271 and 1·272. Design and operation of locomotive, freight and passenger terminals; use of motor transport; railway economics; public relations and regulation; involving individual investigations and reports.

1·311, 1·312. Advanced Highway Transportation (A). Research results and methods of design, construction, maintenance, operation and economics of highways.

1·32. Airport Design (A). Development of a complete layout for an airport, including selection of site, layout of runways, drainage, runway surface type and thickness, terminal layout, lighting, traffic control and maintenance facilities.

1·35. Soil Mechanics and Foundation Engineering (B). Physical and mechanical properties affecting soil action in engineering problems; coefficients of permeability, capillarity and compressibility and their application in practical problems relative to seepage, uplift, liquefaction and the settlement of buildings located above buried compressible soil strata; shearing strength and bearing capacity and their application in problems relative to stabilities of embankments, cuts, retaining walls, shallow footings and pile foundations. Reading assignments on soil sampling, excavation, cofferdams, caissons, types of piles and types of foundations. Special attention given to pressure distribution on retaining walls and footings; to site investigations and selection of sites; to correlation with the closely related field of engineering geology; and to case studies of a wide range of general foundation problems. Laboratory work covering the important soil tests.

1·351. Soil Mechanics and Foundation Engineering (B). Same material in general as covered in 1·35 but somewhat abbreviated; coördinated with design courses in Building Construction instead of Civil Engineering.

1·361. Soil Mechanics (A). Physical and mechanical properties of soil governing its behavior as an engineering material. Basic soil classifications; laws of permeability, capillarity and seepage, compressibility and consolidation theory followed by settlement analysis of structures founded above compressible soil strata; relationships of stresses, strains, and shearing strengths in cohesive and cohesionless soils; critical densities and the quicksand phenomenon in cohesionless soils. *Mimeographed Notes.*

1·362. Soil Mechanics (A). Modern soil research on the basis of the physical studies of 1·361. Stability of slopes and retaining walls; earth and masonry dams, with reference to stability, seepage, and piping effect; bearing capacity and settlement of foundations; piles and pile groups; frost action; and special types of foundations. *Mimeographed Notes.*

1·37. Soil Mechanics Laboratory (A). Technique of soil testing, including measurements of specific gravity, water content, density and limits of consistency; mechanical analyses; permeability, consolidation and shear tests; various special tests.

1·38. Soil Engineering Special Studies (A). Assigned reading, special lectures and conferences covering advanced studies of either theoretical or practical nature in various phases of soil engineering. Material varying with the theoretical background and the special interests of individual students or small groups of students.

1·40. Structures. Outer forces, reactions, moments and shears for fixed and moving loads, the use of influence lines, the design of steel and wooden beams, plate girders, the analysis of continuous beams by the use of the Equation of Three Moments, and Graphic Statics. Spofford, *Theory of Structures.*

1·401. Structures. Abridgement of 1·40. Spofford, *Theory of Structures.*

1·41, 1·42. Structures (B). Continuation of 1·40. Analysis of the more common structures of wood, steel, and masonry, principally by algebraic methods. First term: statically determinate trusses of various forms including simple end supported trusses, three-hinged arches, cantilevers, bracing, towers, and space frames; also statically indeterminate structures of certain types by approximate methods, such as, building frames under horizontal loading, trusses with multiple web systems, and portal frames. Second term: determination of deflections of structures by methods of moment areas, elastic loads, virtual work and Williot diagram. Methods of solution for stresses in statically indeterminate structures by virtual work, least work, slope deflection, and moment distribution. Continuous beams, trusses, building frames and arches.

1·43. Reinforced Concrete Design. Elementary principles involved in the determination of stresses in beams and columns. Design of reinforced concrete buildings of various types and other structures as governed by current specifications.

1·441. Bridge Design (B). Relation of the theory of structures to engineering practice through the preparation of designs and drawings for a riveted plate girder railway bridge, and a steel truss highway bridge. Development of careful, systematic and practical habits of computation.

1·442. Structural Design (B). An extension of 1·441 including the design of a welded girder bridge, a wooden roof truss, a reinforced concrete highway bridge, a reinforced concrete retaining wall, and a steel truss continuous over two spans. Analysis for a reinforced concrete arch.

1·443. Structural Design (B). Abbreviation of 1·441 and 1·442 with emphasis on truss design. Problems, including the design of a wooden roof truss and of a steel truss highway bridge.

1·521, 1·522. Structural Laboratory (A). Lectures, conferences, assigned reading and laboratory work, covering the theory and practice of structural analysis by the use of models. Discussion of the fundamentals of the entire field, with later work in fields of special interest to individual students. Time arranged to suit these individual requirements.

1·541, 1·542. Advanced Reinforced Concrete Design (A). First term: advanced treatment of 1·43 designed for graduate students from other colleges having some training in this field. Complete design for an interior bay of typical factory buildings, illustrating design of floors of various types, columns, footings, etc. and with the application of methods of analysis as applied to continuous structures. Second term: continuation of 1·541, dealing with more difficult types of concrete structures, such as the rigid frame bridge, domes, tanks and similar structures.

1·551, 1·552. Advanced Structural Design (A). Problems met by the designing engineer, such as choice of type, economics, design, erection methods, with special reference to indeterminate structures, such as high buildings, arches, suspension bridges, and continuous trusses.

1·561, 1·562. Advanced Structural Theory (A). Basic theorems underlying the analysis of statically indeterminate structures, and the methods of applying these theorems in the analysis of such structures, computation of deflections by various methods, secondary stress analysis.

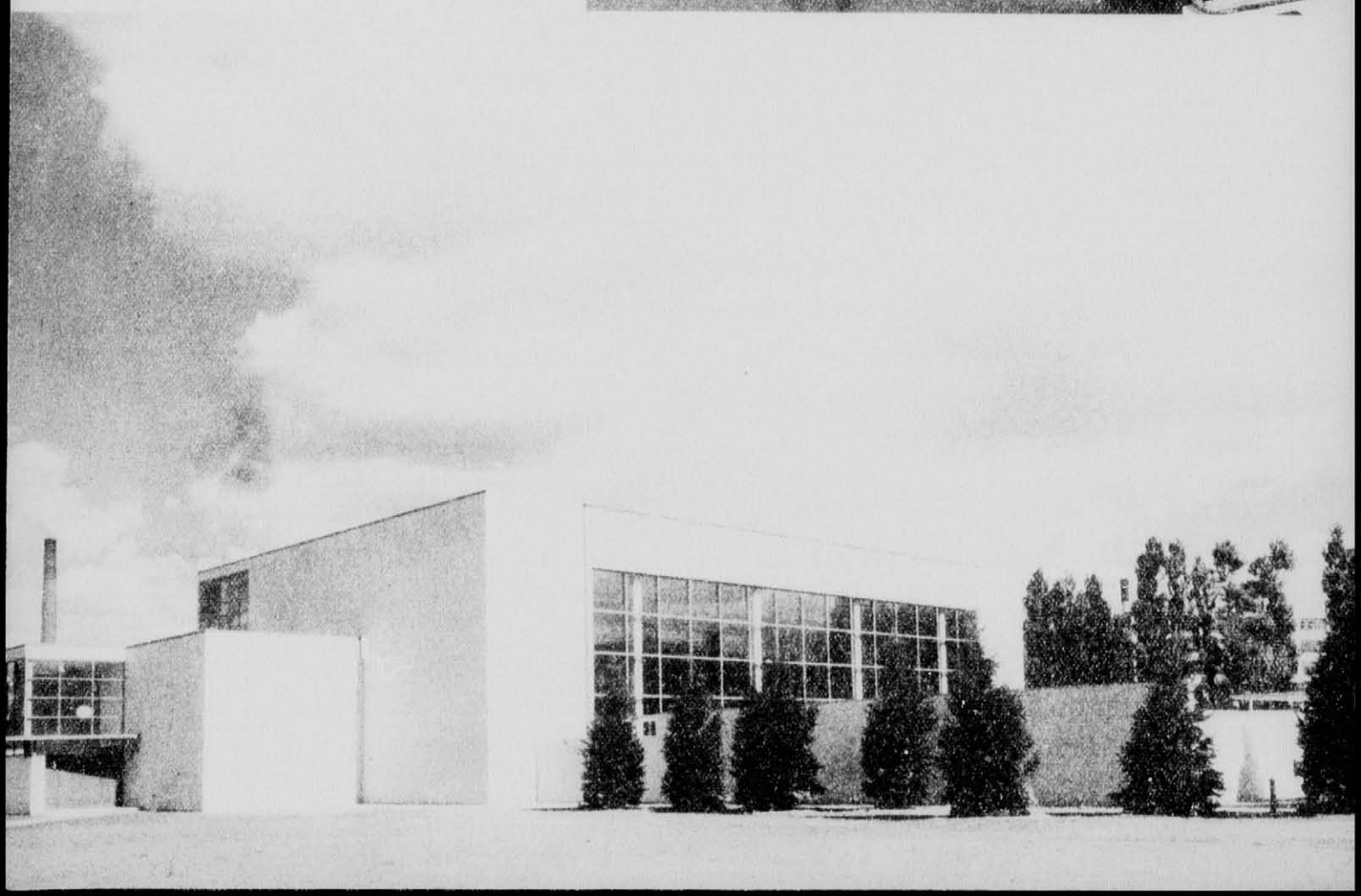
1·571, 1·572. Statically Indeterminate Structures (A). A detailed study of indeterminate structures of certain types such as continuous and suspension-bridges, high building frames, arches, arched dams.

1·61. Fluid Mechanics. Mechanics of compressible and incompressible fluids. Emphasis on viscosity effects, Bernoulli's theorem, the force-momentum principle, laws of

SWIMMING

THE SPLENDID ALUMNI POOL, COMPLETED IN 1940, IS ONE OF THE BEST APPOINTED IN THE EAST. THE BUILDING HOUSES A STANDARD INTERCOLLEGIATE SIX-LANE SWIMMING POOL AS WELL AS A SMALLER PRACTICE POOL. A HUGE WINDOW EXTENDING ACROSS THE ENTIRE SOUTH WALL GIVES UPON A WALLED GARDEN AND SUNNING AREA.







SAILING

ONE OF THE MOST POPULAR RECREATIONS AT TECHNOLOGY IS SAILING ON THE CHARLES RIVER. THE SAILING PAVILION, LOCATED ON THE RIVER DIRECTLY IN FRONT OF WALKER MEMORIAL, HOUSES A LARGE FLEET OF TECHNOLOGY-DESIGNED DINGHIES AS WELL AS A NUMBER OF THE LARGER AND FASTER "110'S." THE NAUTICAL ASSOCIATION DIRECTS ALL SAILING ACTIVITIES, AND EVERY STUDENT IS ELIGIBLE TO PARTICIPATE.



Civil and Sanitary Engineering Continued

similarity and dimensional analysis. Statics, kinetics and dynamics, and application of basic principles to the flow of fluids through orifices, tubes, nozzles, and measuring devices.

1·62. Fluid Mechanics. Continuation of 1·61 with emphasis on the flow of water. Flow in pipes and open channels, dynamics of immersed bodies, and the theory and operation of hydraulic turbines and centrifugal pumps.

1·63. Hydraulics. Essentially the same as 1·62, omitting turbines and pumps, and abbreviating the treatment of pipeflow and open channels. Russell, *Hydraulics, Fifth Edition.*

1·64. Hydraulics. Essentially the same as 1·62 but abbreviating the treatment of pipeflow and open channels. Russell, *Hydraulics, Fifth Edition.*

1·66. Advanced Hydraulics (A). Studies in the advanced field of theory and practice. General fluid flow in pipes; open channels with special reference to non-uniform flow, alternate stages, critical stage, surface curves, hydraulic pump, transitions and wave formations. Russell, *Hydraulics, Fifth Edition; Professional Papers.*

1·67. Design of Harbor Works (A). Study of tides, currents, wave action, methods of shore protection, layout of channels and anchorage basins, size of ships; methods of making soundings, borings, pile driving, pile tests, wharf construction, dredging, land reclamation and other waterfront construction; design of wharves, bulkheads and similar structures; methods and equipment for cargo handling; study of preservative treatment of timber. Field trips including inspection of Boston Port facilities and waterfront construction. (Not offered 1946–47.)

1·681. Theory of Models (A). Principle of dimensiona analysis and application to many problems, theory of models as applied to conditions of dynamic similarity when terrestrial gravitation, universal gravitation, viscosity, capillarity and elasticity are the physical forces acting. Numerous model studies illustrating the work covered.

1·682. River Hydraulic Laboratory (A). Instruction in the construction of models for river hydraulic experiments, method of making such experiments, and interpretation of the results.

1·69. River Engineering (A). Hydraulic factors affecting river flow, theory of bed load transportation, and means of improving rivers with respect to navigation and flood control. (Not offered 1946–47.)

1·70. Hydrology and Flood Control (B). Basic theory of the occurrence and distribution of water on the surface of the earth including precipitation, run-off, infiltration, water losses and their relations, analysis of stream flow data, and frequency and magnitude of flood flows and the effect of reservoirs in reducing them. Classroom work supplemented by supervised problems of applied hydrology in the drafting room. Barrows, *Water Power Engineering.*

1·701. Hydrology and Flood Control (B). An abridgement of 1·70 including the theory, but omitting the practical application in the drafting room. Barrows, *Water Power Engineering.*

1·71. Water Power Engineering (B). Problems involved in the location, design, construction and economics of hydroelectric developments as a foundation for practice in this field, or for the advanced studies of the graduate year. Estimates of water power from stream flow data, theory and practice of hydraulic turbines, elements of design of dam, waterway and power house, cost and value of water power. Supplemented by drafting room exercises with reports and problems of design. Barrows, *Water Power Engineering.*

1·711. Water Power Engineering (B). An abridgement of 1·71 including the theory but omitting the practical design work in the drafting room. Barrows, *Water Power Engineering.*

1·72. Hydrology and Water Power Engineering (B). Condensation of 1·70 and 1·71 omitting the design problems but including the more important phases of the theory.

1·731, 1·732. Advanced Water Power Engineering (A). Supplemented by 1·741, 1·742. Study and design of the various portions of some water power project at a site where actual data are available from surveys and reports. Other general problems of power development with basic theory and practice. A field trip of several days' duration to examine typical power and storage developments. Barrows, *Water Power Engineering*, Creager and Justin, *Hydroelectric Handbook;* Justin and Mervine, *Power Supply Economics.*

1·741, 1·742. Advanced Water Power Design (A). (For description see Advanced Water Power Engineering 1·731, 1·732.)

1·75. Water Supply and Purification (B). Principles of water supply engineering including rainfall and runoff, water consumption, surface and ground water supplies, dams and impounding reservoirs, supply and distribution works, principles of water treatment and design. Investigations, computations, and an engineering report on the preliminary design of a gravity water supply for a small community; also group inspections of nearby water works construction and water treatment works operation.

1·76. Sewerage and Sewage Treatment (B). Principles of design of sanitary and storm water sewers, methods of estimating sewage quantities and storm water runoff, procedures for the design and construction of sewerage systems, principles of sewage and industrial waste treatment and design and construction of sewage treatment works. Design of sanitary sewers for new areas, relief sewers and an intercepting sewer for a small community followed by the design of storm water sewers for a small area; also group inspections of nearby sewage works.

1·77. Water Supply and Sewerage (B). Water consumption, water sources and their development, including wells, dams, reservoirs, supply and distribution mains; procedures for estimating sewage quantities, principles of sewerage design and construction; principles of water and sewage treatment and the design and construction of water and sewage treatment works. Development of design project, including water mains, sanitary and storm sewers for a small community.

1·771. Sanitation. Survey of public and individual water supply and purification methods; uses of water in buildings, cooking, washing, bathing, swimming, waste disposal, and fire protection; elementary hydraulics as applied to plumbing fixtures and supply, waste, and vent piping; public and individual methods of sewage disposal and treatment. Surface and ground water drainage problems. Health aspects of water supply, of sewage and refuse disposal, of heating and ventilation, of housing and of food supplies. Also, insects and rodents in relation to health.

1·78. Sanitary Analysis. Laboratory problems in the analysis of water and sewage and study of chemicals used in water and sewage treatment. Laboratory exercises giving the student an elementary knowledge of certain basic bacteriological and chemical principles involved in water purification and sewage disposal.

1·79. Sanitary Engineering Design (B). Engineering investigation and report covering the design of a water supply system for a small city, including pumping station, long force main, elevated storage and distribution network; and the design of an outfall sewer, sewage pumping station and treatment works for a small community.

1·811. Advanced Sanitary Engineering (A). Principles of modern water treatment engineering, including coagulation, sedimentation, filtration, sterilization, softening, corrosion, and removal of tastes and odors. Also group inspection of nearby treatment works.

1·812. Advanced Sanitary Engineering (A). Principles of modern sewage treatment engineering, including screening, grit removal, sedimentation, removal of colloids and stabilization by contact surfaces and by aeration with activated sludge, chlorination of sewage, digestion, treatment and disposal of sludge, and collection and utilization of gas. Also group inspection of nearby sewage works.

1·821, 1·822. Sanitary Engineering Laboratory (A). Lectures, conferences, assigned readings, and laboratory studies of water, sewage and industrial wastes and treatment processes.

Civil and Sanitary Engineering Continued

1·831. Sanitary Chemistry (B). Lectures, demonstration and laboratory exercises dealing with chemical principles, analyses and control tests involved in purification of water and treatment of sewage and industrial wastes. Discussion of the applications, limitations and interpretation of the tests as used in practice.

1·832. Advanced Sanitary Chemistry (A). Fundamental physical and chemical changes involved in natural purification and in treatment of water and sewage as affected by physical, chemical and biological forces. Exercises in advanced analytical procedures, including instrumental analysis and presentation of seminar topics.

1·84. Bacteriological Examination of Water and Sewage (B). Bacteriology with particular application to the bacteriological examination of waters and sewages and its interpretation. Laboratory procedures including the cultural, microscopical and biochemical methods employed in studying and identifying bacteria with particular reference to water, sewage and sanitation.

1·85. Advanced Sanitary Bacteriology (A). Problems of bacteriology in relation to environmental sanitation; including the atmosphere, the soil, shellfish, swimming pools and bathing beaches, milk and dairy products, water and sewage, with particular attention to the indices of pollution, their use and interpretation.

1·8 Principles of Sanitary Science (A). Lectures and discussions dealing with sources of infection, modes of spread, principles of immunity, antibiotic agents, and the relationship water, sewage, milk, food, insects and rodents to the spread disease. Sanitary problems such as rural sanitation; the sanitation of swimming pools and bathing beaches; summer camps and other overnight camps; street cleaning; refuse collection and disposal; food sanitation; the sanitation of eating and drinking establishments; housing; the atmosphere in relation to health and comfort; school sanitation; industrial sanitation.

1·871. Public Health Administrative Practice (A). Lectures, discussions and problems pertaining to public health administration, epidemiology and vital statistics, including organization and proper functioning of municipal, state and federal health agencies; the case history of specific epidemics of particular interest to the sanitary engineer; and the use of statistical methods and procedures in the collection, analysis and interpretation of vital statistics.

1·872. Public Health Engineering Fieldwork (A). Field trips under professional guidance and for purposes of study and report of public health engineering activities that are included in the program of municipal, state and federal health agencies. Field trips covering the items enumerated under 1·86.

1·881. Advanced Sanitary Design (A). Design of a modern water treatment plant effecting the proper treatment of a given water for domestic and industrial consumption. Conducted in parallel with 1·811.

1·882. Advanced Sanitary Design (A). Design of a modern sewage treatment plant effecting the proper treatment of a given raw sewage. Conducted in parallel with 1·812.

1·891, 1·892. Sanitary Engineering Seminar (A). Designed to give graduate students experience in the preparation and presentation of technical papers and to afford to the students and members of the staff an opportunity to discuss and exchange ideas on matters of current interest to Sanitary Engineers.

1·91. Professional Problems (B). Methods of setting up engineering problems; interrelation of various phases of an engineering project; written and oral presentation of professional ideas; placement problems; non-professional qualifications; professional ethics and professional societies. Lectures by several members of the faculty and by practicing engineers.

1·92. Engineering Construction (B). Construction of civil engineering works, such as railways, highways, water power, water supply and similar projects, including estimates and reports, contracts and specifications, methods of economic comparison, financing of engineering projects, engineering organization and duties, and construction methods illustrated by typical projects.

MECHANICAL ENGINEERING

Subjects 2·00 to 2·99

2·00. Statics. Review of fundamentals, principle of virtual work. Forces and simple stresses in simple two and three-dimensional frames and trusses in machines and structures. Cables and chains. Friction. Distributed force systems and centers of gravity. Stress and strain in tension and compression. Properties of ductile and brittle metals as determined in tension test. Elementary statically indeterminate problems.

2·001. Statics and Dynamics. For selected students who have had some training in statics and dynamics but whose preparation is not sufficient to cover 2·00 and 2·01.

2·01. Dynamics. Kinematics of particles and mechanisms. Inertia forces, momentum and energy of systems in translation and rotation. Balancing of rigid rotors. Moments and products of inertia of areas and plane masses. Elementary problems in vibration and critical speeds. Elementary problems in plane motion of rigid bodies.

2·011. Statics and Dynamics. Abridgement of 2·00 and 2·01.

2·04. Strength of Materials. Elementary analysis of stress and strain in two dimensions; shear stresses and torsion of circular bars, riveted and welded joints; stress concentration; cases of simple loading of thin rings, cylinders and spheres. Theory of bending including shearing forces and bending moments; distribution of normal and shearing stresses, composite and curved beams, differential equation of the elastic curve, methods for the determination of slopes and deflections Statically indeterminate problems in bending. Combined loading. Column theory. Working stresses. Applications to important engineering problems. Timoshenko and MacCullough, *Elements of Strength of Materials.*

2·046. Strength of Materials and Dynamics. Abridgement of 2·04 and 2·06. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

2·06. Dynamics. Simple problems on free and forced vibrations with damping. Rayleigh's method applied to systems of several degrees of freedom. Momentum and energy of rigid bodies and systems in plane motion. Relative motion. The gyroscope.

2·062. Strength of Materials and Dynamics. Analysis of stress and strain at a point, theories of failure of engineering metals. Beams on elastic foundations, plates and shells. Hardy cross method applied to continuous beams, Castigliano's theorem, method of least work. Problems in plane motion, relative motion, and gyroscopes.

2·07. Dynamics. Vibrations of simple systems, free and forced motion with damping. Vibrations of systems with several degrees of freedom. Plane motion of rigid bodies about a point. Electromechanical analogies. Electromechanical systems.

2·081. Strength of Materials (B). Review of stress and strain at a point in two dimensions, the torsion problem with description of membrane analogy, review of bending, beams on elastic foundations, plates and sheets, curved beams and thick cylinders, strain energy methods, failures of metals under stress, plastic flow, creep, fatigue, influence of stress concentration and working stresses. Miscellaneous applications to problems of industry, such as steam piping, rotating machinery, railroad tracks, turbine buckets, etc.

Mechanical Engineering Continued

2·082. Dynamics (B). Vibrations of simple systems, free and forced motion with damping, nature of damping and internal friction, self-excited motions. Introduction to vibration of systems with several degrees of freedom, normal modes and frequencies, approximate methods. Torsional vibration. Vibration isolation. Vibration dampers. Control problems. Rotation of rigid bodies about a point with applications to gyroscopic problems. Brief review of the historical development of mechanics, with emphasis on the significance of the basic principles. Application to important engineering problems in power and marine engineering, automotive engineering, aeronautics, railroads, etc.

2·10. Ordnance Engineering (B). Lectures and calculations on gun design, including stresses and strains in built-up and wire-wrapped guns; the design of recoil and counter recoil mechanisms.

2·11. Industrial Plant Engineering (B). Soils, foundations, footings (plain and reinforced) and types of superstructures; heating and ventilation, air conditioning, and mechanical equipment of buildings; fire protection methods

2·121. Photoelasticity (B). Use of commercial photoelastic apparatus with applications in the analysis of common engineering problems in two and three dimensions, together with lectures on modern photoelastic theory, materials, and methods.

2·125. Research in Experimental Stress Analysis (A). Opportunity for graduate students to apply photoelasticity to the solution of special problems, or to take part in current development of photoelastic theory and technique.

2·126. Experimental Stress Analysis (B). Introduction to some of the more common experimental methods of analyzing stress distributions. Photoelasticity, brittle lacquers, strain gage techniques and instrumentation, analogies, and X-rays, as applied to problems involving static, dynamic, and residual stress distributions.

2·128. Experimental Stress Analysis (B). Similar in content to 2·126, with more time assigned for greater detail in the laboratory exercises.

2·211. Advanced Mechanics I (A). Stress and strain at a point in three dimensions. Introduction to the theory of elasticity with examples of solutions in two dimensions. Development of the strain energy method with applications to beams, curved bars and plates. Survey of the problem of failure of materials under stress, failure theories, fatigue and creep. Applications to important problems in power and marine engineering, aeronautics, railroads, etc. Problems selected with particular emphasis on those aspects which impose limitations on further progress.

2·212. Advanced Mechanics II (A). Review of the variational method applied to mechanics. Development of the foundations of dynamics leading to Hamilton's principle and Lagrange's equations. Introduction to the special theory of relativity. Vibrations and stability of systems with many degrees of freedom, normal modes and frequencies; approximate methods. Systems with variable coefficients and nonlinear systems. Gyroscopic effects in mechanical systems. Selected topics of applications to important problems in engineering, such as rotating and reciprocating machinery, turbine and compressor blades, aircraft propellers, helicopters, gyroscopes, etc. Problems selected with particular emphasis on those aspects which impose limitations on further progress.

2·213. Gas Turbines I (A). Coördinated application of fundamental engineering science to the design and development of gas turbines. Review of thermodynamics and fluid mechanics for flow phenomena in turbines and compressors. Review of problems of mechanical strength and vibrations encountered in rotating machinery and blading of turbines, compressors, heat exchangers and combustion chambers. Fundamentals of design of turbines, compressors, heat exchangers and combustion chambers. Operating characteristics of gas turbine power plants including part load performance and control. Special problems encountered in aircraft applications.

2·214. Gas Turbines II (A). Discussion of selected topics of mechanical engineering science related to gas turbines particularly those which now impose limitations on further progress. Review of problems encountered in power plants, marine engineering, locomotives and aircraft, with examples of construction. Design projects undertaken by students as part of the problem material.

2·221. Plasticity (A). Mechanics of the plastic state of materials with particular emphasis on engineering applications. Mohr's representation of stress and strain in both two and three dimensions. Theories of strength in relation to design. Choice of working stresses under combined stress. New developments in stress-reduction in area relations for metals. General laws of plastic flow as applied to torsion, bars under combined stress, rotating discs, the cold working of tubes under internal pressure, etc.

2·222. Advanced Plasticity Problems (A). Continuation of 2·221 with practical applications to a number of modern engineering problems. Bending, deflection, and buckling of bars and tubes in the plastic state. Creep of both metals and non-metals at normal and elevated temperatures. Relaxation of stresses in bolted flanged connections, and in other design applications. Residual stresses as determined from calculation and experiment. Rolling, drawing, shell forming and extrusion of metals. Plastic flow problems in the field of synthetic plastics. Selection of special problems in consultation with the instructor, and some laboratory work.

2·223. Plasticity Research (A). Experimental and theoretical investigations in the general field of the plasticity of engineering materials.

2·231, 2·232. Theory of Elasticity (A). Theory of elasticity presented from the point of view of the needs of mechanical engineering, with emphasis on strain energy methods.

2·251. Fluid Mechanics. Physical properties of fluids, hydrostatics, continuity, Euler's equation, energy, momentum, dimensional analysis. Application to laminar and turbulent flow in pipes.

2·252. Fluid Mechanics. Continuation of 2·251. Potential flow, circulation theory of lift, boundary layers, drag, effects of compressibility, lubrication; hydraulic turbines, pumps, fans, fluid couplings and torque converters, hydraulic displacement transmissions.

2·256. Fluid Mechanics (B). Physical properties of fluids, hydrostatics, kinematics and continuity, dynamics of ideal and of viscous fluids, dimensional analysis and physical similarity, potential flow and circulation, flow in pipes, boundary layers, single airfoils, hydraulic machinery, lubrication, heat transfer. (Restricted to selected Army and Naval and Coast Guard Officers only.)

2·257. Fluid Mechanics. Accelerated presentation of principal topics of 2·251 and 2·252 and accepted therefor. For students who have had some fluid mechanics but not sufficient to cover the required subjects.

2·258. Hydraulic Transmission and Control. Review of principles of fluid mechanics and application to basic problems, such as: leakage, flow in pipes, orifices and valves; elasticity of fluid and piping. Current practice in the application of hydraulic pumps and motors, control devices and auxiliaries. Analysis of typical hydraulic circuits. (Restricted to selected U. S. Naval Officers only.)

2·261. Lubrication and Friction (B). Presented in two parts: (*a*) Hydromatic lubrication, covering the Petroff and Sommerfield equations and criteria for load capacity; factors for side leakage; and heat balance in a bearing; (*b*) discussion of the critical and well-established experiments on the mechanism of dry friction and its reduction by boundary lubrication and proper design. Discussion of the effect of the constitution of the lubricant and the nature of the bearing surfaces on the load capacity.

2·262. Research in Lubrication (A). Opportunity for the student to select a research problem which may be independent of or closely related to the program in progress in the Lubrication Laboratory; the field including lubrication proper, bearing design, surface finish, and fundamental studies of mechanism of friction from both the experimental and theoretical standpoints.

Mechanical Engineering Continued

2·271. Hydromechanics (A). Equations of motion of ideal fluid, vortex motion, potential flow, circulation, two-dimensional airfoil, Navier-Stokes equation, stability of laminar flow, turbulence, two-dimensional compressible flow.

2·30. Engineering Materials. Manufacture, processing, properties and uses of the common engineering materials. Manufacture of iron and steel, and the important non-ferrous metals and alloys; processing of metals as in casting, hot and cold working heat treatment, and welding; effects of composition and structure on the processing and properties of metals; corrosion resistance and protection of metals; properties and uses of the important non-metallic materials such as plastics, wood and wood products, concrete, rubber, glass, refractories, paints and other protective coatings. Emphasis on developing a working knowledge of the properties of materials and their selection for engineering applications.

2·301. Engineering Materials. Part of 2·30, comprising a study of hot and cold working processes, heat treatment, and welding.

2·302. Engineering Metals. A transition course for students who have previously taken 2·30 and 2·31 only, but require additional work in welding to satisfy the requirements for credit in materials.

2·31. Engineering Metals (B). Processing, properties, and uses of the common engineering metals and alloys. Effects of the various processing operations on the properties of metals and the selection of the method of manufacture for metal parts. Metals studied: cast iron; carbon and alloy steels; copper, aluminum, magnesium, and their alloys; and other important non-ferrous metals and alloys. Foundry melting and alloying, including cupola operation; foundry sand control; sand, permanent mold, dies, precision, and centrifugal casting; hammer, press, and drop forging; rolling; extrusion; wire, rod, and tube drawing; spinning; press operations, such as deep drawing; shearing, bending, and coining; heat treatment processes including annealing, hardening, tempering, carburizing, nitriding, flame and induction hardening, and aging; arc, gas, and resistance welding; brazing; oxygen cutting; and hard surfacing.

2·32. Engineering Metals (B). Continuation of 2·31, covering in more detail some of the important aspects of the metal processing operations and their effect on the metallurgical and mechanical properties of metals. Recent developments in this field and application of our present knowledge of the behavior of metals to the solution of problems in the foundry, metal working, and welding industries.

2·322. Engineering Metals (B). Similar to 2·32. Students attend lectures in 2·32, but have additional time for carrying on related experimental work in the metal processing laboratories.

2·33. Metal Processing (B). Casting, hot and cold working, and welding of metals. Foundry melting and alloying including cupola operation; foundry sand control; sand, permanent mold, die, precision, and centrifugal casting; hammer, press and drop forging; rolling; extrusion; wire, rod and tube drawing; spinning; press operations such as deep drawing, shearing, bending, and coining; arc, gas, and resistance welding; brazing; oxygen cutting; and hard surfacing.

2·34. Mechanical Properties of Metals (B). Mechanical properties of metals and their interpretation and use in design; including strength, ductility, hardness, impact, fatigue, creep, and wear. Application of test data to industrial problems. Battelle Memorial Inst., *The Prevention of Failures of Metals Under Repeated Stress.*

2·351, 2·352. Dynamic Strength of Metals (A). Dynamic properties of metals and their interpretation and use in design. Failure of metals by impact and fatigue. Influence of size, speed, stress concentration, corrosion, surface finish, surface treatment, etc. Effect of mean stress and residual stress. Application to design problems in automotive, aircraft, railroad, and marine engineering.

2·37. Testing Materials Laboratory. Laboratory methods for the determination of the physical properties of engineering materials and their behavior under stress. Usual methods supplemented by study of true stress-strain for plastic action, stress analysis through strain study and by photoelastic analysis. Tests at abnormal temperatures, Magnaflux and Zyglo inspection, special hardness tests, fabrics testing, X-ray examination and research problems included in the lecture material. Cowdrey and Adams, *Materials Testing.*

2·371. Testing Materials Laboratory. Methods of making physical tests to determine the properties of the more common engineering materials and a study of their behavior under stress. Cowdrey and Adams, *Materials Testing.*

2·373. Testing Materials Laboratory. Same as 2·371, and in addition a three-hour period per week devoted to the study of cement and concrete.

2·40. Heat Engineering. First Law of Thermodynamics and internal energy. Properties of liquids, vapors, and gases. Second Law of Thermodynamics, the temperature scale and entropy. Applications to closed systems and to fluids in steady flow. Steady-state heat transfer through resistances in series and between flowing streams. Keenan, *Thermodynamics;* Keenan and Keyes, *Steam Tables, Air Tables.*

2·401. Heat Engineering. For students who have taken heat engineering but whose preparation is not sufficient to cover 2·40 and 2·42.

2·402. Heat Engineering. Same as 2·40 with, in addition, applications to engines and turbines and laboratory exercises in heat engineering. Keenan, *Thermodynamics;* Keenan and Keyes, *Steam Tables.* (Restricted to selected Officers of the U. S. Navy and Coast Guard only.)

2·41. Heat Engineering. Brief study of the fundamental laws and conceptions of engineering thermodynamics; physical properties of gases, saturated and superheated vapors and their application to thermodynamic problems including the use of steam tables and charts; laws governing the flow of gases and vapors and their use in heat engineering; elementary steam turbine theory and practice; theoretical vapor cycles; the reciprocating steam engine; theoretical gas cycles and the internal combustion engine; theory and practice of gas compression; steam boilers, accessories and the elementary principles of combustion. Brief discussion of the principles of refrigeration, heat transmission and humidity problems; also the principal apparatus and machines involved.

2·42. Heat Engineering. Reciprocating steam engines and turbines, power-plant cycles, the air standard cycle of the internal combustion engine, gas mixtures and internal combustion engines, mixtures of air and water vapor, and an introduction to the thermodynamics of chemistry. Keenan, *Thermodynamics;* Keenan and Keyes, *Steam Tables, Air Tables.*

2·422. Heat Engineering. Heat-engine cycles, mixtures of gases and vapors, introduction to the thermodynamics of chemistry, refrigeration, heat and power from combustion, gas-turbine processes. Keenan, *Thermodynamics;* Keenan and Keyes, *Steam Tables, Air Tables.* (Restricted to selected Officers of the U. S. Navy and Coast Guard only.)

2·43. Heat Engineering (B). Heat transfer by conduction, convection and radiation with applications to design. Refrigeration cycles and reciprocating compressors. McAdams, *Heat Transmission;* Keenan, *Thermodynamics.*

2·44. Heat Engineering (B). Availability with applications to closed systems and to steady flow. Applications of first and second laws to reactions and solutions. Introduction to thermodynamics of mixtures. Pressure-volume-temperature relations for pure substances and mixtures. Phase diagrams for mixtures. Mass transfer by diffusion and turbulence. Keenan, *Thermodynamics.*

2·45. Advanced Engineering Thermodynamics (A). First and second laws of thermodynamics, their application to fixed mass and flow processes and to the determination of the properties of fluids. Introduction to the thermodynamics of solutions and chemical reactions and study of the equilibrium of a pure substance. Keenan, *Thermodynamics.*

2·47. Steam Turbine Engineering (B). Thermodynamics, and mechanics applied to problems in steam turbine engineering.

Mechanical Engineering Continued

2·48. Gas Turbine Engineering (B). Comparative study of gas turbine processes. Design of the flow path for compressor and turbine. Design of regenerator.

2·482. Gas Turbine Engineering (B). Same as 2·48 with laboratory and special problems added.

2·491, 2·492. Flow of Compressible Fluids(A). One-dimensional treatment, with effects of area change, friction, and heat transfer. Normal compression shocks. Method of small perturbations for subsonic and supersonic flow. Supersonic flow around a corner. Oblique compression shocks. Method of characteristics. Hodograph method. Iteration and numerical techniques. Experimental methods.

2·50. Heat Measurements. Laboratory exercises in the practice of heat measurements, including various types of temperature measuring instruments, heat of combustion and heat transfer. Lectures on the theory of temperature measurement, heat transfer and heat insulating materials.

2·501. Heat Measurements. Same as 2·50, omitting the lectures.

2·53. Heat Measurements (B). Selected experiments with laboratory investigation of problems connected with the industrial application of heat such as thermal conductivity, thermal expansion, specific heat, ceramics, etc.

2·56. Mechanical Engineering Practice (B). Application of Mechanical Engineering fundamentals to the solution of problems encountered by the Mechanical Engineer, with emphasis on the generation and use of steam for the production of power and in industrial processes.

2·562. Mechanical Engineering Practice (B). Similar to 2·56 with additional time devoted to laboratory or design.

2·57. Advanced Power Plants (A). Modern power plants, including a study of the design and installation of high pressure boiler, economizers, air preheaters, modern fuel burning furnaces and automatic combustion controls. Study of the various steam cycles and types of auxiliary drive to show their effect on station heat balance. Discussion of deaërators, evaporators, condensers, heater, etc., including turbine and machinery foundations and layouts. Lectures and problems supplemented by trips.

2·601, 2·602. Food Engineering. Brief survey of the fundamental principles of thermodynamics with specific application to problems in heat transfer, refrigeration, and air conditioning as they are related to food processing. Discussion of methods, materials, and equipment used in the preparation and handling of foodstuffs including canning, packaging, and bottling equipment. Laboratory work as a supplement to lectures.

2·621. Refrigeration (B). Refrigeration at more than one level. Operation of various types of compressors, evaporators, condensers, and automatic controls used in commercial refrigerating systems. Heat flow problems in condensers and evaporators. Application of refrigeration in the manufacture of dry ice.

2·622. Applied Refrigeration (B). Physical properties of low temperature insulants; heat transfer through typical walls of cold storage plants, refrigerator cars, and refrigerator ships; moisture and temperature conditions necessary for the preservation of important foods; brief study of the microbiology of foodstuffs.

2·641. Refrigeration Engineering (A). Study of thermal, physical, and toxic properties of the chief refrigerants. Discussion of the time required to freeze ice and frost formation. Theory and calculation of size of cooling towers. Application of refrigeration to skating rinks, shaft sinking, petroleum, breweries, and the manufacture of ice cream.

2·642. Low Temperature Refrigeration (A). Thermodynamic processes for producing low temperature refrigeration. Problems of heat exchangers, insulation and rectification. Applications of low-level refrigeration to the purification of industrial gases such as oxygen, nitrogen, hydrogen, methane, etc.

2·66. Air Conditioning (B). Study and calculation of load, direct and indirect heating systems, heating boilers and water heaters, ventilation and the fundamentals of air conditioning

2·661. Heating and Ventilation. Thermal balance in the human body in relation to the thermal balance in a surrounding building enclosure. Thermal relationships of the building to climate and weather. Insulation of the building to provide a suitable enclosure. Techniques of heating, heat generation and their control.

2·662. Heating and Ventilation. Continuation of 2·661. Ventilation and its techniques together with discussion of the fundamental problem and techniques of cooling for comfort.

2·671. Air Conditioning, Advanced (A). Psychrometric and comfort data with application to air conditioning problems. Typical air conditioning equipment and controls will be studied with their application to various types of problems.

2·681. Engineering Laboratory. Use and calibration of instruments in mechanical engineering; use of metering devices for air, steam, and water; practice of heat measurements including heat of combustion of fuel and heat transfer; experimental studies involving use of steam engines, steam turbine driven pumps, steam pumps, steam specialties, stationary internal combustion engines, an air blower and a single stage air compressor.

2·682. Engineering Laboratory (B). Continuation of 2·681 with equipment such as the following: an air washer for humidity control, a two-stage air compressor, the M. I. T. power and heating plant, heat exchangers, a hydraulic turbine, and a refrigeration machine.

2·683. Engineering Laboratory. More complete coverage of the work outlined in 2·681.

2·687. Hydraulic Laboratory. Supplement to classroom theory, including exercises upon orifices, nozzles, weirs, pipes, hydraulic turbines, centrifugal pumps, and other hydraulic equipment.

2·693. Refrigeration and Air Conditioning Laboratory. Experimental work involving application and research problems in air conditioning and refrigeration; with equipment including standard condensing units, air washer, heating and cooling coils, constant temperature rooms, and equipment of special design. Facilities available for the use of more than one refrigerant.

2·701. Machine Drawing. Engineering drafting room procedure and technique in the production of working drawings of machinery. James, Mackenzie and Sloane, *Working Drawings of Machinery*.

2·72. Machine Design. Theories of common mechanisms, with their application in design, including wrapping connectors, screws, spur and bevel gears, worm gearing, shafts, bearings, etc.; materials, forms and proportions of parts, friction and efficiencies. (Restricted to selected U. S. Navy and Coast Guard officers only.)

2·730. Machine Design. Lectures and drafting-room exercises covering the kinematic design of the basic mechanisms. An introductory course in machine design by application of the fundamentals of kinematics to geometric design. Sloane *Engineering Kinematics*.

2·731. Machine Design. Design of machine elements with due consideration to the problems involved in operation at high speeds. Design of a simple machine.

2·732. Machine Design (B). Continuation of 2·731. Complete engineering design of a comprehensive machine.

2·751, 2·752. Machine Design (RA). Thorough and rigorous discussion of the many factors involved in the design of complex machines. (Restricted to selected U. S. Naval Officers only.)

2·761. Machine Design (RB). Arranged and adapted to the needs of specialists in torpedo design. (Restricted to selected U. S. Army and Navy Officers only.)

2·78. Design of Hydraulic Machinery (B). Theory and design of displacement type hydraulic machinery and its applications in industry. Discussion of problems in the control of speed, position, torque, and power.

Mechanical Engineering Continued

2·782. Design of Mechanical Systems (B). Discussion and design of mechanical systems involving application of hydraulic, pneumatic, and electronic equipment. Consideration of simple closed cycle control systems. Reduction of machine vibrations. Applications of principle of similitude to machine design problems.

2·783. Control Problems in Mechanical Engineering (A). General theory of automatic regulation. Application to advanced problems in temperature, pressure, flow, speed and position control. Speed and power regulation of prime movers. Studies of the dynamics of industrial processes and mechanical systems. Use of simulative methods in dynamic analysis. Consideration of the elements used in industrial control systems.

2·79. Elementary Internal Combustion Engines (B) Fundamentals of the internal combustion engine, including spark-ignition and compression-ignition cycles. Discussion of combustion, friction, cooling, carburetion, and other factors affecting power, efficiency, and general performance. Selection of the most suitable type of engine for various specific applications.

2·791. Internal Combustion Engines (B). Fundamentals of the internal combustion engine, including capacity, efficiency, thermodynamics and combustion. Taylor and Taylor, *The Internal Combustion Engine.*

2·792. Internal Combustion Engines (B). Continuation of 2·791. Fuels, lubricants, cooling, carburetion, distribution, ignition, friction, and supercharging. Taylor and Taylor, *The Internal Combustion Engine.*

2·794. Internal Combustion Engine Laboratory (B). Laboratory exercises supplementing the classroom work of 2·791 and 2·792. Effects of operating and design variables on engine performance, and use of instruments, with especial emphasis on precision of measurements.

2·7941, 2·7942. Internal Combustion Engine Laboratory (B). Content same as 2.794 but extended over two terms.

2·796. Internal Combustion Engine Design (B). Introduction to engine design, including work in engine dynamics, stresses, materials, and design procedure.

2·797. Internal Combustion Engine Design (A). Fundamental principles of design, laws of similitude, properties of engine materials, design of important elements. Student chooses a particular type of engine-aircraft, automotive or Diesel, and makes preliminary calculations and assembly drawings of important parts.

2·798. Internal Combustion Engine Design (A). Continuation of 2·797. Lectures on detail design of additional parts and of auxiliaries. Calculations and drawings on valve gear, superchargers and auxiliary equipment.

2·799. Automotive Dynamics (A). Balance of automotive engines and vibration problems associated with automotive engines and vehicles. Den Hartog, *Mechanical Vibrations.*

2·801, 2·802. Advanced Internal Combustion Engine Problems (A). Analytical and experimental treatment of special problems in connection with internal combustion engines.

2·805. Diesel Engines (B). Fundamentals of two- and four-stroke Diesel engines, including fuels, fuel injection, combustion, scavenging and supercharging, cooling requirements, design arrangements and materials. Examination of existing types. Compressor-Diesel-gas turbine combinations. Power transmission. Taylor & Taylor, *The Internal Combustion Engine.*

2·851. Machine Tool Laboratory. Use and application of machine tools. Includes laying-out work, filing, scraping, machine parts, drilling, reaming, counterboring and tapping, tool grinding, straight and taper turning, screw cutting, milling, cylindrical and surface grinding and chucking. Special attention to the cutting angles and adjustments of cutting tools and cutting speeds for each material worked. Smith, *Advanced Machine Work.*

2·852. Machine Tool Practice. A continuation of 2·851, including fundamentals of tool making, hardening and tempering, gear cutting, thread milling and generating, planing and shaping, turret lathe and automatic screw machine practice, grinding and lapping, broaching, precision measuring, time study and production manufacturing processes. Smith, *Advanced Machine Work.*

2·871. Manufacturing Engineering (B). Principles and practice in production design, selection of factory equipment, tool and gage design, and inspection methods. Lectures and drawing-room exercises on the manufacturing design of a commodity to be produced in quantity, including the principles of dimensioning detail drawings with tolerances and the preparation of other necessary specifications required to convey precise and complete information for the selection of equipment, tool design, production, and inspection. Study and drawing exercises in tool and fixture design, as well as gages. Buckingham, *Principles of Interchangeable Manufacturing;* Roe and Lytle, *Factory Equipment;* Dowd and Curtis, *Tool Engineering.*

2·872. Preparation for Manufacturing (B). Study of many engineering problems which must be solved before a product can be manufactured in large quantities after the design has been completed: such as engineering organization, estimating costs, design of tools and equipment, quality control, process and product development. Application of measurement to dimensional engineering standards, shop measurements and analysis of measurement. Buckingham, *Production Engineering.*

2·901, 2·902. Principles of Fabric Structure [2·902 (B)]. Discussion of the properties of fibers as related to the properties of yarns and fabrics; properties of yarns as related to fabrics; construction and finishing of fabrics to produce certain desirable characteristics in these materials. Material dealing with principles of woven fabric structure together with the formation of knitted, braided, twisted, and felted materials.

2·903. Elements of Textile Manufacturing. Production and properties of textile raw materials and operations basic to the manufacture of cotton, wool, silk, flax, jute and rayon.

2·904. Principles of Textile Manufacturing (B). Continuation of 2·903 covering the combination of operations such as blending, carding, combing, drafting, twisting, etc., into processes as for cotton, woolen, worsted, spun and thrown filament, and bast fiber materials; involving mill organization studies and plant inspections.

2·905, 2·906. Textile Technical Analysis (A). Physical determinations of strength, stretch, moisture regain, twist and various mechanical properties of interest to the yarn and fabric technician. Formulation and proper presentation of data, precision of measurements, graphical interpretation of data, variable factors which influence textile testing results, and outlining of present trends in textile research in this country and abroad.

2·907, 2·908. Textile Microscopy (A). Application of optical and microscopical equipment to technical analysis of textiles. Lectures and laboratory on the types of equipment, their use and the technique of textile microanalysis for fiber, yarn and fabric. Opportunity for intensive research on projects involving quantitative determinations; development of technique; application of photomicrography, polarized light, fluorescence, swelling technique, etc., to textile microscopy. Schwarz, *Textiles and the Microscope; Library References.*

2·911. Textile Testing Laboratory (A). Opportunity for the student to operate standard textile-testing equipment and obtain practical experience in the field covered by the lectures of 2·905.

2·912. Textile Research Laboratory (A). Studies of the variable factors influencing textile tests with opportunity to carry out one or more individual research problems in the physical or optical analysis of textiles.

Mechanical Engineering Continued

2·913, 2·914. Textile Technology Seminar (A). Opportunity for students and staff members to present critical discussions of important problems in fiber technology, textile analysis and textile microscopy together with reviews of the current literature, and the results of researches in these fields at the Institute.

2·991, 2·992. Mechanical Engineering Seminar (A). Discussion and reports on special topics in mechanical engineering and related fields. Development and test of ability of candidates for the doctorate to digest and summarize an assigned topic within their general field of study, taking an active part in discussion and criticism of such presentation. At least one contribution per term by each registrant. (Open only to students working for the Sc.D. degree.)

METALLURGY

Subjects 3·00 to 3·99

3·01. Non-Ferrous Metallurgy I. Copper, lead and zinc, covering the extraction of the metal from ores and concentrates by pyro-, hydro-, and electrometallurgical methods and the refining of the crude products. The more general application of such fundamental operations as roasting, sintering, smelting, leaching, etc. Closely coördinated with 3·04. Hayward, *Outline of Metallurgical Practice.*

3·02. Non-Ferrous Metallurgy II. Production and refining of aluminum, magnesium, nickel, and other non-ferrous metals, not covered in 3·01. Hayward, *Outline of Metallurgical Practice.* (Not offered 1946–47.)

3·04. Metallurgical Laboratory. Roasting, sintering, smelting and leaching of copper and lead ores, together with refining and desilverizing of copper and lead. Practice in the use of various types of electric furnaces. Production of steel, ferro-alloys, calcium carbide, etc. by electrothermic methods and other pyrometallurgical and electrochemical processes.

3·041. Electric Furnaces (B). Theory and practice of electric furnaces with particular attention to metallurgical applications. (Not offered 1946–47.)

3·05T. General Metallurgy (B). Fuels, refractories, fluxes and slags and their relation to the entire field of process metallurgy. Fundamental principles of roasting, smelting and refining together with charge calculations, thermal balances and materials balances. Hofman, *General Metallurgy;* Hayward, *An Outline of Metallurgical Practice.* (Not offered 1946–47.)

3·06. Advanced Non-Ferrous Metallurgy (A). Smelting and refining of the principal non-ferrous metals discussed in a weekly seminar. Present practice discussed and possible improvements suggested and criticized.

3·07. Metallurgy of Common Metals. For engineering students who do not expect to practice metallurgy as a profession. Iron and steel, copper, lead, zinc, aluminum, antimony, tin and nickel. Sources, methods of extraction, physical properties of metals, principal uses, origin and effect of impurities, refining and industrial alloys. Hayward, *An Outline of Metallurgical Practice.* (Not offered 1946–47.)

3·08. Advanced General Metallurgy (A). Fuels, refractories and the principles of roasting and smelting. Critical analysis of the manner in which these principles are carried out in present practice and suggested improvements.

3·09. Metallurgical Calculations. Stoichiometric aspects of industrial processes in ferrous and non-ferrous metallurgy illustrated by the solution of numerous problems. Butts, *Metallurgical Problems.*

3·10. Metallurgical Plant Visits. One week spent in visiting metallurgical plants in New Jersey and Eastern Pennsylvania. Production of iron and steel, zinc, copper, lead and non-ferrous alloys. Students meet instructor about one week before opening of fall term. For men expecting to register for 3·01 or 3·12. (Not offered 1946–47.)

3·12. Metallurgy: Iron and Steel. Production of wrought iron, pig iron, steel and alloy steels. Design and engineering operations incident to iron and steel manufacture and economic advantages of the various processes. Lectures supplemented by plant visits, covered by reports and seminars.

3·20. Metallurgical Thermodynamics (B). Thermodynamics emphasizing those portions especially useful in metallurgical operation. Free energies of substances at elevated temperatures and activities of metals in solid and liquid alloys, used in interpreting metallurgical phenomena and in determining the feasibility and limitations of metallurgical processes.

3·21. Principles of Steelmaking (A). Reactions in the manufacture of steel, studied from the viewpoint of physical chemistry. Reduction of ore, reactions of liquid iron and steel with slags and gases and the chemical effects of alloys and deoxidizing agents. Influence of melting and refining methods upon the properties of the finished product.

3·30. Metallography. General methods in the study of metals and alloys, construction and interpretation of equilibrium diagrams and relations between the constitution of alloys and their physical properties. The iron-carbon diagram with its application to the heat treatment and the use of steel and cast iron. Laboratory exercises, with microscopic examination of a series of typical non-ferrous and ferrous alloys. Williams and Homerberg, *Principles of Metallography.*

3·31. Physical Metallurgy I. Principles of physical metallurgy, covering such basic subjects as the characteristic properties of metals, solid solutions, intermetallic compounds and aggregates thereof; construction and metallographic interpretation of equilibrium diagrams; plastic deformation and rupture of metals; phenomena of recovery, recrystallization and grain growth; kinetics and mechanism of phase changes in the solid state. Commercial non-ferrous alloys used as a basis of discussion wherever possible.

3·32. Physical Metallurgy II. Constitution, properties, heat treatment, selection and uses of steel, cast iron and other iron-base alloys. Equilibrium diagrams, phase transformations, grain size, hardenability and surface hardening.

3·33. Industrial Physical Metallurgy (B). Lectures and laboratory conferences with applications of metallography to industrial problems. Examination of microstructures of normal and defective commercial alloys. Critical résumé of the fundamentals of modern physical metallurgy essential to the proper interpretation of the microstructures.

3·34, 3·35. Advanced Physical Metallurgy (A). Subjects within the general field of physical metallurgy, such as stable and metastable alloy systems, ternary phase diagrams, diffusion, phase transformations and precipitation phenomena, theories of metal hardening, and the physics of hardenability. Particular attention paid to the more recent publications on these topics.

3·38, 3·39. Advanced Physical Metallurgy. Fundamental properties of metals and alloys with particular reference to materials used in torpedo construction. (Restricted to selected U. S. Naval Officers only.)

3·391, 3·392. Properties of Metals. Metallurgical properties of metals and alloys with reference to materials used in ship construction. The making, microstructure, processing, heat treatment, joining and corrosion resistance of non-ferrous and ferrous alloys. (Restricted to selected U. S. Navy and Coast Guard Officers only.

3·394. Metallurgy. Structure, properties, and applications of non-ferrous metals and alloys Phase diagrams, plastic deformation, recrystallization, heat treatment, corrosion resistance, and other important properties. Brief summary of production methods for the more important non-ferrous metals. Heyer, *Engineering Physical Metallurgy;*

Metallurgy Continued

Williams & Homerberg, *Principles of Metallography.* (Restricted to selected U. S. Naval Officers only.)

3·395. METALLURGY. Structure, properties, and applications of iron, steel, and cast iron. Heat treatment, surface hardening and corrosion and heat resistant properties. Brief review of production of iron and steel. Heyer, *Engineering Physical Metallurgy;* Williams & Homerberg, *Principles of Metallography.* (Restricted to selected U. S. Naval Officers only.)

3·40. CORROSION AND HEAT RESISTING ALLOYS (B). Electrochemical theories of corrosion. Discussion of typical corrosion behavior of engineering materials at high and low temperatures. Industrial techniques, such as electroplating, anodizing, painting, and other surface treatments employed to ameliorate corrosion.

3·41. INDUSTRIAL NON-FERROUS ALLOYS. Mechanical properties, heat treatment, selection and uses of brass, bronze, bearing metals, alloys of aluminum, magnesium and other non-ferrous metals.

3·42. POWDER METALLURGY (B). Physical and chemical methods for the production of metal powders. Pressing and annealing of alloy powder compacts and resulting properties of the finished compact. Problems of adhesion, diffusion, recrystallization and grain growth as they apply to this field. Present industrial applications of powder products.

3·422. POWDER METALLURGY LABORATORY (B). Laboratory work and conferences with powder metallurgy practice and its application to industrial problems.

3·43. CORROSION OF METALS (A). Principles of electrochemistry applied to the corrosion of metals and alloys in aqueous solutions and other corrosive media.

3·44. METALLURGY OF HEAT RESISTANT ALLOYS (A). Study of metal behavior at high temperature as compared to low temperature behavior. Evaluation of test methods for high temperature performance. Close examination of the binary and ternary systems most important in high temperature service. Correlation of the effects of variations in casting, forging and heat treatment on the properties and structural characteristics of these alloys. Quantitative evaluation of the presently known alloys.

3·50. X-RAY METALLOGRAPHY (B). Use of X-rays in the study of metals. Radiographic examination of metal parts, as well as the X-ray diffraction study of atomic and granular structures of metals, and their relations.

3·51. PHYSICS OF METALS (B). Modern theories of the metallic state resulting from a study of the physical properties of metals.

3·52. ADVANCED PHYSICS OF METALS (A). Various problems of the crystalline metallic state and the dependence of physical properties upon structures. Experimental methods of obtaining information in this field. Laboratory work in the form of short research problems.

3·55. PHYSICAL PRINCIPLES OF METALS TREATMENT (B). Mechanical treatment. Elastic and plastic state. Residual stress. Methods of measurement. Application to problems of shaping of metals. Various conditions of heat flow encountered in thermal treatments of metals. Shrinkage, distortion and cracks. Application to general treatment of metals, as in casting, annealing and quenching, and local treatment of metals as in welding, surface hardening, continuous casting, etc.

3·56. SPECIAL PROBLEMS IN PHYSICAL PRINCIPLES OF METALS TREATMENT (B). Laboratory and class work in the form of short research problems related to the subject of course 3·55.

3·60. FERROMAGNETISM (A). Outstanding properties of ferromagnetism materials, their interpretation, and the application of ferromagnetism to the investigation of the physical structure of metals. (Not offered 1946–47.)

3·62, 3·63. SPECIAL PROBLEMS IN METALLURGY (A). Minor investigation in one of the special branches of metallurgy. Open only to graduate students properly qualified in the special field.

3·65. THEORY OF THE SOLID STATE (B). A semi-quantitative presentation of the modern concept of solids with particular reference to metals. Electronic configuration of the elements and the manner in which these ideas can lead to an understanding of binding energies, specific heats, thermal expansion, and the magnetic and electrical properties of metals. (Not offered 1946–47.)

3·70. CERAMICS (B). Introduction to the more advanced ceramic subjects. Selection of ceramic materials, molding, drying and burning, as well as the physical properties of finished products. Commercial processes carried out on a small scale.

3·71. OPTICAL CERAMICS (B). Methods of petrography applied to the study of ceramic products and raw materials, such as clay, cement, glass, porcelain, refractories, etc.

3·73. FUNDAMENTAL CERAMIC PROCESSES (A). Forming, drying and burning of clay articles, such as whitewares, refractories, terra cotta, etc. Principles involved in the manufacture and use of glass, cements and abrasives. Principles of kiln and furnace design with practical examples.

3·74. PHYSICAL PROPERTIES OF CERAMIC PRODUCTS (A). Methods of determining the properties of finished ceramic articles. Influence of manufacturing methods on these properties with effective methods of control.

3·75, 3·76. SPECIAL PROBLEMS IN CERAMICS (A). Advanced work in this field. Time devoted to lectures, conferences, assigned readings, or laboratory work.

3·81. MINERAL DRESSING I. Introduction to the dressing of ores, coals and mineral substances from the unit-process point of view. Emphasis on the principles involved in the severance, separation and aggregation of particulate materials, and on the relationship of these principles to physical and chemical laws and to sound engineering design. Processes including crushing, grinding, screening, classification, gravity concentration, float-and-sink separation, flotation, amalgamation, magnetic separation, thickening, filtration, and sintering. Gaudin, *Principles of Mineral Dressing.*

3·82. MINERAL DRESSING II. The flotation process and its broad applications. Gaudin, *Flotation.*

3·83. MINERAL DRESSING III (B). Crushing and grinding. Fundamentals of size distribution and size reduction of particulate solids.

3·84. MINERAL DRESSING IV (B). Fundamentals of separating particulate solids according to differences in specific gravity.

3·86. QUANTITATIVE MINERAGRAPHY. Mineralogical study of ores and minerals from the point of view of their dressing or subsequent processing. Ores or minerals studied in polished section, thin section, as loose grains or as polished briquettes. Emphasis on quantitative and dimensional aspects of textural and structural relationships.

3·87. ORE TESTING (B). Practice in choosing concentration methods for specific ore samples, in developing laboratory dressing technique, and in preparing reports.

3·88. MINERAL DRESSING PRACTICE (B). Principles of arrangement, location, and operation of mills; mill costs, general economics of dressing operations, typical flowsheets, and fundamentals of design. Richards and Locke, *Textbook of Ore Dressing.* (Not offered 1946–47.)

3·89. MINERAL DRESSING DESIGN (A). A specific problem in mill design, covering the development of the quantitative flowsheet and the drawing up of specifications for, and the general arrangement of the equipment. Taggart, *Handbook of Ore Dressing.*

3·90. ADVANCED MINERAL DRESSING (A). Informal discussion of topics selected according to the needs of the students. Examples of suitable topics: application of fluid mechanics to gravity concentration, of physical chemistry to flotation, of colloid chemistry to flocculation and thickening, of elasticity and plasticity to comminution.

3·901. ADVANCED MINERAL DRESSING LABORATORY (A). Study of an ore, a process, or a machine in the field of mineral dressing.

3·902. ADVANCED MINERAL DRESSING LABORATORY (A). Continuation of 3·901.

ARCHITECTURE AND PLANNING

SUBJECTS 4·00 TO 4·99

4·031, 4·032. VISUAL FUNDAMENTALS. The structure of two dimensional picture surfaces. The elements: point, line, shape, value, form, texture. Their organization: balance, dynamic equilibrium, tension, rhythm, proportion, etc. Experimentation with graphic tools in order to become acquainted with their potentialities.

4·041, 4·042. LIGHT AND COLOR. Research in the organization of light and color in two and three dimensions. Studies in light modulation with cameraless photography, light modulators, light and shadow boxes. Space organization with light.

4·051, 4·052. GRAPHIC PRESENTATION (B). Lettering, typographical layout, photomontage, collage, charts, diagrams, posters, etc. PHOTOGRAPHY. The study of light as a creative medium; photographic observation of surfaces, textures and structures. Documentation of subjects relevant to students of architecture.

4·053, 4·054. PAINTING (A). Where the student has the opportunity to test his ability to express himself. DISPLAY, EXHIBITION AND STAGE TECHNIQUE. Utilization of the previous studies of light, color, and graphic expression in three dimensional relationships.

4·07. SHOP. Working experience with commonly used materials to develop familiarity with their qualities and the influence of these qualities on their application in design. Use of hand and power tools to inculcate techniques required in future subjects for making quick and accurate architectural models or full-scale furniture designs.

4·10. ARCHITECTURAL ILLUMINATION. Solution of small problems in architectural design chosen to illustrate the influence of illumination requirements on architectural form. Collaborative work with professional students of architecture on advanced problems involving illumination in buildings.

4·41. FINE ARTS. Illustration and analysis of typical artistic productions, to stimulate the habit of observation, and to make the student sensitive and discriminating in his artistic preferences. Sufficient history to place significant periods and masters. Classwork in common for all; outside work specialized, as students prefer, in any of the fine arts. Demonstration in the Graphic Arts, and practice for students desiring it.

4·451, 4·452. HISTORY OF ARCHITECTURE. Illustrated lectures comprising a general survey of the Architecture of all periods, supplemented by reference reading, theme writing, and conferences.

4·461, 4·462. EUROPEAN CIVILIZATION AND ART (B). History of culture, mainly that of Europe. The main currents of science and philosophy, with emphasis upon literature, sculpture and painting. Lectures, readings, and reports.

4·50. OFFICE PRACTICE. Work in the office of a planning commission. Problems in design or research having a definite relation to the activities of the planning commission concerned, with supervision at regular intervals by an instructor.

4·52. OFFICE PRACTICE (A). Office practice in the office of a city or regional planning agency, the work required in research or design being of an advanced nature.

4·541, 4·542. HOUSING SEMINAR (A). Open only to a limited number of mature students, and not given if there are less than five registrants. General introductory evaluation of the housing problem; intensive critique of concepts and relationships in housing from social, technical, economic, and administrative points of view; historical survey beginning with the 1914 legislation in Europe, with special critical attention directed to contemporary solutions in Europe and the United States; consideration of present social and economic trends and their future implications to housing. Fortnightly exercises, each student presenting a portion of the subject selected for that exercise, his presentation being based upon extensive reading offered by a large bibliography. Oral presentations supplemented in all cases by written reports. Serious library work.

4·59. GOVERNMENT AND PUBLIC ADMINISTRATION. Structure of local and state governments; powers and duties of local authorities; general survey of the field of public administration, including the relationship of administrative agencies to the legislative and judicial branches of government; general principles of municipal finance; long-term programming and financing of public works.

4·60. PLANNING LEGISLATION AND ADMINISTRATION (B). Survey of past and present legislation relating to city planning and housing; general powers and duties of local authorities; typical acts relating to planning and housing in the United States and abroad; modern tendencies in legislation; other legal aspects of planning, such as zoning laws, building codes, private deed restrictions, etc. Administrative problems of planning commissions and zoning boards of appeal; organization and administration of planning projects in state, county, region, and city; securing citizen and official interest and sanction.

4·62. SITE PLANNING AND CONSTRUCTION. Primarily for students in City Planning, including problems in site planning with emphasis on the relations to physical conditions, landscape construction, and costs. Use of contour maps, layout of roads, pedestrian circulation, grouping of buildings, surface and subsurface drainage, utilities, community services, efficiency of land use, details of construction and costs of management (public and private). Major portion of the subject devoted to preparation of site and utility plans for a specific project.

4·621. SITE PLANNING AND CONSTRUCTION (B). Contains all of the subject matter of 4·62, presented primarily for advanced students in Architecture.

4·641. PRINCIPLES OF CITY PLANNING. Historical background of the modern city planning movement, presented in a series of lectures. Evolution of the modern city and relation of architecture and engineering to problems of city development and civic design, concluding with a discussion of fundamental principles of city and regional planning. Thomas Adams, *Outline of Town and City Planning.*

4·651, 4·652. THEORY AND PRACTICE OF CITY PLANNING. Advanced problems of city and regional planning, together with modern methods of dealing with them. Collateral reading, written reports, and round table discussions.

4·661, 4·662. CITY PLANNING RESEARCH (A). Selected topics in the field of city and regional planning. Supervised study, with conferences, readings, and reports but without lecture hours.

4·681. CITY AND REGIONAL PLANNING. Practical application of city and regional planning theory to towns, cities, and regions, including problems of replanning and redevelopment in existing communities. Individual problems, supplemented by group projects worked out in collaboration, and preliminary and final reports.

4·682. CITY AND REGIONAL PLANNING. Continuation of 4·681.

4·683. CITY AND REGIONAL PLANNING (B). Continuation of 4·682.

4·691. ADVANCED CITY AND REGIONAL PLANNING (A). Continuation of 4·683.

4·692. ADVANCED CITY AND REGIONAL PLANNING (A). Continuation of 4·691.

4·721, 4·722. ARCHITECTURAL DESIGN. Investigation of requirements and determination of solutions for building problems selected from many fields of human activity (habitation, education, health, recreation, government, religion, industry, merchandising, and transportation). Relationship of buildings to physical and social environment, technique of organizing spaces of different kinds in relation to each other, climate and orientation, and selection of appropriate materials and construction. Individual and collaborative work.

4·731, 4·732. ARCHITECTURAL DESIGN. Continuation of the planning studies initiated in the previous year. At least one problem in each term carried to an advanced stage of analysis to give facility in the adaptation of a building to its

Architecture and Planning Continued

site, to apply structural methods and calculations, and to investigate typical details such as windows, copings, stairways. Numerous short problems emphasizing methods of dealing with specific conditions in planning or the use of materials.

4·741, 4·742. Architectural Design. Consolidation of previous design experience. Problems affording an opportunity to study particular conditions encountered in larger buildings, such as: circulation, control, and safety of crowds, accommodations for vehicles and freight, and the use of elevators, and special equipment. Presentation of one detailed problem in the second term, with studies of structure, assembly of materials, heating and ventilating, sanitation, acoustics, electricity, and illumination.

4·751. Architectural Design (B). Problems emphasizing basic community needs in housing, recreational, commercial, and educational categories, and inviting speculation as to the future possibilities for adequate solutions to these problems. Disposition of groups of buildings on new sites with analysis of economic considerations.

4·761, 4·762. Architectural Design (A). Research, development of program, and design of buildings with particular attention to thorough consideration of social, economic, and technical influences and integration of these factors in the solution of the problem. Site plans, considered in their architectural and engineering aspects; and collaborative projects with graduate students in City Planning.

4·78. Planning Principles. Principles underlying all good planning such as the logical relation to one another of the different parts of a building, the arrangement of proper lighting and circulation, and development of the building envelope.

4·811. Structural Analysis. Methods of analysis in design of elementary architectural structures and application of these methods to a problem in architectural design. Consideration of loads, in the design of simple and continuous beams, columns and details of assembly. Analysis of a simple roof truss. W. H. Lawrence, *Notes on the Analysis and Design of Elementary Structures; Mimeograph Notes.*

4·812. Structural Analysis. Continuation of 4·811 including analysis of building types, design of a steel framing and plate girder. Analysis and design of elementary reinforced concrete floor systems, beams, column, and footings. Application to a problem in design. *Mimeograph Notes.*

4·91. Special Problems in Architectural Acoustics (A). Broad study of functional acoustic design in architecture, based on project work in the fields of impedance and absorption measurement of sound-absorptive materials, full-scale study of sound distribution and diffusion in rooms, and investigation of sound transmission through building structures, conducted in the Acoustics Laboratory.

CHEMISTRY

Subjects 5·00 to 5·99

Inorganic Chemistry

undergraduate subjects

5·00. Entrance Chemistry. Lectures, recitations and laboratory given during the summer to cover the entrance recommendation in chemistry.

5·01, 5·02. General Chemistry. Fundamental principles of chemical science and the chemistry of the more common elements and their important compounds. Latimer and Hildebrand, *Reference Book of Inorganic Chemistry;* Hildebrand, *Principles of Chemistry;* Bray and Latimer, *A Course in General Chemistry.*

5·061, 5·062. Advanced Inorganic Chemistry (B). Physical and chemical properties of the elements and their compounds, presented in a correlative manner. Facts of inorganic chemistry systematized as far as possible with the aid of a comparatively small number of generalizations. Survey of the more important modern theoretical developments in this field, especially the structural aspects of inorganic substances. Discussion of the results of recent experimental investigations, wherever pertinent, throughout the course.

graduate subjects

5·071, 5·072. Special Topics in Inorganic Chemistry (A). Selected subjects, varying from year to year, presented by the members of the class and the staff, followed by a general discussion by the group. Subjects chosen from current fields of inorganic investigation, and expected to be of sufficiently wide scope to require a literature search in the preparation of the subject for presentation.

5·08. Advanced Inorganic Laboratory (A). Typical research methods, including such procedures as employment of high vacuum technique, conduct of operations in inert atmospheres and in non-aqueous media, isolation of compounds of the rarer elements, etc. Reference to the original literature required for experimental details.

5·09. Radiochemistry (A). Chemistry of the production, isolation, and identification of radioactive atoms. Introduction to the techniques of preparation and measurement of radio-elements. Applications of these techniques to chemical problems. Laboratory study of special topics including radiochemical analysis, the fission process, and the reactions following nucleogenesis.

Analytical Chemistry

undergraduate subjects

5·10. Qualitative Analysis. Discussion of theories underlying the reactions of qualitative analysis with particular attention to the law of mass action. Practice in writing chemical equations. Laboratory work conducted on a macro scale of a large number of solutions and solids, including alloys, pigments, minerals, slags and miscellaneous commercial products. Preparation for quantitative analysis, correlating and systematizing much of the information already obtained in general inorganic chemistry. Noyes and Swift, *Qualitative Chemical Analysis.*

5·11. Qualitative Analysis. Class-room work essentially the same as that in 5·10, with fewer experiments and analyses performed in the laboratory. Noyes and Swift, *Qualitative Chemical Analysis.*

5·12. Quantitative Analysis. Discussion of principles of volumetric and gravimetric analysis with detailed attention to the solution of stoichiometric problems. Laboratory work consisting of quantitative analysis by volumetric and gravimetric methods of typical natural and commercial products, and covering acidimetry, the permanganate and iodimetric processes, precipitation methods and gravimetric methods. Considerable emphasis on the development of careful laboratory technique. Hamilton and Simpson, *Calculations of Quantitative Chemical Analysis;* Talbot, *Quantitative Chemical Analysis.*

5·13. Quantitative Analysis. Continuation of 5·12. A correlative study of analytical chemistry for the identification and determination of the more common constituents. Analysis of silicates, minerals, ores and alloys including electrolytic and electrometric methods, and when possible, an original study of some special analytical problem. Gas analysis.

5·141. Analytical Chemistry. Instrumental methods of analysis. Chemical applications of the microscope, including microchemical qualitative analysis, spot tests, and identification of crystalline material by the polarizing microscope. Use of the spectrograph, spectrophotometer, polariscope, polarograph, colorimeter, and refractometer.

5·35. Applied Chemistry. Theoretical principles underlying the causes and prevention of corrosion. Critical examina-

Chemistry Continued

tion from the corrosion viewpoint of the composition of numerous industrial alloys and the chemistry of protective coatings such as: paints, varnishes, lacquers and inhibitors, Speller, *Corrosion — Causes and Prevention*.

Organic Chemistry

UNDERGRADUATE SUBJECTS

5·41. Organic Chemistry I. Comprehensive survey of the chemistry of carbon compounds, including study of the basic principles and most important classes of the acyclic, isocyclic and heterocyclic divisions. Emphasis on systematic nomenclature, general synthetic methods, and characteristic reactions, with appropriate attention to practical applications of organic compounds in science and industry.

5·414. Organic Preparations. Fundamental unit processes and techniques of synthetic organic chemistry; experimental study of typical reactions of organic classes.

5·416. Organic Preparations. Examples of synthetic techniques in organic chemistry, and experimental study of typical reactions of organic classes, culminating in a short special synthetic problem.

5·417. Quantitative Organic Analysis. The determination of carbon, hydrogen, nitrogen, halogens, sulfur and certain functional groups by micro methods.

5·42. Organic Chemistry II. Development of the general synthetic and analytical methods of organic chemistry with particular emphasis upon bifunctional and polyfunctional organic compounds and their derivatives, carbohydrates fats, proteins, dyestuffs, pharmaceuticals, etc. Further emphasis on basic principles coupled with substantial amplification and extension of fundamental theories and methods as applied to acyclic, isocyclic and heterocyclic divisions.

5·424, 5·426. Identification of Organic Compounds. Fundamental methods of identification of organic compounds of known structure. Test of acquired proficiency in methods of procedure by rigorous identification of assigned "unknowns," and by execution of a special experimental problem in the field of organic qualitative analysis.

5·428. Organic Chemistry Laboratory. Practice in the fundamental techniques of organic chemistry. Emphasis on synthesis and identification of simple organic compounds, as well as experimental study of the typical reactions of the more important classes of compounds. Primarily for students majoring in biology and biological engineering, and those intending to enter medical school.

5·43. Organic Chemistry III (B). Introduction to the theoretical interpretation of reactivity, reaction mechanisms and molecular structure of organic compounds. Application of theories of electronic structure, resonance, acids and bases, steric hindrance and stereochemistry with emphasis on recent developments.

5·44. Organic Chemistry IV (B). Discussion and evaluation of the general synthetic methods of organic chemistry, in which attention is also given to the isolation and characterization of products of biological significance (antibiotics, sterols, and alkaloids).

GRADUATE SUBJECTS

5·51T. Organic Chemistry: Synthesis, Advanced (A). Survey of organic reactions and the methods by which they are applied to synthetic problems in organic chemistry.

5·52T. Organic Chemistry: Mechanism, Advanced (A). Theory and factors which govern the reactivity of organic compounds. Present state of knowledge of mechanism of reactions. Molecular structure and influence of resonance.

5·53T. Organic Chemistry: Identification, Advanced (A). Systematic methods for the unequivocal identification of organic classes, functional groups, and individual compounds Study of methods of establishment of structure. Modes of differentiation between compounds with closely similar properties.

5·581T. Advanced Organic Laboratory: Methods (A). Theory and practice of laboratory technique, including micromanipulation, fractionation of a drop, vacuum fractionation, molecular distillation, various types of special apparatus, etc.

5·582T. Advanced Organic Laboratory: Identification (A). Laboratory practice in problems of identification, structural determination, and characterization of functional groups.

5·591T, 5·592T. Recent Advances in Organic Chemistry (A). Consideration, in each term, of various topics of current interest and significance in organic chemistry or closely allied fields. Appropriate development of each topic as an independent unit by a short series of lectures by various members of the staff. Different unit topics in each term and year.

Physical Chemistry

UNDERGRADUATE SUBJECTS

5·61. Physical Chemistry I. Atomic weights, elementary thermodynamics, properties of gases, liquids and crystals, ideal solutions, transference and conductance of ionized solutes, thermochemistry, homogeneous equilibrium. Millard, *Physical Chemistry for Colleges*.

5·611. Physical Chemistry Laboratory I. Laboratory coördinated with the topics of 5·61.

5·612. Physical Chemistry Laboratory I. Abridgement of 5·611.

5·62. Physical Chemistry II. Continuation of 5·61. Change of equilibrium with temperature, heterogeneous equilibrium, phase equilibrium, kinetics of chemical reactions, free energy of chemical changes, potentials of electrolytic cells.

5·621. Physical Chemistry Laboratory II. Laboratory coördinated with the topics of 5·62.

5·622. Physical Chemistry Laboratory II. Abridgement of 5·621.

5·63. Introduction to Thermodynamics (B). Fundamental definitions and concepts; first and second laws of thermodynamics with applications to chemical systems, ideal and real gases, ideal and real solutions, partial molal quantities, chemical equilibrium; third law of thermodynamics and applications to chemical systems, free energy calculations. Noyes and Sherrill, *A Course of Study in Chemical Principles*.

5·64. Introduction to Radiation Chemistry (B). Structure of atoms as inferred from results of experiments: deflection of charged particles in electric and magnetic fields, interaction of matter with charged particles or neutral particles of high velocity; emission and absorption of radiation. Discussion of these results and the periodic table in terms of the quantum theory. Transition to the study of molecular structure provided through the concepts presented.

5·65. Kinetics of Chemical Reactions (B). Introduction to kinetic theory of gases with special emphasis on the calculation of collision frequencies; theoretical and experimental aspects of the kinetics of homogeneous reactions in gaseous and liquid systems. Hinshelwood, *Kinetics of Chemical Change*.

5·66. Surface and Colloid Chemistry (B). The structure of surfaces; surface and interfacial tensions, including solid-fluid interfaces; adsorption, and measurements of surface area; rates of heterogeneous reactions; electrokinetic effects; types of colloids, and methods for preparation and purification; methods for studying size, shape and structure of the colloidal particle; applications to natural and synthetic colloidal systems.

GRADUATE SUBJECTS

5·71. Physico-Chemical Experimental Techniques (A). Unit experiments designed to illustrate principles and research techniques in the following fields, among others: production, control, and measurement of pressures, temperatures and temperature differences in various ranges from very low to very high; measurement of mass and volume; determination of physical properties of fluid mixtures; measurements of electromotive force, current, and resistance; determination

Chemistry Continued

of energy, intensity and wave length of radiation; production of and determination of the properties of molecular, ionic and electronic beams. (Not offered 1946–47.)

5·72T. Molecular Spectra and Molecular Structure (A). Experimental and theoretical aspects of molecular spectra; use of spectroscopic data in the solution of structural problems, particularly those of interest to organic chemists.

5·73. Advanced Radiation Chemistry (A). Modern statistical methods for calculating macroscopic properties such as free energy, entropy, and heat capacity require a knowledge of the *microscopic* properties of molecules. These properties such as bond strengths, internuclear distances, atomic angular distribution, nuclear spin, and dissociation energies are derived from spectroscopic data. The mechanics of molecular motion are considered, and with the aid of the quantum theory, the relation of molecular constants to spectroscopic constants is derived. The primary reactions of photochemistry are interpreted in terms of the spectra.

5·74. Statistical Mechanics (A). Introduction to the principles and methods of statistical mechanics, with applications to physico-chemical problems. Thermodynamic properties of ideal gases, real gases, crystalline solids, and liquids. Mayer and Mayer, *Statistical Mechanics.*

5·75, 5·76. Chemical Thermodynamics (A). Development of the general thermodynamic theory from the first and second laws. Application of the theory to homogeneous and heterogeneous systems in which chemical reactions may take place. Gibbs, *Thermodynamics;* mimeographed notes.

5·77. Kinetic Theory (A). Development of the kinetic theory of gases from the modern standpoint with applications to laboratory problems involving gases. Kennard, *Kinetic Theory of Gases.*

5·79. Physical Chemistry of High Polymers (A). Physical and chemical properties of substances of high molecular weight, considered from a fundamental viewpoint. Molecular structure of natural and synthetic high polymers; thermodynamics, kinetics, and mechanism of polymerization reactions; thermodynamic and mechanical properties of polymers and their solutions. Emphasis on general behavior, rather than specific practical applications.

Research

5·90. Special Problems in Chemistry (A). Directed research and study of special chemical problems. For graduate students only.

5·911, 5·912. Journal Meeting in Inorganic Chemistry (A). Discussion of recent publications on topics of interest to the inorganic chemist. Scope of these topics generally somewhat more limited than those given in 5·071 and 5·072, although the report is expected to include a brief review of the field related to the particular paper chosen for discussion.

5·913, 5·914. Journal Meeting in Organic Chemistry (A). Discussion of current journal publications in organic chemistry by graduate students and staff members.

5·931, 5·932. Seminar in Physical Chemistry (A). Discussion of topics of current interest in physical chemistry by staff members and students.

5·941, 5·942. Research Conference in Inorganic Chemistry (A).

5·943, 5·944. Research Conference in Organic Chemistry (A).

Research (A). Research for any of the advanced degrees in inorganic, analytical, organic or physical chemistry.

ELECTRICAL ENGINEERING

Subjects 6·00 to 6·99

6·00T. Principles of Electrical Engineering (Electric Circuits). Limitations of circuit theory; idealizations inherent in symbolic representation by means of circuit elements; steady-state alternating-current theory for linear circuits, including polyphase systems; complex function loci; transient behavior of linear and nonlinear circuits; electric-circuit representation of electromechanically coupled systems. *Electric Circuits*, by Members of the Department Staff.

6·002. Principles of Electrical Engineering. Second half of 6·00T. Transient behavior of linear and non-linear circuits; electromechanically coupled systems.

6·01T. Principles of Electrical Engineering (Magnetic Circuits and Transformers). Properties of magnetic materials; magnetic circuits; transformers for power and communications circuits; transformers in polyphase systems. *Magnetic Circuits and Transformers*, by Members of the Department Staff.

6·02T. Principles of Electrical Engineering (Engineering Electronics). Engineering electronics including the internal phenomena of vacuum and gas tubes, and the analysis of circuits containing such tubes; single-phase and polyphase rectifiers, amplifiers, oscillators, modulators, and demodulators. *Applied Electronics* by Members of the Department Staff.

6·03T. Principles of Electrical Engineering (A-C Rotating Machinery) (B). Polyphase synchronous and induction machines, single-phase alternating-current motors, synchronous converter. Lawrence, *Principles of Alternating Current Machinery, Third Edition.*

6·04. Principles of Electrical Engineering (Electric Power Transmission) (B). General survey of transmission-line problems, calculation of line constants, short-line solutions, skin effect, corona, insulator stresses, hyperbolic-function solution of long-line problems, graphical methods, circle diagrams, transients, system stability, solution of networks. Woodruff, *Principles of Electric Power Transmission, 2d Edition.*

6·05. Principles of Electrical Engineering. Resistance and resistance networks; associated electrical measurements laboratory experiments; orientation lectures, educational films. *Electric Circuits*, by Members of the Department Staff.

6·11T. Principles of Electrical Engineering. Similar to 6·02.

6·16. Electricity. Electricity rate structures and schedules; wires and safe wiring practice; d-c and a-c generators; transformers; electronic devices and rectifiers; d-c and a-c motors; motor control equipment; batteries. This subject treats the foregoing equipment as components of the modern building and the principles involved as the concern of the designer. Applications in heating, ventilating, air-conditioning, lighting, refrigeration, elevators, conveyors, communications, signal systems, protection of person and property, therapeutics and other services to occupants of the buildings are studied as separate or combined devices. Elevators are treated as a traffic problem in vertical transportation.

6·17. Illumination. A study of the design of lighting systems for best seeing. Photometric units and measurements, properties of the eye, characteristics of lamps and luminaires, daylight.

6·18. Fundamentals of Electrical Engineering. Fundamental principles of electric and magnetic circuits and the application of these principles to the theory and performance of direct- and alternating-current machines. Presentation of the basic elements common to the electrical field, illustrated and amplified by association with engineering applications laid out as the first part of a two-term program with electronic and other aspects of electrical engineering considered during

Electrical Engineering Continued

the second term subject. Classroom instruction supplemented by experimental work in the electrical-engineering laboratories. Fitzgerald, *Basic Electrical Engineering.*

6·19. Fundamentals of Electrical Engineering. Continuation of the two-term program begun in 6·18. Electron-tube parameters and equivalent circuits, theory of simple amplifier, oscillator, rectifier, photoelectric-cell, and gas-filled tube circuits, and brief survey of electrical-measurement and -control techniques. Fitzgerald, *Basic Electrical Engineering.*

6 191. Electrical Engineering. Similar to 6·19. (Restricted to selected U. S. Army Officers only.)

6·20. Electronic Control and Measurement (B). Analysis and design principles of electronic devices for control and measurement in engineering, as applied to phototube devices, voltage regulators, water-level controls, spot-welder controls, sensitive wattmeters, voltmeters, ohmmeters, high-speed recording instruments, stroboscopes, flash-photography apparatus, etc. Detailed consideration of the following subjects: grid current and its effect in high-impedance circuits; amplifiers with direct, resistance-capacitance, push-pull and degenerative coupling; methods of frequency conversion to facilitate amplification or measurement; trigger circuits; and negative-resistance oscillators. Emphasis on importance of the nonlinear properties of electron tubes either as limitations or as useful characteristics.

6·202. Electronic Control and Measurement (B). Continuation of 6·20.

6·211. Application of Electricity to Industry (B). Scientific basis for modern applications of electricity in industry. Sources of energy. Analysis of power production in United States. Choice of system. Elements of electrical energy costs. Distribution of energy within the plant. Principles of electric heating, including energy conversion to heat, heat transfer, heating and cooling of metals, resistance heating, arc furnaces, low-frequency and high-frequency induction furnaces.

6·212. Applications of Electricity to Industry (B). Mechanical, thermionic and photo-electric applications. Duty cycles. Operating characteristics of motors. Controller design and application, including types, methods of acceleration and retardation, protective devices. Essentials of connecting motor to load. Principles of moving fluids and solids. Problems in the application of motors, electron tubes and photo-electric cells.

6·213. Industrial Applications of Servomechanisms (B). Presentation of the elements of the dynamics of closed-cycle control systems with emphasis of their application to Industry, illustrated by the treatment of control problems in Aeronautical, Chemical, Electrical, and Mechanical Industries, etc. The procedures for expressing analytically the characteristics of the process and for synthesizing the control to accomplish desired control operations considered quantitatively for a wide range of industrial problems.

6·221, 6·222. Analysis and Control of Power System Measurements (B). Analysis of power system not only from the point of view of power generation, transmission and distribution, but also in respect to measurements, materials and instruments used in determining performance and control. Study of cable circuits, relays, insulation measurements and performance, circuit analysis and grounding systems. Study of energy costs, rates, load characteristics and economic loading.

6·23. Electrical Implementation (B). Principles underlying electrical methods of measurement, operation, and control in problems involving devices, processes, and systems of nonelectrical as well as electrical nature. Comprehensive case studies selected from such topics as dynamic performance of electromechanical systems of moving-conductor, moving-iron, piezoelectric and magneto-strictive types; electrothermal systems; elementary theory of automatic control; switching systems; the design point of view, including use of physical similitude, optimizing of performance, and minimizing of costs. Emphasis upon use of electric-circuit analogies and models.

6·251. Electric Machinery Design (B). Transformers and induction motors. Materials of construction, methods so construction, calculation of electrical characteristics, eddy-current losses in the windings, and influence of various factors of design on manufacture and operation of machines.

6·252. Electric Machinery Design (B). Design of synchronous and direct-current machines. Continuation of 6·251, but also complete within the term.

6·26. Insulators and Semi-Conductors (B). Comprehensive introduction to the field of vacuum, gas, liquid and solid insulation. Interpretation on a molecular basis of the properties of materials. Discussion of the applications of dielectrics in modern electrical equipment.

6·27. Principles of Illuminating Engineering. Introductory and broad survey of the whole field of illuminating engineering. Classroom work, problems, and laboratory investigations dealing with light sources, photometric units and measurements, vision, and lighting design. A foundation for advanced subjects. Moon, *The Scientific Basis of Illuminating Engineering.*

6·271, 6·272. Principles of Illuminating Engineering (B). Detailed treatment of particular phases of the subject matter of 6·27. Calculation of illumination from point sources with symmetric and asymmetric distributions, calculation of illumination from surface sources, the unit sphere method, the contour integral method, applications to daylighting and built-in artificial lighting. Photochemical theory of vision, data on the visual thresholds and application to lighting design. Design of lighting systems, reflectors, and glassware. Moon, *The Scientific Basis of Illuminating Engineering.*

6·281. Principles of Wire Communications (B). Electrical transmission characteristics, as a function of frequency, of long lines with distributed constants in the steady state, distortion and its correction, communications transformers, insertion loss, networks, loading, filters, balancing networks, repeaters and carrier-current systems.

6·291. Principles of Radar (RB). Fundamental principles of radar. Theory of operation and features of radar timing circuits, indicators, r-f systems, transmitters, and receivers. Applications to representative search systems. Related laboratory work. (Restricted to selected U. S. Naval Officers only.)

6·292. Principles and Applications of Radar (RB). Study of representative search and fire control systems, with particular attention to design features. Identification systems. Radar countermeasures. Current trends in radar developments. Related laboratory work. (Restricted to selected U. S. Naval Officers only.)

6·293. Principles and Applications of Radar (R). Introduction to radar. Brief treatment of basic principles followed by a survey of representative airborne systems. Utilization of radar in bombing and gun-directing systems. Related laboratory work. (Restricted to selected U. S. Army or Naval Officers only.)

6·294. Principles and Applications of Radar (RB). (Restricted to selected U. S. Army or Naval Officers only.)

6·295. Principles and Applications of Radar (RA). (Restricted to selected U. S. Naval Officers only.)

6·30. Principles of Electrical Communications. Fundamental principles for the solution of electric circuit problems in the Communications field, including the following topics: Fourier series and Fourier integrals and their use in analysis and synthesis; introduction to network synthesis with emphasis upon the reactive case; equivalent and impedance-transforming networks; effect of small amounts of incidental dissipation; single- and double-tuned circuits and other simple types of coupling networks.

6·311. Principles of Electrical Communications (B). Theory and applications of vacuum tubes and their associated circuits as elements of communications systems. Nonlinear operation of tubes, amplifiers, feedback systems, oscillators, amplitude and frequency modulators, demodulators, converters, and power supplies. Cathode-ray tubes and circuits Brief consideration of typical radio transmitters and receivers.

6·312. Principles of Electrical Communications (B). Detailed studies of various radio communications systems.

Electrical Engineering Continued

Analysis of transmitters and receivers for amplitude and frequency modulation services with reference to design problems. Short-wave transmitters and receivers. Ultrahigh-frequency generators including velocity-modulation devices and magnetrons.

6·313. Shipboard Radio Communication Equipment (RB). Study of selected shipboard radio communication systems. Analysis of transmitters and receivers for amplitude and frequency modulation services in various frequency ranges. Design considerations. Related laboratory work. (Restricted to selected U. S. Naval Officers only.)

6·314. Radio Navigational Systems (RB). Principles of radio direction finders. Radio beacons and blind-landing systems, loran, and radio altimeters. Analysis of representative systems. Current development trends. Related laboratory work. (Restricted to selected U. S. Naval Officers only.)

6·315. Aircraft Electronic Equipment (RB). Representative airborne radio and radar systems. Special military applications of airborne radar. Related laboratory work. (Restricted to selected U. S. Naval Officers only.)

6·321. Principles of Electrical Communications (B). Discussion of the propagation of voltage and current on transmission lines in the sinusoidal steady state; significant features of low- and high-frequency applications; properties of almost lossless lines; impedance transforming properties of lines; transmission line charts; use of lines as coupling networks and as resonators; introduction to the theory of wave filters and corrective networks.

6·322. Principles of Electrical Communications (B). Physical aspects of vector analysis and of Maxwell's field equations; discussion of the problems of electrostatics, magnetostatics, and dynamics to show reasons for introducing concepts of scalar electric and magnetic vector potential functions; retarded potentials; plane waves in dielectrics and conductors; skin effect; the concept of skin depth and the calculation of effective resistance; Poynting's theorems; reflection and refraction of plane waves; propagation of waves along infinite conducting planes; rectangular wave guides; the radiating dipole; the linear antenna; antenna impedance; antenna arrays and radiation patterns.

6·331, 6·332. Electrical Communications Laboratory (B). Study of experimental procedures in communications. Use of modern laboratory instruments. Measurements on vacuum-tube circuits and passive networks at audio and radio frequencies. Microwave components, basic pulse circuits, and sound systems. Correlation of physical behavior and theory of operation.

6·34. Electrical Communications Laboratory (B). Special undergraduate work with vacuum-tube circuits, audio-, radio- and ultrahigh-frequency measurements and acoustics arranged to meet the needs of the individual student. Experience in design, construction, and testing of components of communications systems. Facilities available for a wide variety of experiments dealing with: amplitude- and frequency-modulated transmitters and receivers; radio navigational aids; television systems; pulse circuits; microwave devices; antennas; radar; and acoustics.

6·36. Principles and Applications of Sonar (RB). Fundamental principles of sonar. Transducers, characteristics of underwater sounds, direct listening devices, fathometers, echo ranging devices, mechanical equipment including hoist-train systems, bearing deviation indicators, and sonar test equipment. Current development trends. Representative sonar sets. Related laboratory work. (Restricted to selected U. S. Naval Officers only.)

6·40. Elements of Electrical Engineering. Applications of the general principles of the electric and magnetic circuit and electronics to the generation, distribution and utilization of direct- and alternating-current power. Applications based upon modern industrial problems involving motor drive, illumnation, automatic control, rectification, measurement and communication with continuous attention to the economic justification for each solution. Hudson, *Engineering Electricity, Third Edition.*

6·43. Electrical Engineering. Fundamental theory of direct-current and magnetic circuits magnetic and electric fields. Fundamentals and characteristics of direct-current machinery, with emphasis on the selection of machinery and control equipment as affected by torque requirements and duty cycles imposed by the load. Timbie and Bush, *Principles of Electrical Engineering, Third Edition;* Kloeffler, Brenneman, and Kerchner, *Direct-Current Machinery.* (Restricted to selected U. S. Naval and Coast Guard Officers only.)

6·44. Electrical Engineering. Continuation of 6.43 on direct-current machinery, with experimental work in the Electrical Machinery Laboratory. Fundamental theory of alternating-current circuits, with comprehensive problems illustrating the theory and its applications. Kloeffler, Brenneman, and Kerchner, *Direct-Current Machinery;* Lawrence, *Principles of Alternating Currents, Second Edition; Instructions for Students in Electrical Engineering Laboratories, Eleventh Edition.* (Restricted to selected U. S. Naval and Coast Guard Officers only.)

6·45. Electrical Engineering (RB). Theory and characteristics of transformers, synchronous machines and induction machines, with emphasis on selection of alternating-current machinery and control equipment as affected by torque requirements and duty cycles imposed by the load. Lawrence, *Principles of Alternating-Current Machinery, Third Edition; Instructions for Students in Electrical Engineering Laboratories, Eleventh Edition.* (Restricted to selected U. S. Naval and Coast Guard Officers only.)

6·46. Electrical Engineering (RB). Elementary theory of electronic devices and their applications in circuits for measurement and control purposes, with emphasis on amplifiers and rectified-power supplies. *Applied Electronics* by members of the Department Staff. (Restricted to selected U. S. Naval and Coast Guard Officers only.)

6·48. Electrical Equipment of Buildings. Design of electric wiring, lighting and elevator systems for buildings. Cook, *Electric Wiring.*

6·501, 6·502. Electrical Engineering Seminar (A). Designed to give graduate students experience in the preparation and presentation of technical papers, and to present to the students and staff of the Department, both at the meetings and by means of the file of completed Seminar papers which is maintained in the Vail Library, the history of developments which are of special interest to electrical engineers.

6·511. Electric Power Circuits (A). Theory of symmetrical components and application to electric power systems operating under unbalanced conditions. Theory of equivalent circuits with application to component parts of power networks. Calculation of resistance, inductance and capacitance of transmission lines for currents of the different sequences. Analysis of single and multiple faults. Comprehensive treatment of electric power systems in the steady state. Lyon, *Applications of Symmetrical Components;* Edith Clarke, *Circuit Analysis of A-C Power Systems.*

6·512. Electric Power Circuits (A). Transients on long lines. General theory of travelling waves, followed by a consideration in detail of reflections and refractions at junction points, circuit discontinuities and terminals, effect of resistance, inductance and capacitance in series and in parallel with the line, the effect of choke coils, etc. Lightning and its effect on transmission lines. Review of laboratory and field test methods and apparatus. Principles and practice involved in lightning protection of lines. Ruedenberg, *Elektrische Schaltvorgänge;* Bewley, *Traveling Waves on Transmission Systems.*

6·515. Power Systems Laboratory (A). Power-network analysis using the network analyzer (an alternating-current calculating board). Problems including those relating to steady-state operation; to symmetrical and unsymmetrical faults; and to steady-state and transient stability. Problems preferably submitted by the student.

6·516. Power System Analysis. (A). Studies of the technical problems which arise in the operation of major transmission systems and in planning for system expansion and inter-

Electrical Engineering Continued

connection. Discussion of theoretical aspects of the problems and application of methods of analysis to the study of representative modern power systems on the M. I. T. Network Analyzer. Problems concerned with both normal steady-state operation and operation during and immediately following fault conditions; such as, steady-state power and reactive-power flow and its control in large systems; voltage regulation and the maintenance of voltage levels; interconnection of generating units within a station and its effect on system reliability and on relaying and circuit-breaker duties; steady-state and transient stability and power limits and their effects on system operation and design; frequency variations and tie-line power swings; and the action and effects of governors, excitation systems, and damper windings.

6·521, 6·522. Advanced Alternating-Current Machinery (A). Analysis of more intricate electrical problems met in the operation of alternating-current machinery; such as effect of unbalanced conditions on the operation of synchronous and induction machines; eddy currents in laminations, solid rotors, and conductors of direct-current and alternating-current machines; harmonic analysis of the magnetic density existing in the air gap of synchronous and induction machines including the effect on generated e.m.f., torque, and vibration; transient conditions due to the sudden alteration of the electric circuits or to the sudden variation of the shaft load of synchronous and induction machines, particularly the effect of sudden short circuit on the current and torque and the conditions which arise while pulling into step and phase swinging. Facilities available in the machine-transients laboratory for supplementary experimental work

6·531, 6·532. Power System Economics (A). Determination of demand, energy and customer components of cost of electric power. Allocation of demand costs. Study of load curves, load, diversity, loss and demand factors, load duration and peak percentage curves. Analytical studies of prediction of peak demand and energy output. Theory of incremental heat rates and their application to load division. Incremental loading of generating stations including effect of losses in transmission circuits. Rate structures, Hopkinson and Wright demand rates, off-peak rates, power-factor and coal clauses. Increment costs. Cost of energy losses in a power system. Economics of power-factor costs, correction and conductor sizes. Problems in interconnection studies and methods of operation. Cost, economic functions and value of hydro power. Firm capacity. Rate bases, depreciation, financial and operating statistics and forms of organization, problems in public utility economics and management. Relation between load, capacity and service continuity. Economics of radial distribution, primary and secondary networks.

6·541. 6·542. Electric Power Generation (A). Economics and technique of electric power generation. Study of the generating station as a unitary instrument for the conversion of energy. Generation with an appropriate degree of reliability at minimum total cost. Effect of the characteristics of the load curve on cost of generation. Thermal efficiency and commercial economy of various heat cycles. General layout of the generating station. Calculation of fault currents and operation of protective devices. Division of load among generating units for minimum cost. Interrelation between steam and hydro generation. By-product generation. Joint operation of industrial and central-station plants. Energy storage systems.

6·551, 6·552. Railroad Electric Traction (A). Electrical and mechanical principles and economic considerations relating to railway electrification. Mechanics of traction, calculation of speed-time curves, train resistance for conventional design, light-weight, and stream-lined equipment as a function of weight and speed, energy consumption and power demand, analysis of motor characteristics, design and control as applied for traction purposes, analysis of motive-power equipment, steam, diesel-electric and electric as applied to traction purposes, power-distribution circuits, factors affecting substation rating and spacing, equivalent circuits for power distribution for analytical purposes or network-analyzer representation, calculations of short-circuit and ground currents, power costs and transportation economics. Study of the foregoing as regards electrification in particular and transportation in general.

6·561. 6·562. Advanced Network Theory (A). Discussion of the methods of network synthesis and their applications to the design of networks for prescribed driving-point or transfer characteristics including such networks as wave filters, attenuation or phase equalizers, coupling networks for wide-band or feedback amplifiers, etc. Theoretical development beginning with an enlargement of the more elementary methods of network analysis out of which are established the properties of physical driving-point impedance functions and the necessary conditions for the physical realizability of a prescribed impedance or of a set of impedance functions characterizing a network with several terminal-pairs. Discussion of synthesis procedures including a variety of methods pertinent to the design of nondissipative and dissipative networks with one and two terminal-pairs, with consideration of various methods of obtaining equivalent networks and of the collaterally useful concept of the duality. Discussion of pertinent properties of analytic functions of a complex variable.

6·571, 6·572. Principles of Illuminating Engineering (A). Latest researches in physiological optics and their applications to lighting, vector field method of calculating illumination, and design of lighting equipment. Moon, *The Scientific Basis of Illuminating Engineering.*

6·58. Transients in Linear Systems (A). Formulation from physical considerations, of differential equations of circuit and field problems in electrical, mechanical, thermal and acoustical systems which permit of linear treatment; analogies; mathematical studies of transient disturbances in these systems, using the Laplace transformation method as a means of solving the differential equations. Requisite background in complex variable theory for use of the method.

6·585. Applications of Integral Equations in Electrical Engineering (A). Applications of integral equations to various problems in electrical engineering, such as problems of electrostatics, skin effect, interreflections of radiant energy, and vibrations. Particular attention devoted to the solution of integral equations by approximating the kernel and by use of various numerical and graphical methods.

6·586 Engineering Applications of Field Theory (A). Engineering treatment of methods for the solution of Laplace's equation and their practical applications. A supplement to the usual electric-circuit theory (one space dimension) by developing methods for two and three dimensions. Byerly, *Fourier Series and Spherical Harmonics.*

6·59. Communications Laboratory (A). Advanced work on a substantial problem or selected group of problems. Opportunity for specialization in pulse systems including television, networks, microwaves, antennas, and acoustics. For students with a mature independence of attack and investigatory ability. Conferences, with opportunity for detailed criticism and discussion.

6·602. Mathematical Analysis by Mechanical Methods (A). Methods used in the mechanization of mathematical process with emphasis on the handling of variables. Computation, treated as an engineering problem, with attention to design and economic limitations. Examinations, demonstrations and tests of theo perating principles of computing mechanisms, both of the measuring type and of the counting type.

6·605. Servomechanisms (A). Principles of dynamic analysis of closed-cycle automatic control system with emphasis on the quantitative study of system behavior. Correlated treatment of system analysis and synthesis in terms of differential equations and complex functions. Relation between transient behavior and steady-state behavior to sinusoidal disturbances treated in terms of time solutions, and magnitude and phase characterstics expressed as vector contours to a linear or decibel scale. Applications to a wide class of control or regulation problems.

6·606. Servomechanisms (A). Servomechanism theory embodying advanced analysis and quantitative design of a number of automatic control systems. Investigation of electric, hydraulic, and electro-hydraulic servo-mechanisms

Electrical Engineering Continued

with the aid of supporting applied electronics, electric circuits, electrical machinery and fluid machinery theory as applied to servo-mechanisms. Laboratory work on quantitative measurements and evaluation of servomechanism performance.

6·607. Servomechanisms Laboratory (A). Quantitative measurement and synthesis of a wide variety of typical closed-cycle systems. Program varied to meet particular needs of the student. Project type of problems recommended in contrast to unrelated minor studies.

6·608. Servomechanisms (A). The content of subject 6·606 without the laboratory work. Registration accepted only where satisfactory accomplishment in laboratory work can be demonstrated.

6·61. Engineering of High Voltages and High-Energy Particles (A). Principles and techniques involved in the insulation, measurement, and use of voltages in the 100- to 5000-kv. range. Analysis of direct-current electrostatic, alternating-current, and impulse-voltage sources. Theory and characteristics of high-voltage insulating media with emphasis on compressed gases, high vacuum, and solids immersed in these. Acceleration of charged particles to high energies. Physical properties of high-energy X-rays, cathode rays, neutrons, and radiations from artificially radioactive materials. Trends in the development of high-voltage power for transmission. Analysis of methods of generation and conversion for direct-current power systems.

6·621, 6·622. Radio Lines, Antennas and Propagation (A). Applications of electromagnetic theory in radio engineering. First term: theory and application of wave guides; R-F line components of various types including cavity resonators, matching elements and coupling devices; principles of microwave network design. Second term: general theory of radiation and its application to the analysis of representative types of antennas; emphasis placed on the design of antenna arrays, microwave reflectors and lenses.

6·623. Principles of Pulse Circuits (A). Analysis of basic pulse-forming circuits including overdriven amplifiers, multivibrators, trigger circuits, and artificial transmission lines. Consideration of counting circuits, sweep circuits, pulse amplifiers, pulse-modulated radio-frequency sources, ultra-high-frequency and microwave receivers. Applications to radar, television, pulse-time communication systems, and laboratory instruments.

6·631. Engineering Electronics (A). Electrokinetic theory of gases, including free paths, mobility, diffusion, ionization, recombination and space-charge effects. Potential distributions between electrodes immersed in a gas, and theory and characteristics of glow, spark and arc discharges. Application to rectifiers, grid-controlled arc tubes, circuit breakers and lightning arresters. Cobine, *Gaseous Conductors.*

6·632. Engineering Electronics (A). Engineering application of electronic apparatus. Current, voltage, and energy considerations in circuit interruption involving arcs. Mercury arc rectifiers and associated circuits. Electric welding arc. Inversion and other special applications. Cobine, *Gaseous Conductors.*

6·633. Electronic Circuit Theory (A). Analysis of circuits employing electron tubes, especially those used in non-communication applications. Emphasis on the principle of operation, not on physical details of instruments. More difficult analyses, omitted from 6·20 and 6·202, are included in this subject.

6·64. Dielectric Materials (A). An advanced study of the structure and properties of non-metals and their behavior in electric and electromagnetic fields. Gases, liquids and solids discussed with emphasis on dielectric polarization, electric breakdown, and conduction through insulators and semi-conductors and on pertinent mechanical properties. While the applications considered are of special importance to the electrical engineer, the viewpoint is that of the chemist and physicist as well. Lecture demonstrations.

6·651, 6·652. Power System Measurements, Analysis and Economy (A). Power system analyzed not only from the point of view of power generation and system interconnection, but also with regard to materials, instruments, measurements and planning for determining equipment and system performance. Study of electrical insulation in equipment and cable circuits with regard to properties, measurements and tests as influencing system performance. Study of cable circuits, circuit analysis, grounding systems, primary and secondary networks, and relays and instruments. Study of actual and synthetic load curves, incremental rates and economic loading, rate structure, incremental costs, economic conductor sizes, generation and transmission costs and problems in engineering economy.

6·661, 6·662. Principles of Electric Machine Development (A). Various types of electric machines and apparatus and calculation of their characteristics. Eddy-current loss in rectangular wire windings in transformers and generators. Theory of measurement of core loss with poor wave form. Allowable overloads for transformers. Heat resistivity, free convection and radiation. Slot harmonics in induction motors and choice of slot numbers. Reactance and temperature rise of bus-bars. Inductance, magnetic field strength and mechanical force of round coils in air. Flux-plotting. Usual methods of calculation including the potential method. Graphical flux-plotting. Unbalanced magnetic pull in rotating machines. Eddy currents in round wires, tubular conductors and induction furnaces and solutions by means of Bessel functions.

6·663, 6·664. Aircraft Electrical Systems and Machines (A). Problems arising in the design, coördination, and operation of d-c and a-c electric power and control apparatus and distribution systems for use in aircraft, emphasis being placed on basic fundamentals rather than specific present-day techniques. Comparison of d-c and a-c systems; steady-state and transient analysis of these systems; discussion of basic problems in the design of electrical machinery for use in aircraft; and brief discussion of the basic theory of automatic control devices. Machine characteristics determined in the laboratory and used in the study of representative aircraft systems on the M.I.T. Network Analyzer.

6·671, 6·672. Vibrations (A). Theory of vibration of mechanical systems including certain acoustical and hydraulic problems. Complex-notation method generally used. (Short preliminary instruction in this method for students from other courses while the Electrical Engineering students work on more purely electrical problems. Thereafter, the two groups united.) Forced, transient, and self-induced vibration. Single and multiple degrees of freedom. Analogies between electrical and mechanical systems. Nonlinear systems. Application to mechanical devices, machines, and structures. Vibration measurements and corrections. Use and limitations of models, mechanical and electrical. Noise in machines, its causes and control. Control of temperature oscillations. The tide and an analysis of tidal power possibilities. Stresses in bus-bars and bus-bar supports. Inertia effects in high-speed mechanisms.

6·68. Special Problems in Electrical Engineering (A). Opportunity for individual study, under a staff member, of advanced subjects related to Electrical Engineering not otherwise included in the curriculum. Program to suit individual requirements by the student and staff members interested, subject to approval of the professor in charge.

6·681. Special Problems in Fire Control (RA). (Restricted to selected U. S. Naval Officers only.)

6·69. Sound in Electrical Communications (A). Principles and apparatus involved in the production, measurement, transmission and reproduction of sound by electrical means. Laboratory measurements of sound fields and performance of receivers and transmitters.

6·73. Advanced Electrical Measurements Laboratory (A). Advanced work of the nature of that given in 6·75, and 6·76, the choice of problems being suited to the individual student.

6·74. Advanced Electrical Machinery Laboratory (A). Laid out in accordance with the needs of the individual student, special problems on direct and alternating-current machinery being selected.

Electrical Engineering Continued

6·75. Electrical Measurements Laboratory. Measurement of the properties of linear circuit elements and their behavior in circuits; measuring methods and equipment; and investigation of the characteristics of magnetic materials and transformers. *Instructions for Students in the Electrical Engineering Laboratories. Eleventh Edition*, 1943.

6·756. Electrical Measurements Laboratory. For college transfer students who have been allowed partial credit for 6·75 and 6·76.

6·76. Electrical Electronics Laboratory. Characteristics of electronic devices and their use in engineering applications, including rectifiers, thyratron control circuits, amplifiers and oscillators.

6·77. Electrical Machinery Laboratory. Characteristics and fundamentals of direct-current machinery. Ricker and Tucker, *Electrical Engineering Laboratory Experiments, Fourth Edition;* Kloeffler, Brenneman, and Kerchner, *Direct-Current Machinery; Instructions for Students in Electrical Engineering Laboratories, Eleventh Edition*, 1943.

6·78. Electrical Machinery Laboratory. Polyphase circuits, symmetrical phase components, transformer, synchronous generator, synchronous motor, three-phase induction motor. Ricker and Tucker, *Electrical Engineering Laboratory Experiments, Fourth Edition; Instructions for Students in Electrical Engineering Laboratories, Eleventh Edition*, 1943.

6·781. Electrical Machinery Laboratory. Polyphase circuits, symmetrical phase components, power transformer, synchronous generator, synchronous motor, single-phase and three-phase induction motors, and power rectifiers. *Textbooks same as for* 6·78.

6·79T. Electrical Machinery Laboratory. Characteristics of single-phase induction motors, synchronous converters and power rectifiers, special purpose alternating-current machinery, characteristics of power transmission lines. *Textbooks same as for* 6·78.

6·80. Electrical Measurements Laboratory (B). For Electrical Engineering students who desire work in addition to that included in any one of subjects 6·75, 6·76, 6·83 or 6·84, and for any other students requiring a special program in electrical measurements laboratory. Arranged to suit the requirements of the individual student.

6·82T. Electrical Electronics Laboratory. Similar to 6·76.

6·83. Electronic Engineering Laboratory. Choice of work by the student, subject to the counsel of his instructor, from a broad selection of topics having to do with the application of electronic devices to measurement and control purposes in engineering: amplifiers, voltmeters, trigger circuits, relaxation and phase-shift oscillators, voltage regulators, phototube devices, and thyratron applications.

6·84. Electrical Implementation Laboratory. Choice of work by the student, subject to the counsel of his instructor, from a broad selection of the topics listed for 6·23.

6·85. Electrical Engineering Laboratory. Ten exercises designed to familiarize students with the elements of electrical measurements and with the characteristics and fundamental principles of operation of the ordinary types of electrical machinery and control apparatus. Ricker and Tucker, *Electrical Engineering Laboratory Experiments, Fourth Edition; Instructions for Students in Electrical Engineering Laboratories, Eleventh Edition*, 1943.

6·86. Electrical Machinery Laboratory (B). For electrical engineering students who desire work in addition to that included in any of the subjects 6·77, 6·78, 6·781, or 6·79T and for any other students requiring a special program in electrical machinery laboratory. Arranged to suit the requirements of the individual student.

6·89. Electrical Engineering Laboratory. Eight laboratory exercises similar in subject matter to those of 6·85. *Textbooks same as for* 6·85.

6·901—6·904. General Electric Industrial Practice. Practical work done by the coöperative students in testing, manufacture, engineering and research in plants of the General Electric Company located in Lynn, Schenectady, Pittsfield, and Philadelphia. The output of this company ranges from minute vacuum tubes to heavy power units, and embraces the fields of power, communications, illumination, and electronics.

6·911—6·914. Boston Edison Public Utility Practice. Work done by coöperative students in maintenance of lines and of electric and steam plants, testing and standardizing of equipment, conduct of sales department, engineering and research related to public utility problems.

6·941—6·944. Bell System Communications Practice. Work done by coöperative students in the manufacture of communication equipment at Kearny, N. J., and in its installation and maintenance in a Bell Telephone operating company, including at least one term's work devoted to research and development of communication and electronic apparatus at the Bell Laboratories in New York City.

6·951—6·954. General Radio Industrial Practice. Work done in the plants of the General Radio Company, Cambridge, in research, engineering, manufacture and testing of high-grade measuring instruments especially adapted to the fields of communications and electronics.

6·961—6·964. Philco Corporation Industrial Practice. Work done by coöperative students in testing, manufacture, engineering and research in the plants of the Philco Corporation in Philadelphia, Pa., which operates an experimental television broadcasting station and specializes in the manufacture of communication and electronic devices.

BIOLOGY

Subjects 7·00 to 7·99

7·01, 7·02. General Biology, I and II. Introduction to the study of plant and animal organisms, including man, with consideration of their structure, function, development, heredity, and interrelationships (classification, evolution, distribution). First term — presentation of a general survey of the above subjects. Second term — a more detailed presentation, with particular reference to botany, including plant physiology, and invertebrate zoölogy. Laboratory work integrated with the lectures and recitations throughout the course.

7·03. Genetics (B). Discussion of the facts and theories of heredity and their relation to the present state of biological theory in general.

7·11. Embryology. Classroom and laboratory work on the development of animals from the germ cells to the organ systems.

7·12. General Cytology (A). Fundamental cytology of mitosis, meiosis, spermatogenesis, and genetic mechanics, together with the morphology of secretory, excretory, contractile, absorptive, and conducting cells; activities of cells and cell structures in physical chemical terms. Application of methods of modern cytology in the laboratory with emphasis on study of living material.

7·14. Comparative Anatomy. Comparative gross anatomy of vertebrates and essential histology of the organs, with the structures partly dissected out by students and partly demonstrated by the instructor. Classification and general zoölogy of vertebrates.

7·19. General Physiology I (B). Physical chemical basis for the structure and colloidal properties of protoplasm.

7·20. General Physiology II (B). Fundamental proc-

Biology Continued

esses which characterize cells and tissues, including permeability phenomena, cell division, growth of cells and organisms, metabolism, contractibility and motility, irritability, glandular secretion, and excretion.

7·211. General Physiology Laboratory I(B). Laboratory coördinated with the topics of 7·19.

7·212. General Physiology Laboratory II(B). Laboratory coördinated with the topics of 7·20.

7·31. Biology of Bacteria. Bacteriology as a biologic science, stressing the fundamental principles and pure science aspects of the subject. Laboratory work including the basic techniques for studying bacteria, with use of selected types. Salle, *Fundamental Principles of Bacteriology*. (Not offered 1946–47.)

7·321, 7·322. Advanced Bacteriology (A). Reports and discussions on bacterial physiology and growth, including nutrition, energetics, respiration and anaerobiosis, growth factors, temperature effects, bacterial variation, and use of statistical measurements in quantitative bacteriology. In the second term, laboratory problems and demonstrations including bacterial dissociation, filtration techniques, viruses, and special problems. (Not offered 1946–47.)

7·80. Biochemistry (B). Experiments illustrating basic principles of biochemical procedure as applied in various fields without special emphasis upon clinical aspects of physiological chemistry. Lectures on the nature of chemical processes in plants and animals with special attention to the metabolism of foodstuffs and the nature of protoplasms.

7·81. Enzymology (A). Quantitative study of enzyme reactions, their products, and the conditions governing activity.

7·82. Advanced Biochemistry (A). Technique for biochemical analyses and bio-assays, based on the recent literature.

7·831, 7·832. Biochemistry of Micro-organisms [7·831 (B), 7·832 (A)]. Emphasis on quantitative aspects of the metabolic activities of micro-organisms. Investigation of problems in the general biochemistry of yeasts, molds, and bacteria, by analytical and research methods now in use in various laboratories. Isolation and identification of various metabolic products, metabolic balance sheets, and respiration studies.

7·85. Biophysics I (A). Optical methods useful in biochemical and biological research. Techniques used in photography, spectrography, microscopy (including ultra-violet and electron microscopy), polarization optics, and X-ray diffraction.

7·86. Biophysics II (A). Isotopic tracers, surface chemistry, the ultracentrifuge, electrophoresis, and other physical equipment and techniques applicable to biological and biochemical problems. Biological effects of radiant energy.

7·87. Spectroscopy of Biological Materials (A). Spectroscopic methods applied to biological and biochemical problems, with emphasis on visible and ultraviolet absorption spectrophotometry and photochemical techniques. Infra-red, Raman, fluorescence, and emission spectra are considered briefly.

7·871. Spectroscopy of Biological Materials Laboratory (A). Laboratory work coördinated with the topics of 7·87.

7·881. Biophysics Laboratory I (A). Laboratory coördinated with the topics of 7·85.

7·882. Biophysics Laboratory II (A). Laboratory coördinated with the topics of 7·86.

7·91, 7·92. Instrumentation in Biology I and II (A). Principles of electrical instrumentation in the biological sciences including research and industrial biology and certain aspects of medical science. 7·91: principles of electrical measurements and the construction and operation of electrical instruments. 7·92: principles of electronics and electronic devices, including amplifiers, oscillographs, photoelectric cells, X-ray tubes, and dosimeters.

7·93. Selected Topics in Biology (A). Class work in various fields of biology not covered by the regular subjects of instruction.

7·941, 7·942. Research Problems (A). Directed research in a field of biological science, but not contributory to graduate thesis.

PHYSICS

Subjects 8·00 to 8·99

General Physics

8·00. Entrance Physics. Entrance requirement in Physics. No laboratory work is given.

8·001. Physics. Brief survey of physics for graduate students in Architecture or Economics to remove undergraduate deficiencies in physics.

8·01. Physics (Mechanics). Fundamental laws of point and rigid body mechanics. Free use of elementary calculus.

8·012. Physics (College Transfer). Given first term for college transfer students already allowed partial credit for 8·01 and 8·02 on the basis of a previous substantial course in general physics. Not to be taken by any student who must take or repeat 8·01 and 8·02. Supplements the student's training in amount necessary to cover the requirements of 8·01 and 8·02. Free use of calculus.

8·02. Physics (Mechanics and Heat). Lectures, laboratory and recitations. Divided into two parts: (*a*) Mechanics of continuous media preceded by a study of gravitational field of force and orbital motion. (*b*) The first and second laws of thermodynamics and elementary kinetic theory of gases.

8·03. Physics (Electricity). Introduction to the fundamental laws of electricity and magnetism and their applications. Electrostatics, steady currents and magnetic fields, and time-varying electric and magnetic fields. Quantitative work throughout, with free use of calculus, both in the theory and applications.

8·034. Physics (College Transfer). Given second term for college transfer students already allowed partial credit for 8·03 and 8·04 on the basis of a previous substantial course in general physics. Not to be taken by any student who must take or repeat 8·03 and 8·04. Supplements the student's training in amount necessary to cover the requirements of 8·03 and 8·04. Free use of calculus.

8·04. Physics (Electricity, Optics and Modern Physics). Continuation of 8·03, approximately one-third of the subject bringing to a conclusion the study of electricity. Discussion of electromagnetic waves leads to optics; devoted to both geometrical and physical optics. Quantitative character of 8·03 continued and free use of calculus.

8·061. Intermediate Physics (Thermodynamics and Kinetic Theory). Physics of intermediate grade, material somewhat more advanced than 8·01–8·04. First and second laws of thermodynamics with applications to properties of gases, change of state, and chemical equilibrium. Elementary kinetic theory, Maxwell distribution of velocities, and the Maxwell-Boltzmann formula.

8·062. Intermediate Physics (Electronics). Continuation of 8·061. Electron ballistics, theory of electron emission, Fermi-Dirac distribution, Schottky effect, high field emission, secondary emission, photoelectric effect, Townsend discharge, glow discharge, arc discharge, rectifiers and filters.

Physics Continued

8·09. Physical Measurements. Introduction to experimental physics with emphasis on laboratory manipulation. Glass blowing, microsoldering, vacuum technique, evaporation of metals and assembly of optical systems. Application of the techniques to physical measurements. Selected experiments on heat, electricity, light, X-rays, gas kinetics and properties of matter.

8·11. Experimental Physics (B). Introduction to experimental research techniques. Assigned laboratory exercises, including setting up and carrying through experiments concerned with fundamental principles in nuclear, atomic, and molecular physics. Designed to bridge the gap between elementary laboratory and research in modern physics.

Acoustics

8·13. Vibration and Sound (B). First part: a study of the dynamics of vibrating bodies; coupled oscillators, strings, membranes and plates. Second part: a study of the transmission and radiation of sound. Properties of loudspeakers and microphones treated, and the characteristics of speech and hearing discussed.

8·131. Experimental Acoustics (B). Laboratory subject in acoustics, including measurements on acoustical absorbing materials, calibration of loudspeakers and microphones, recording and analysis of noise, vibration analysis, and experiments in supersonics and in physiological acoustics.

8·132. Architectural Acoustics (B). Study of the acoustical design of rooms and buildings. Experiments will accompany many of the principal topics; measurement of sound, reverberation, absorption coefficients, room resonance, vibration isolation, sound transmission, and insulation.

8·135. Special Problems in Acoustics (A). Advanced problem in acoustics or vibrations with assigned reading and consultations.

Optics and Photography

8·15. Photography. Elementary subject primarily an elective for students not in Course VIII.

8·152. Advanced Photography. Advanced laboratory subject. Determination of the various characteristics of photographic materials and practice in photographic technique.

8·161. Optics. Fundamental principles of geometrical, physical and physiological optics. Refraction at spherical surfaces, thick lenses, the limitation of rays by apertures, lens aberrations, the resolving power of optical instruments, diffraction, interference, polarization, radiation light sources, the eye, photometry, color, photoelectricity, the design and construction of optical instruments, stereoscopy, and description of the performance of well-known optical systems such as telescopes, microscopes, photographic objectives, and projection systems.

8·162. Optical Measurements. Principles, methods and manipulation of optical instruments.

8·173. Color Measurements (B). Measurement and specification of color in the objective and subjective sense and the application of such methods to industrial problems. Experiments illustrate the photometric and chromatic properties of the human eye and give experience in the technique of spectrophotometry and colorimetry.

8·183. Special Problems in Optics (A). Experimental work in the optics laboratory with assigned reading and consultation.

Electronics

8·202. Electronics Laboratory. Intermediate electrical and electronic measurements.

8·21. Physical Electronics (A). Introduction to the theoretical and experimental aspects of physical electronics, including electron emission from solids (thermionic emission, photoelectric emission, secondary emission and strong-field emission); excitation of electrons in luminescent materials and other solids; excitation and ionization of gases by electrons; and gas discharge phenomena.

8·212. Physical Electronics Laboratory (A). Lectures and laboratory for the development of techniques useful for research in physical electronics and their application to the experimental investigation of important phenomena of physical electronics.

8·23. Electrical Discharges in Gases (A). Fundamental processes of electron emission from cathodes and interaction with gas. Velocity distribution of electrons in a discharge, with application to calculation of mobility and diffusion of electrons and to the effect of magnetic fields. Various types of discharges, including the Townsend discharges and breakdown, Geiger-Muller tubes, the cathode fall, plasma, and anodic parts of glow discharges and arcs.

8·25. Special Problems in Electronics (A). Advanced problem in electronics, with assigned reading and consultation.

X-Rays and the Structure of Matter

8·261. Macroscopic Properties of Matter I (A). Static and dynamic properties of matter in bulk. Elastic, dielectric, magnetic properties of solids and liquids. Interactions as they occur in piezoelectricity and magnetostriction, thermal and caloric effects, specific heats. (Alternate years; not offered 1946–47.)

8·262. Macroscopic Properties of Matter II (A). Optical properties of matter and their relation to the elastic, electric, and magnetic properties. Crystal optics, electro- and magneto-optical effects, photoelasticity, diffraction by supersonic waves, light scattering, dichroism, metallic reflection. (Alternate years.)

8·27. X-rays and Crystal Physics (B). X-ray apparatus, production of X-rays, absorption, scattering, refraction, X-ray spectra. Theory and application of the diffraction of X-rays in matter to the determination of the structure of crystals, and the atomic and molecular arrangement in liquids and amorphous solids. General review of the structure of matter as determined by X-ray diffraction analysis.

8·28. X-Ray Diffraction (A). Selected topics of advanced nature in the theory of X-ray diffraction and its application to the study of the structure of matter. Introduction to crystal chemistry. Application of space group theory to crystal structure determination. Diffraction in perfect and imperfect crystals. Diffuse scattering. Fourier treatment of X-ray diffraction, and the Patterson-Harker method of analysis. (Alternate years; not offered 1946–47.)

8·29. Theory of the Solid State (A). Classification of the various solid types. Born-Karman theory of lattice vibrations. Motion of electrons in periodic field, Brillouin zones, and application to the theory of electrical conductivity in metals, insulators, and semi-conductors. Classification of phase transitions. Rotational, orientational transitions, liquid structure, ferromagnetism, superconductivity, paramagnetic analysis. (Alternate years; not offered 1946–47.)

8·30. Special Problems in Crystal Physics (A), Advanced problem in X-ray diffraction or crystal physics. with assigned reading and consultation.

Atomic Structure and Spectroscopy

8·311. Atomic Structure. Electron and ion beams, and scattering of alpha-particles, electrons, and light by atoms. The corpuscular nature of light and the wave nature of the electron. The Bohr theory of atomic structure and the vector model of the atom. Radioactivity and nuclear structure.

8·312. Atomic Structure Laboratory. Continuation of 8·09 with application of the laboratory techniques to the study of selected topics in modern physics such as absorption and emission spectra, inelastic impacts of the first and second kind, resonance radiation, fluorescence, critical potentials, gamma ray absorption and artificial radioactivity.

8·32. Line Spectra (A). Experimental and theoretical phases of spectroscopy. Production of spectra and spectro-

Physics Continued

scopic analysis. Characteristics of atomic spectra and their interpretation in terms of current theories of atomic structure.

8·343. Special Problems in Spectroscopy (A). Experimental work in the Spectroscopy Laboratory, with assigned reading and consultation.

8·40. Introduction to Nuclear Physics (B). Survey of the principal fields in nuclear physics designed for undergraduates. Static properties of atomic nuclei, binding energy, nuclear models. Radioactive transformations. Properties of charged particles, neutrons and gamma rays. Transmutation, fission, artificial radioactivity.

Nuclear Physics

8·411. Nuclear Physics I (A). Advanced experimental nuclear physics, including description of the properties of nuclei and nuclear transformations, observational methods and instruments and correlation of experimental results with current theory. Charge, mass, radius, nuclear moments, statistics, parity, and selection rules for nuclear transitions. Interaction between particles, binding energy, nuclear models. Radioactive transformations, theory of statistics and fluctuations.

8·412. Nuclear Physics II (A). Continuation of 8·411. Ionization, scattering, and radiative losses for swift charged particles. Properties of neutrons. Origin of gamma rays and their interaction with matter. Transmutation; fission; reactions induced by charged particles, gamma rays, and neutrons; excitation functions. Artificial radio activity, nuclear spectroscopy.

8·413. Nuclear Physics Laboratory (A). Study of the properties of particles from natural, artificial and fission disintegrations and the corresponding measuring instruments. Use of counters, coincidence amplifiers, ionization chambers, and the cyclotron.

8·42. Cosmic Rays and High Energy Phenomena (A). Mesons and their occurrence in cosmic rays and interaction with nuclei and heavy particles, showers, cascades. Artificial production of mesons and their properties.

8·43. Theory of Nuclear Structure (A). Review of the current theories of the structure of atomic nuclei. Nature of internuclear forces. Calculation of nuclear binding energies, collision, excitation functions for transmutation, fission including reactions induced by neutrons, light or heavy charged particles, gamma rays. Theory of alpha and beta radioactivity.

8·441. Special Problems in Nuclear Physics (A). Experimental work on radioactivity, nuclear bombardment, and general nuclear research, with assigned reading and consultation.

Theoretical Physics

8·461. Introduction to Theoretical Physics I (Mechanics) (B). Mechanics of particles, planetary motion, rigid bodies, vibrating particles, vibrating strings and membranes, elasticity and hydrodynamics. Use of Lagrange's equations and generalized coördinates, ordinary and partial differential equations, Fourier series, and vector analysis.

8·462. Introduction to Theoretical Physics II (Electromagnetic Theory) (B). Electrostatics and magnetostatics. Maxwell's equations, the potentials, Poynting's theorem. Plane waves in empty space, reflection and refraction. Wave guides and resonant cavities. Spherical waves, field of oscillating dipole. Radiation from antennas and antenna arrays, and from atoms and molecules. Interference, diffraction, scattering. Electron theory of dielectric constant, permeability, and polarization.

8·463. Introduction to Quantum Theory I (A). Survey of quantum theory and its applications, beginning with a discussion of the Schroedinger equation for free particles, formation of wave packets. Particles in a force field. Operators, average values, transition probabilities. Central field problems, angular momentum, approximate methods, particles in magnetic fields, spin, many body problems in atomic spectra, molecular structure and spectra.

8·464. Introduction to Quantum Theory II (A). Continuation of 8·463 beginning with radiation problems, scattering, virtual levels. Applications to nuclear physics, statistics, theory of gases and solids, kinetic theory. High energy phenomena preceded by a treatment of the special theory of relativity.

8·48. Advanced Mechanics (A). Transformation theory of dynamics, perturbation theory, theory of orbits. Applications to light and electron optics. (Alternate years; not offered 1946–47).

8·491. Methods of Theoretical Physics (A). Solution of physical problems systematized by grouping them according to the partial differential equation they satisfy. Boundary conditions and methods of solution peculiar to each equation, including separation of variables, eigenfunctions, Green's function, integral equations, variational and perturbation procedures, integral representations, conformal transformations. Applications to problems in electrostatics, hydrodynamics, acoustics, electromagnetic theory, quantum mechanics, etc.

8·512. Statistical Mechanics (A). Review of thermodynamics, followed by consideration of the fundamental statistical quantities such as ensembles, distribution functions, partition sums. Thermodynamic functions for perfect gases. Entropy constants, mixtures, chemical reactions. Application to theory of specific heat, real and degenerate gases. Electric and magnetic properties of matter, high polymers, order-disorder transformations. Fluctuations, irreversible phenomena, Onsager's symmetry relations, kinetic equations. (Alternate years; not offered 1946–47.)

8·521. Advanced Quantum Mechanics I (A). Fundamental equations of quantum mechanics, and properties of important operators, using the symbolic method of Dirac. Binding, collision processes, virtual levels for two body central field problems. Pauli theory of spin, followed by the many body problems of atomic and molecular spectra, with discussion of perturbation, variational, and Hartree methods. Many body problems involving scattering, excitation, emission, and absorption of radiation.

8·522. Advanced Quantum Mechanics II (A). High energy phenomena. The special theory of relativity followed by a treatment of the Dirac equation and the fine structure of hydrogen spectra. General field theory, quantization of electron, electromagnetic and meson fields. The theory applied to the Compton effect, meson production, nuclear forces, etc. (Alternate years; not offered 1946–47.)

8·56. Electromagnetic Wave Theory (A). Radiation theory, electromagnetic boundary-value problems, propagation in dispersive media with application to the ionosphere. Application of Fourier and Laplace transform theory to field equations. (Alternate years.)

8·60. Special Problems in Theoretical Physics (A). Reading, consultation, and original investigation on a problem in theoretical physics.

CHEMICAL ENGINEERING

Subjects 10·00 to 10·99

10·17. Industrial Chemistry. Industrial aspects of fuels, combustion and furnaces through the solution of numerous problems. Lewis and Radasch, *Industrial Stoichiometry.*

10·18. Industrial Chemistry. Industrial chemical processes studied from the point of view of both the chemical reactions forming the basis of the process, and the plant necessary for carrying on these reactions. Development of

Chemical Engineering Continued

interrelationships of the different industries as to raw materials, sources of energy, and standard types of apparatus and a general survey of the field obtained. Extensive problem work.

10·21. Industrial Chemistry (B). Continuation of 10·18. Industries dealing with amorphous solids, including glass, ceramics, leather, paints, textiles, paper, rubber, etc. Lewis, Bronton and Squires, *Industrial Chemistry of Colloidal and Amorphous Materials.*

10·25. Industrial Chemistry (A). Industrial stoichiometry and the industrial chemistry of more important chemical industries. Discussion of the interrelationships of the important industries and problem work on the various processes. For graduate students primarily interested in industrial chemistry and particularly for new students from other schools who have had insufficient training in industrial stoichiometry.

10·26. Industrial Chemical Laboratory (B). Laboratory development of a chemical process illustrating the integrated application and utilization of chemical principles and methods in solving industrial problems. The materials involved are analyzed and relevant physical and chemical characteristics measured. Reaction equilibria and rates are determined, side reactions investigated and methods of process control explored. Experimental results are studied and interpreted to bring out the full technical significance of all chemical information available. Discriminating and effective presentation of conclusions is developed through oral and written reports.

10·27. Industrial Chemical Laboratory (A). Experience in methods of attack upon typical industrial chemical problems, necessitating brief laboratory investigation. Problems of current industrial interest and emphasis upon the interpretation of experimental results and their effective presentation in a series of group conferences. (Not offered 1946–47.)

10·28. Chemical Engineering. Thermal properties of matter and the energy relationships underlying mechanical and chemical processes, including discussion of the first law of thermodynamics as applied to both batch and flow processes, and such operations as combustion, compression and handling of fluids, thermal control of chemical reactions, and the like. Development of second law and its elementary applications. Weber, *Thermodynamics for Chemical Engineers.*

10·29. Chemical Engineering (B). Quantitative engineering applications of the second law, including heat engines, heat recovery, particularly in chemical operations, thermal level of heat in relation to industrial processes, chemical equilibria and thermodynamic efficiency of chemical processes. Attention to high pressure operations, particularly the influence of pressure on thermal effects and chemical equilibrium. Weber, *Thermodynamics for Chemical Engineers.*

10·30. Engineering Equipment. For students selecting the Chemical Engineering Practice Option, X-B. Instruction and practice in testing engineering equipment such as pumps, fans, turbo-blowers, blowing engines, motors, generators, etc., commonly used in chemical engineering operations. Emphasis on the determination of the operating characteristics of such equipment under plant conditions.

10·31, 10·32. Chemical Engineering (B). Basic principles underlying the unit operations of chemical industry. Discussion of fundamental problems in flow of heat. Analysis of the operation of evaporation, distillation, drying, humidification, filtration, subdivision of solids, hydraulic classification and similar topics. Emphasis on quantitative relationships illustrated by the solution of numerous problems. Walker, Lewis, McAdams and Gilliland, *Principles of Chemical Engineering.*

10·311. Heat Transfer (RB). Fundamentals of conduction, convection, and radiation of heat, with applications to problems arising in practice. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

10·33. Analytical Treatment of Chemical Engineering Processes (A). Conservation of matter and energy, the laws of equilibrium, and reaction rate. Problems of diffusion requiring certain mathematical techniques. Training in setting up ordinary and partial differential equations corresponding to specific physical situations, and presenting methods available for their solution, including various graphical constructions. Sherwood and Reed, *Applied Mathematics in Chemical Engineering.*

Engineering Operations

10·40. Chemical Engineering Thermodynamics (A). Properties of homogeneous and heterogeneous systems, physical and chemical equilibria and energy effects, and mechanical manipulation and control of industrial processes. Emphasis on behavior of complex mixtures, correlation of data, and methods of approximation. Weber, *Thermodynamics for Chemical Engineers.*

10·41. Distillation (A). Basic principles of distillation, as applied to binary mixtures, both of complete and limited miscibility and to multicomponent systems. Problems including batch and continuous simple distillations, steam distillations, vacuum and pressure distillation, rectification, heat recovery and the like. Special attention to graphical methods. Robinson and Gilliland, *Elements of Fractional Distillation.*

10·45. Distillation and Absorption (A). Distillation, including rectification of binary and complex mixtures. Diffusional processes, with attention to design computations for gas absorption equipment. A combination and condensation of subjects 10·41 and 10·46, using same texts.

10·46. Absorption and Extraction (A). Basic principles of equilibria, mechanism and rate of interaction. Quantitative applications including the absorption of single gases, such as sulfur dioxide, ammonia and hydrochloric acid, and complex mixtures, such as light oil, casing-head gasoline, refinery gases, and the like. Attention to graphical methods. Basic principles of extraction by liquids, solvent recovery by absorption and the leaching of various solids. Sherwood, *Absorption and Extraction.*

10 50. Heat Transmission (A). Application of the fundamentals of conduction, radiation and convection of heat to the problems and situations in chemical industry. Emphasis upon the general relationships between fluid dynamics and diffusional processes. Empirical, but dimensionally sound approach to the problem. Extensive use of graphical methods. Trends of present development. McAdams, *Heat Transmission.*

10·52. Chemical Engineering II (A). Offered for graduates of other schools whose training in chemical engineering differed from that given in 10·31 and 10·32. Emphasis on basic theories in flow of fluids and flow of heat. Application to problems of advanced character. Attention to recent developments in chemical engineering. Walker, Lewis, McAdams and Gilliland, *Principles of Chemical Engineering.*

10·53. Chemical Engineering Design (A). Open only to students completing the field work of Course X-A. Design of a complete plant, from the viewpoint of both chemical engineering and economics.

10·54. Economic Balance in Chemical Industry (A). Development of original power in the solution of problems in chemical industry. Problems covering a wide range of topics, with quantitative analysis of various factors under the control of the designer, determining the optimum design from the viewpoint of cost and economic return.

10·55. Economic Balance (A). Shorter subject of the same character as 10·54.

Applied Chemistry

10·62. Applied Chemical Thermodynamics (A). Energy relations of chemical processes. Equilibria and thermal effects in heterogeneous and homogeneous systems, and technique in utilization of data in interpretation and practical control of chemical reactions.

Chemical Engineering Continued

10·63. Industrial Chemistry II(A). Chemical industries dealing primarily with amorphous materials, including thermoplastics, textile fibres, cellulose products, leather and rubber. Survey of the general principles of colloidal chemistry followed by analyses of important problems encountered in these industries. Lewis, Broughton and Squires, *Industrial Chemistry of Colloidal and Amorphous Materials.*

10·65. Catalysis and High Pressure Processes (A). Principles involved in the use of high pressures and catalysts in certain chemical reactions, such as the synthesis of ammonia, synthesis of mixtures of aliphatic compounds, alcohols and hydrocarbons from water gas, hydrogenation of coal and oils, cracking of mineral oils, etc.; discussion of industrial applications, equipment requirements, and opportunities for research.

10·661. Introduction to Colloid Chemistry (A). Discussion of the colloidal state of matter and of the characteristics and behavior of colloids; description of natural colloids and of the different methods of producing matter in the colloidal state, and consideration of the methods applied in the study of substances in the colloidal state. Hauser, *Colloidal Phenomena.*

10·662. Colloid Chemistry (A). A continuation and extension of 10·661, with attention to recent developments in surface reactions, gel formation, and their technical significance. Hauser, *Colloidal Phenomena.*

10·663. Introduction to Applied Colloid Chemistry (A). Fundamentals of colloid chemistry. Arranged primarily for X-A students, but may be taken by other graduate students unable to attend courses in colloid chemistry during the first term. Hauser, *Colloidal Phenomena.*

10·673. Colloid Chemistry Laboratory (A). Training a limited number of men in the use of special instruments such as stalagmometers, bubble pressure pipettes, and surface and interfacial tensiometers. Including the laboratory technique of dialysis, electro-dialysis, cataphoresis, modern microscopic technique, and micro-dissection, as well as the theoretical background pertaining to these methods. Hauser and Lynn, *Experiments in Colloid Chemistry.*

10·674. Colloid Chemistry Laboratory (A.) Continuation of 10·673.

10·68. Corrosion (A). Selection of equipment for use in chemical engineering processes. Emphasis on resistance to corrosion and theories of corrosion and methods of prevention.

10·69. Plastics and Other High Polymeric Substances (A). Survey of the chemical and physical properties and molecular structure of organic and inorganic high polymeric substances. Emphasis on specialized colloid chemical and physical methods of investigation necessitated by the unique properties of this class of materials. Correlation of theoretical considerations of structure with properties of practical industrial importance. Mason and Manning, *Technology of Plastics and Resins.*

FUEL ENGINEERING

10·70. Principles of Combustion (A). Open to students wishing to specialize in the engineering rather than the chemical phase of fuel engineering. Emphasis on the application of fundamental principles in combustion reactions, including high output power plants of rocket and jet types. Problems illustrating the quantitative application of principles to fuel utilization.

10·71. Fuel Engineering (A). For students with an adequate background of physical and organic chemistry and thermodynamics. Mechanism of the combustion reactions, and application of combustion principles to problems of design or use of equipment for fuel processing and utilization.

10·74. Furnace Design (A). Principles and calculations of furnace design and construction dealing with rates of heat transfer and with flow of gases in furnaces. Quantitative design and layout of several furnaces, retorts or still-settings.

10·76. Seminar in Radiant Heat Transmission (A). Theory and derivations incident to heat transfer in furnaces, including general law of total radiation in its differential form, its applications to radiation between finite solid surfaces with evaluation for special shapes of engineering importance, the law of spectral energy distribution of radiation, its application to radiation from luminous and non-luminous gases, powdered coal flame radiation, and optical pyrometry.

10·79. Automotive Fuels (A). Discussion of refinery technology, particularly cracking; the mechanism of combustion in Otto and Diesel cycle engines; the relation of "engine knock" to chemical structure of a fuel; thermodynamics of engine cycles, allowing for dissociation; the volatility of motor fuels; gum in gasoline; theory of bearing lubrication. Problems and comprehensive report required on some motor fuel subject.

School of Chemical Engineering Practice

10·81. School of Chemical Engineering Practice — Bangor Station (A). Emphasis on the study of electrolysis, drying, humidification, evaporation, absorption and causticization. Conducted in the plants of the Eastern Corporation at South Brewer, Maine, manufacturers of writing papers and sulphite pulp and of the Penobscot Chemical Fibre Company at Oldtown, Maine, manufacturers of soda and sulphite pulp. Offered from July through December and from February through May.

10·82. School of Chemical Engineering Practice — Parlin Station (A). Distillation, heat transfer, fluid flow, handling of corrosive materials, plant layout, and industrial chemical operations such as those employing catalysis and high pressure. Conducted at the Cellulose Products plant of Hercules Powder Company in Parlin, New Jersey. Offered from July through December and from February through May.

10·83. School of Chemical Engineering Practice — Buffalo Station (A). Flow of fluids, flow of heat and combustion, the work extending over a wide field. Quantitative studies are made and tests run on coke ovens, blast furnace stoves, gas producers and the like. Experimental work on flow of heat, flow of fluids, absorption and other unit studies of chemical engineering is carried out in connection with the recovery of light oil and ammonia from coke oven gas. Conducted at the Lackawanna Plant of the Bethlehem Steel Company. Offered from July through December and from February through May.

10·84. School of Chemical Engineering Practice — Bangor Station. Similar to 10·81. Given during the second period of the academic year.

10·85 School of Chemical Engineering Practice — Parlin Station. Similar to 10·82. Given during the second period of the academic year.

10·86. School of Chemical Engineering Practice — Buffalo Station. Similar to 10·83. Given during the second period of the academic year.

General

10·90. Experimental Research Problem (A). Designed to meet the needs of special and graduate students who wish to carry out some minor investigation in a particular field. Subject and hours arranged to fit individual requirements.

10·911, 10·912. Research Conferences (A). Regular conferences are held with research students by the Staff of the Laboratories of Chemical Engineering in which the work is conducted.

10·991, 10·992. Seminar in Chemical Engineering (A). Offered for post graduate students on doctors' theses.

GEOLOGY

SUBJECTS 12·00 TO 12·99

12·011. MINERALOGY. Blowpipe analysis, followed by an intensive laboratory study of the common non-silicate minerals, developing the student's ability to identify the common minerals on sight. Warren, *Determinative Mineralogy;* Hurlbut, *Dana's Manual of Mineralogy.*

12·012. MINERALOGY. Continuation of 12·011, covering a study of the common silicate minerals. Warren, *Determinative Mineralogy;* Hurlbut, *Dana's Manual of Mineralogy.*

12·05. MINERALOGICAL SEMINAR (A). Presentation and discussion of literature bearing on certain phases of theoretical mineralogy. (Alternate years.)

12·06. MINERALOGICAL RESEARCH (A). Supervised research on some mineralogical or crystallographic problem, with the intention that each investigation will result in a publication.

12·15. PETROGRAPHY. Laboratory work on rock thin sections, using the polarizing microscope, including lectures on the occurrence and genesis of rocks and rock minerals. Confined to igneous and metamorphic rocks. Harker, *Petrology for Students;* Tyrrell, *Principles of Petrology;* Rogers and Kerr, *Optical Mineralogy.*

12·161, 12·162. PETROLOGY SEMINAR (A). Discussion of the composition and fabric of igneous and metamorphic rocks. Assigned reading, exercises, and reports.

12·17. ADVANCED PETROGRAPHY (A). Methods and instruments used in petrological research. Arranged to suit the requirements of individual students, and may include mechanical fractionation methods; Rosiwal analysis and staining techniques; mineral identification using X-ray powder photography and Universal stage methods; statistical analysis with X-rays and the Universal stage.

12·20. ELEMENTARY CRYSTALLOGRAPHY. Basic subject dealing with classical concepts of crystallography important in the study of mineralogy, metallography, chemistry and optical crystallography, and including symmetry, crystal classes, crystal systems, indices, crystal forms, habit, twinning, parting, cleavage, isomorphism, and polymorphism. Laboratory study of crystal models to acquaint the student with a working knowledge of important crystal forms.

12·23. OPTICAL CRYSTALLOGRAPHY. Optical properties of crystals with special reference to the identification of crystalline substances with the aid of the polarizing microscope. Larsen and Berman, *Microscopic Determination of the Nonopaque Minerals* (*U. S. Geological Survey Bulletin 848*); Buerger, *Optical Identification of Crystalline Substances.*

12·24. THEORETICAL CRYSTALLOGRAPHY (B). Introduction to the theory of the structure of crystals, and application of crystal structure concepts to crystallography and mineralogy, including elementary crystal chemistry, structures of the silicates, polymorphism and transformations, disordered structures, solid solution and segregate phase formation, crystal growth and habit, crystal imperfection and lineage structure, and plastic deformation of crystals.

12·26. X-RAY CRYSTALLOGRAPHY (A). Theory and methods of determining the unit cells and space groups of crystals, including lattice geometry, simple aspects of X-ray diffraction theory useful in crystallographic investigations, rotating- and oscillating-crystal methods. Weissenberg method, de Jong-Bouman method, precession method, determination from X-ray data of lattice type, unit cell, and space-group, and precision determination of cell dimensions. (Alternate years.) Buerger, *X-ray Crystallography.*

12·27. CRYSTALLOGRAPHIC RESEARCH (A). Supervised research on some crystallographic problem.

12·301, 12·302. GENERAL GEOLOGY. Geological processes, including the nature and origin of rocks and minerals, the surficial processes and results of erosion and deposition, and the development and evolution of plants and animals as determined from the fossils in the rocks. The first term devoted to physical geology — minerals, rocks, and the geologic work of streams, oceans, glaciers, and the wind. The second term devoted to a brief study of structural geology, followed by historical geology. Lectures, laboratory demonstrations and work on specimens and maps, and field trips to points of geologic interest in the vicinity.

12·321. ENGINEERING GEOLOGY. Geology adapted to the needs of engineers. Ries and Watson, *Elements of Engineering Geology.*

12·322. ENGINEERING GEOLOGY (B). Relations of geology to engineering problems, with reviews of actual cases.

12·36. ECONOMIC GEOGRAPHY OF THE WORLD. Basic geography of the lands and seas of the world. Resources of significance in world-economy — their nature, location, extent, the trade routes, ports, etc., that forward them to their destination.

12·37. GEOMORPHOLOGY (B). Fundamental principles of geomorphology. Constructional land forms — plains, plateaus, mountains and volcanoes — are first examined and classified. Consideration of cycles of erosion, caused by diverse eroding agencies in each class of constructional land form; and the various types of destructional land forms which erosion produces; thus developing the histories of valleys, of glacial and aeolian land forms, and of shore lines leading to the final intergradation of the destructional with constructional land forms. Opportunity for voluntary field work.

12·38. ADVANCED GEOMORPHOLOGY (A). Critical study of the several theories of geomorphological principles; illustrated by special problems, varying from year to year in accordance with the chief interests of the students. Opportunity for research in geomorphology; and voluntary field work.

12·39. REGIONAL GEOMORPHOLOGY OF THE EARTH. Comprehensive treatment of the surface-forms of the world. Forms of all lands in terms of the processes that shaped them; including the continents, the continental and oceanic islands, and the geomorphology of all sea-floors. Emphasis upon cause and process and upon comparison between homologous regions.

12·40. ECONOMIC GEOLOGY (B). Occurrence and origin of ore deposits. Lindgren, *Mineral Deposits, Fourth Edition.*

12·41. ECONOMIC GEOLOGY LABORATORY (B). Training in the determination of ore minerals and their relationships in hand specimens and in polished sections. Laboratory results are correlated with the geological occurrence of the ores. Laboratory supplement to 12·40.

12·42. APPLIED ECONOMIC GEOLOGY (B). Application of geology to: prospecting for new ore bodies, geophysical prospecting, alluvial prospecting, diamond drill core interpretation, mine sampling and ore estimation. Discussion of methods of underground geological mapping. (Alternate years, not offered 1946–47.)

12·431, 12·432. ADVANCED ECONOMIC GEOLOGY LABORATORY (A). Study of specimens or suites of specimens from mineral deposits; metallographic or petrographic work.

12·433, 12·434. ADVANCED ECONOMIC GEOLOGY SEMINAR (A). Seminar including reading and reports based upon the literature of ore deposits.

12·44. ECONOMIC GEOLOGY OF FUELS (B). Geology of natural gas, petroleum and coal, adapted to the needs of engineers.

12·511, 12·512. PALEONTOLOGY. The past life of the earth, studied through a comparison with living plants and animals. Shimer, *Introduction to the Study of Fossils, Second Edition;* Twenhofel and Shrock, *Invertebrate Paleontology.*

12·52. ADVANCED PALEONTOLOGY (A). Laboratory work and assigned reading upon the Invertebrata or upon some aspect of stratigraphic geology.

12·53. INDEX FOSSILS (A). Determination of the geologic age of rock formations in North America through a study of their included organic remains. Shimer and Shrock, *Index Fossils of North America.* (Not offered 1946–47.)

12·581. SEDIMENTATION (B). Survey of the chief types of sediments and sedimentary rocks with discussions on the

Geology Continued

environmental conditions under which they are formed and deposited. Twenhofel, *Treatise on Sedimentation;* Grabau, *Principles of Stratigraphy;* and Hatch, Rastall, and Black, *The Petrology of Sedimentary Rocks.*

12·582. Sedimentation (A). Consideration of the important primary and secondary chemical and physical characteristics of sedimentary rocks, supplemented by microscope work in the laboratory, and by occasional field trips. Twenhofel, *Treatise on Sedimentation;* Grabau, *Principles of Stratigraphy;* and Hatch, Rastall, and Black, *The Petrology of Sedimentary Rocks.*

12·60. Glacial Geology (B). Glaciers, and glacial periods. Origin and motion of glaciers together with the landforms resulting from glacial action. Causes and history of ice-ages considered as a contribution to the geologic history of the earth.

12·63. Physical Geology Seminar (A).

12·64. Geology of North America (A). Geological history of each province beginning with the present physiography of the continent, including the stratigraphy, orogeny and igneous intrusives and extrusives and their influence upon the present structure and topography of the continent. (Alternate years, not offered 1946–47.)

12·66. Research (B). For students desiring special library, laboratory or field work on geologic problems.

12·671, 12·672. Problems in Geology Seminar (A). Seminars in alternate weeks, devoted to major problems in geology, of fundamental rather than special interest, which merit special or detailed consideration. Members of the staff will collaborate, each taking charge of those seminars which deal with subjects within his special field. Each session will consist of a lecture followed by group discussion.

12·701, 12·702. Structural Geology (B). Primary structural features of igneous and sedimentaty rocks and the nature and causes of secondary structural features, joints, fissures, faults, folds and rock cleavage, their manner of formation and significance. The second term is largely devoted to laboratory and field work.

12·71. Advanced Structural Geology (A). Nature, significance, and causes of structural features produced by earth deformation.

12·80. Geology of Coal and Petroleum (B). Origin and stratigraphy of coal, oil shale and petroleum and consideration of geology and economics of the major fuel deposits. Elementary treatment of physical principles in underground fluid equilibrium and flow, and of methods used in estimating reserves in oil fields.

12·81. Advanced Geology of Petroleum (A). Structural and stratigraphic relations of oil fields with special emphasis on those in the United States. Application of the principles deduced from selected regions leading to location of new oil fields, proposed by the class and critically examined in conference.

12·851, 12·852. Advanced Theoretical Geophysics. (A). Selected topics in terrestrial physics: age of rocks; thermal problems; seismology and elastic problems; problems in crustal mechanics; figure of the earth and gravitational problems. Jeffreys, *The Earth.*

12·86. Elements of Seismology (B). A general introductory survey. The nature of earthquakes and their effects, and the propagation of seismic waves and their bearing upon the structure of the earth. Seismic instruments and the applications of seismology to prospecting and engineering. (Alternate years.)

12·87. Introduction to Geophysical Prospecting (B). Orientation subject to acquaint the student with the geophysical prospecting methods as a geological tool. Discussion of the principles, possibilities and limitations of the methods, and the nature of the problem of interpreting the observational data.

12·91. Elements of Mining (B). Fundamentals of mining practice, including prospecting, exploration, drilling, shaft-sinking, drifting, explosives, blasting, timbering, haulage, hoisting, ventilation, drainage, mining law, health and safety. Mining terminology. Lewis, *Elements of Mining.*

12·92. Mining Methods and Practice (B). Continuation of 12·91. Mining systems, costs, engineering and administration. Attention concentrated on adaptability and operation of representative methods of mining as applied to either open-pit or underground mining of metals and nonmetallics.

12·94. Mineral Economics (B). World mineral resources, their political and economic importance and industrial potential. Effects of distribution, control, monopolies, cartels, and tariffs on availability of mineral raw materials. Attention directed to economic planning, self-sufficiency, nationalism, strategic minerals.

12·95. Mine Valuation (A). Methods of examination and principles of valuation to equip the student with the theory of valuation and its practical application to representative types of mineral property. Emphasis on sampling, sampling calculations, estimation of ore, costs, selling prices, markets, profits, the interest rate, depletion, and taxation. Baxter and Parks, *Mine Examination and Valuation.*

12·96. Mineral Economics Seminar (A). Discussion of more advanced phases of the world mineral situation.

For description of the following see Division of General Studies.

G9. Geology.

G28. Economic Geography.

G29. Topography in the World War.

NAVAL ARCHITECTURE AND MARINE ENGINEERING

Subjects 13·00 to 13·99

13·01, 13·02. Naval Architecture (B). Geometry of the ship, principle of flotation, load line, capacity, tonnage, stability, buoyancy and stability in damaged condition, trochoidal waves, strength calculations, rolling and other ship oscillations, resistance, propellers, propulsion, powering, steering and launching. Rossell and Chapman, *Principles of Naval Architecture;* Taylor, *Speed and Power of Ships.*

13·021. Naval Architecture. Resistance and powering of ships, influence of form and coefficients on resistance; powering and propulsion, propeller design, influence of hull on action of propeller; steering and maneuvering; rolling, pitching and yawing. Rossell and Chapman, *Principles of Naval Architecture.*

13·022. Naval Architecture. Similar to 13·02, but omitting work on launching and motions of ships among waves. Resistance, powering, propulsion, propellers and steering. (Restricted to selected U. S. Naval Officers only.)

13·03T. Naval Architecture and Ship Design (A). Principles and procedures to be followed in the preparation of the preliminary design of ships. Manning, *Basic Design of Ships.*

13·031. Ship Design (A). Work in the drawing room of an original and individual nature. Work includes the necessary calculations and plans required for the preparation of the preliminary design of a ship selected by the student.

13·04. Naval Architecture and Ship Design (A). Problems in naval architecture and ship design more advanced than those given in the undergraduate course. Special attention to historical development, basic design of various types, structural design, stability in the damaged condition, sub-

Naval Architecture and Marine Engineering Continued

division, powering, analysis of performance, economics of design, general arrangement, cargo handling, launching, heating, ventilation, air conditioning, hull piping systems, etc. Discussion of naval and merchant vessels. Original design of a merchant ship is carried out by each student. (Not offered 1946–47.)

13·12. Theory of Warship Design (RB). Principles involved in the general arrangements of warships and in the design and installation of hull systems, fittings, and auxiliary machinery. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

13·13. Theory of Warship Design (RA). Stresses in a warship and the design of the hull structure. Hovgaard, *Structural Design of Warships*. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

13·15. Theory of Warship Design (RA). Principles and procedures to be followed in the preparation of the preliminary design of warships and the design of armor protection. Manning, *Basic Design of Ships*. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

13·16. Theory of Warship Design (RA). Considerations involved in the design of the military equipment of warships and in the design of protection against underwater attack; design of ventilation and air-conditioning systems. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

13·21. Warship Design (RB). Work in the drawing room which includes fairing a set of lines for a warship from preliminary design data; calculations for and drawing of displacement and other curves, cross curves of stability and curves of statical stability. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

13·22. Warship Design (RB). Work in the drawing room which includes calculations for and preparation of a curve of floodable length and the general arrangement plans of a warship. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

13·24. Warship Design (RA). Work in the drawing room which includes calculations and drawings for the general strength investigation of a warship; structural plans of midship section and a transverse bulkhead and shell expansion plan. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

13·25. Warship Design (RA). Work in the drawing room which includes preparation of structural plans of the strength deck of a warship, the stem and bow framing or sternpost and after framing and propeller strut and the transverse strength calculation of a warship. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

13·26. Warship Design (RA). Work in the drawing room which includes the preparation of the necessary plans and calculations for the preliminary design of a warship; preparation of the structural plan of a gun foundation. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

13·34. Ship Construction. Structural arrangements of ships; general arrangements of ships of various classes; hull systems, including fire, drainage, sanitary, oil and ventilation systems; hull fittings and equipment, including anchor handling, steering gear, cargo and boat handling equipment.

13·40. Elementary Ship Construction. Lectures mainly on the operation of shipyards, although some time devoted to the geometry of ship form, propelling machinery and construction of yachts. Work in the drawing room including fairing of the lines, calculating the displacement and drawing the midship section of a small wooden vessel. Manning, *Manual of Ship Construction*.

13·42. Ship Drawing. Lines drawing, displacement, curves of form; calculations for stability and floodable lengths. Rossell and Chapman, *Principles of Naval Architecture*.

13·45. Ship Design (B). Lectures on structural design of ships, including general and local stresses and the design of shell, inner bottom, decks, framing, and bulkheads. Drawing room work, including general arrangement plan, ventilation diagram, and launching calculation. Hovgaard, *Structural Design of Warships;* American Bureau of Shipping, *Rules for Building and Classing Steel Vessels*.

13·46. Ship Design. Lectures on the basic principles of ship design and the methods of preparing the preliminary design of a ship. Preparation of the following structural plans in the drawing room: midship section, shell expansion, a main transverse bulkhead and deck in way of cargo hatches; and general strength calculation. Manning, *Basic Design of Ships*.

13·47. Ship Design. Fairing of lines; calculations for and drawing a floodable length curve, load line calculation, general arrangement plans of cargo ship with particular attention to cargo handling arrangements, midship section plan for cargo ship.

13·52. Marine Engineering. Steam and Diesel machinery; fuels, combustion, boilers, reciprocating engines, turbines, condensers, feed heaters, feed water systems and steam power plant layouts. Diesel and oil engines; types of engines, fuel injection and combustion, valve gears, supercharging, oil engine fuels, Diesel electric drive and motor ship auxiliaries. Chapman, *The Marine Power Plant*.

13·54. Marine Engineering (B). Topics in dynamics and stress analysis. Dynamics of the crank-connecting rod mechanism; stresses in connecting rods; the balance of rotating and reciprocating machines; elementary vibration theory; torsional vibration in internal combustion engines and marine reduction gears; vibration of ships; dynamics of governors and flywheels; mechanical similitude and other related topics.

13·55. Marine Engineering. Following a brief review of nozzle and blade design the important dimensions of several turbines are computed and their principal features compared with other modern turbines. Effects of superheat, increased pressure, vacuum; types of auxiliary drive and heat balance of the marine steam plant. Discussion of critical speed, blade strength, and design of reduction gears; fans, blowers and centrifugal pumps.

13·56. Marine Engineering. Economic aspects of marine engineering; comparison of fuels, and the various types of steam and Diesel propelling machinery for different types of ships and trade routes; the economical operation of propelling machinery and auxiliaries at sea and in port; heat balances; boilers, main engines, auxiliaries and auxiliary systems; turbo-electric and Diesel-electric drives; gas turbine developments.

13·61, 13·62. Marine Engineering Design (B). Calculations and preliminary design of main propelling units for a steamship; determination of sizes of auxiliaries; machinery layout; diagrammatic arrangements of principal piping systems; application of modern heat transfer formulas; propeller design, and other marine engineering problems.

13·71, 13·72. Naval Engineering (A). Modification of 13·75 and 13·76, arranged for students other than XIII-A.

13·73. Mechanical Vibration (A). The free and forced vibration of systems of a single degree of freedom; complex variable and vector representation; Fourier Series; harmonic analysis by tabular and mechanical methods; systems of several degrees of freedom; torsional systems; the balance of rotating machinery and reciprocating engines; the elements of torsional vibration problems in reciprocating engines.

13·74. Mechanical Vibration (A). Advanced theory of the torsional vibration of reciprocating engines, including uniform distributions, forced vibration, calculation of amplitude, branched systems, etc. The transverse vibration of uniform and irregular beams and the application to the vibration of turbines and other rotating machinery; Rayleigh's Stodola's and other methods; separation of normal modes of vibration; vibration isolation; La Grange's theorem; nonlinear systems; self-sustained oscillation.

13·75, 13·76. Naval Engineering (RA). Various types of steam, Diesel and electric propelling machinery and auxiliaries; gas turbine developments. A machinery layout made in the drafting room for a specified ship, involving the basic design of boilers, propelling machinery, gears, condensers, auxiliaries, shafting and propellers. Attention to fuels, lubrication, feed heating systems, heat balances, estimates of per-

Naval Architecture and Marine Engineering Continued

formance, analyses of trials, etc. Comparison of the various types of propelling machinery and auxiliaries. (Restricted to selected officers of the U. S. Navy and Coast Guard only.)

13·78. PROPELLER THEORY AND EXPERIMENTAL RESEARCH (A). Discussion of modern ideas of propeller action based on air-foil theory; cavitation; interactions of hull and propellers; various available methods of design. (Not offered 1946–47.)

13·79. PROPELLER DESIGN (RA). Momentum and blade element theories of propeller action. Propeller testing procedure. Methods of presenting propeller test data. Application of theories and test data to the design of ships' propellers. Strength of propeller blades. (Restricted to selected officers of the U. S. Navy and Coast Guard only.) (Not offered 1946–47.)

13·791. PROPELLER DESIGN (A). Similar to 13·79.

13·81, 13·82. SHIP OPERATION (B). Engineering and economic aspects of ship operation; various items making up the operating disbursements and incomes; calculations for operating expenses and profits on various trade routes, comparison of different types of fuels and machinery for different sizes of ships and various lengths of voyage; influence of size of ship, sea speed, block coefficient, port speed, and length of voyage on operating expenses; cubic and dead-weight ships; the design of cargo and passenger vessels from the owner's point of view; tonnage measurements, fuel conservation, repairs and maintenance; study of present and future trade routes, cargo movements, and factors influencing ocean freight rates. Coastwise, inland water transportation and interrelation of land and marine transportation. Problems in cargo and passenger ship operation.

13·83. PORTS AND PORT FACILITIES. Functions, layouts and facilities of ports and passage of cargo through ports; piers, quays, roadstead ports; transit sheds; shipside cranes, warehouses, lighters; movement of cargo to and from hinterland, port belt line railroad, road vehicles and roadways, inland water craft, feeder line vessels; study and comparison of world ports and their cargoes, facilities and hinterlands; port administration, port planning and port charges; port competition; marine passenger terminals; coördination of inland transportation with ocean shipping.

13·84. CARGO HANDLING AND STOWAGE. Methods of cargo transfer between ship and shore; handling of bulk and liquid cargoes; cargo handling equipment; cargo transfer through deck hatches, the longshoremen's gang, cycle of operation, types of slings; movement of cargo between shipside and transit shed, transit shed vehicles; design of the ship from the point of view of cargo handling, hatches, booms, winches and rigging; cargo transfer through side ports; conveyors and elevators; costs and speeds of cargo transfer; essential requirements in the stowage of cargo, palletized cargo, cargo stowage plans; refrigerated cargoes, cargo ventilation; factors making for rapid turn-around and reduction of cargo handling costs; longshore labor problems. Presentation and discussion of a paper by each student on an assigned port. Trips to the waterfront to observe cargo handling and to visit various types of cargo ships.

BUSINESS AND ENGINEERING ADMINISTRATION

SUBJECTS 15·00 TO 15·99

15·11. INTRODUCTION TO BUSINESS MANAGEMENT (B). Functions and methods of business. Corporate organization, finance, accounting, production, marketing, with emphasis on interrelations between these functions. Considers business problems in the order they would be encountered in a new business: survey for a new venture; promotion, organization; personnel; operation; control; expansion or liquidation. (Not open to Course XV; may be taken as elective in other Courses.)

15·20. OCEAN SHIPPING ADMINISTRATION. Ocean services and traffic agencies and their organizations; rate and traffic agreements; ocean shipping documents; ocean rates and regulation; marine insurance; and admiralty law. (Not offered, 1946–47.)

15·30. PERSONNEL MANAGEMENT. Personnel management as a staff function to assist line executives. On the basis of case material, fundamental requirements for personnel work discussed as to principles that build and problems that test constructive personnel policies. Selection, placement and follow-up of employees; basic problem of worker's attitude toward authority; the plant as a social system; man-power problems; recruitment, training and upgrading; management-union relationships; establishment and maintenance of satisfactory working conditions; job analysis and grading; employee evaluation; interviewing as a tool of management; wage administration; employee counseling.

15·41. FINANCE (B). Principles of financial organization and management. Modern business corporation; instruments and agencies used in finance — corporate securities, investment banking and exchanges; problems of internal financial control. Specific cases illustrating principles and affording opportunity for individual analysis.

15·42. FINANCIAL PROBLEMS (B). Selected topics in the fields of corporate and personal finance. Case studies in internal financial administration of industry providing opportunity to apply the principles developed in 15·41 to concrete situations. Major part of subject devoted to problems in personal finance, including consideration of investment, insurance and taxation.

15·46. FINANCIAL ADMINISTRATION OF INDUSTRY (A). Practical problems of internal financial management. Analysis of specific problems confronting business managers in manufacturing, mercantile and public utility fields. Use of case method, with other readings also required. Emphasis on current financial operations; financial problems relating to taxation, consumer purchasing power and availability of investment funds. Oral and written reports.

15·50. ACCOUNTING. Familiarity with use and interpretation of financial reports as an essential business tool. Brief consideration of double-entry bookkeeping. Problems inherent in the typical financial statements. Form and content of balance sheets and of profit and loss statements considered; problems of surplus, depreciation and valuation. Introduction to methods of statement analysis. Reports and accounting policies of actual companies form the basis for discussion. (Not open to students below third year.)

15·51. INDUSTRIAL ACCOUNTING (B). Application of accounting control to industry. Principles of cost analysis as applied to problems of manufacturing, distribution and administration. Teaching material from a wide variety of business situations.

15·52. ACCOUNTING. Introduction to elements of accounting. Preparation and structure of representative financial reports to stockholders and creditors examined for use and significance. (Not offered 1946–47.)

15·55. PROBLEMS IN ACCOUNTING POLICY (A). Consideration of case problems involving accounting policy approached from administrative viewpoint. Application of analytical methods to financial data. Nature and determination of income, asset valuation, presentation of net worth, consolidated statements.

15·58. PROBLEMS IN ACCOUNTING CONTROL (A). Scope of accounting function with emphasis upon duties and responsibilities of controller. Records systems and extent to which various actual systems meet desired requirements. Periodic reports, budgets, costs, cash control, internal control, intercompany and branch control, machine accounting, taxes and

Business and Engineering Administration Continued

other special problems, including relation of controller to stockholders and to public bodies.

15·61. The Law of Contracts (B). Law of contracts. Rules applicable to formation of contracts, their performance and discharge and also rights of third parties in contracts. Rules applicable to special kinds of contracts such as agency, sales and negotiable instruments.

15·62. The Law of the Market (B). Rights and liabilities of buyers and sellers of goods and also rules of law applicable to customary methods by which purchases and sales financed. Uniform law of sales and uniform law of negotiable instruments.

15·63. Industrial Law (B). Legal aspects of social control of industry through governmental agencies. Constitutional powers and limitations of Federal and State authorities, and trends of administrative law, past, present, and probable. Relationship between government and business as evidenced by rules and regulations which are currently developing, considered with especial emphasis upon financial, production, and marketing problems arising therefrom. Law relative to inventions and their management, commonly called patent law.

15·64. Patent Law (B). Legal aspects of patents, copyrights, and trade-marks. Detailed discussion on what constitutes patentable invention; methods by which a patent may be obtained; its protection after issuance against infringement; rights obtained under copyright laws of the United States; and trade-mark laws of both the United States and the several states.

15·65. Labor Law (B). Fundamental legal principles underlying formation and operation of labor unions, limitations upon right to strike and right of boycott, and control of union activities through administrative governmental agencies.

15·70. Production. Basic treatment of manufacturing process. Factory organization and personnel; fabricating and assembling sequences; productive facilities, their selection, arrangement and coördination; product design; purchasing; internal and external transport of materials; inspection; stores; and salvage. Plant visits and reports.

15·71. Production (B). Application of principles of scientific management to production control; material control; standardization and simplification; design and administration of wage systems; new product control; industrial conversion and management engineering techniques.

15·72. Technique of Executive Control (B). Survey of the means by which line executive deals with working group. Nature of executive responsibilities and methods of supervision, devices for stimulating desire of employee to improve quantity and quality of his work; ways of collaborating with other executives and functional specialists. Common executive difficulties with subordinates, associates, and superiors.

15·73. Management Laboratory (B). Work Simplification and Time Study. Technique of motion study in simplification and standardization of manual work. Process charts, micro-motion and principles of motion economy, proper workplace layout, labor-saving tools and equipment, assembly jigs, etc. Motion picture films of industrial operations; labor relations involved in introduction of work simplification; problems of employee training; and bearing of motion economy upon morale. Use of stop watch for rate setting includes such topics as selected times, leveling factors, fatigue study, allowances, base-rate evaluation.

15·74. Advanced Management Laboratory (B). Advanced techniques in work simplification, motion study, and time study, with especial emphasis upon managerial procedures followed in introducing and demonstrating analytical techniques to administrators, executives, and to employees; organization and operation of work simplification training programs, coördination with suggestion systems, and maintenance of progress schedules and records of waste elimination.

15·75. Manufacturing Analysis (A). Formation of analytical sequences of appraisal of management methods in manufacturing. Evaluates such factors as process, facilities, operating methods, organization, control structures, incentives. Analyzes specific activities of such functions as purchasing, storage, traffic, research, design, inspection, salvage and maintenance.

15·76. Mass Production Methods (B.) Principles and advantages of direct-line method of manufacture, production engineering and preliminary work necessary to set up fabrication and assembly lines, and control systems used to maintain flow of production along various lines throughout plant. Reading assignments, problems from actual war plants, plant visits, and small term projects constitute required work.

15·81. Marketing and Reports. Broader social and economic aspects as well as managerial problems involved in marketing operation. Product policy, selection of channels of distribution, brand policy, advertising and sales promotion, customer relationships and problems of price structure. Major emphasis on marketing of manufactured consumer goods, with some attention given to marketing of industrial goods and agricultural products. Instruction primarily by problem method, supplemented by reading assignments and conferences with marketing executives. Written and oral reports on various aspects of marketing.

15·82. Sales Promotion Strategy and Methods (B). Overall strategy involved in use of various sales promotional methods to secure consumer and trade acceptance of products and services. Advertising and use of salesmen as tools in accomplishing a desired promotional task. Advertising methods, including choice of themes, selection of media, copy and layout technique, methods of testing effectiveness and organization for efficient operation of the activity. Treatment of management of the sales force including selection, training, supervision and control of salesmen with brief consideration of principles of salesmanship. Administrative control of sales operations and role of price policy as it affects promotional problems. Several discussion sessions with marketing executives.

15·83. Marketing Research: Field Surveys (B). Basic principles and techniques in marketing research. Original field study by class, each student making a substantial number of field interviews. Training of student to analyze a problem in its components, secure facts necessary for its solution, interpret data, and prepare suitable written report.

15·84. Marketing Research: Sales Analysis and Potentials (B). Sources of information and techniques used in analyzing sales activities and in measuring market potentials. Characteristics and usefulness of variety of sources of market data. Emphasis on market for manufactured products including both industrial and consumer goods. Class projects involving analysis of sales records, of product use reports and of buying power indices and other measures of market opportunities. Stress on use of existing data.

15·86. New Product Appraisal and Development (A). Sources of ideas for new or improved products and methods for screening such ideas in light of potential market demand, costs, prices, and suitability to company's production and marketing facilities; organizational relationships and methods used to insure coördination between production, research, marketing, financial and other company departments affected by product decisions. Problems on transferring new products from development stage to regular production, package design, testing market acceptability, and planning introductory sales campaigns. Much of case material from direct contact with business executives actively engaged in product development and evaluation.

15·88. Marketing Seminar (A). Administrative and policy-making level of marketing problems, including coördination of promotional, distribution, product, and price policies; critical appraisal of sales planning and control methods; long range planning of marketing activities and appraisal of effects of governmental controls.

15·92. Industrial Problems (B). With collaboration of operating executives, government representatives and military officials, field of managerial activities and problems currently shouldered by industrialists surveyed. Field interviews, conferences, classroom presentations, case problems and discussions serve to reflect interdependence of marketing and contract-procurement, finance, accounting, production and

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labor, and interrelations of the going business as a whole with government and public.

15·94. Contemporary Problems Seminar (A). Contemporary industrial and economic issues. Preparation includes assignments to current periodicals as well as text references. Development of facility in appraisal of current trends; stimulation of interest in business relationships with government, labor and public; experience in discovering key factors influencing contemporary events. Guests (faculty members or industrialists) participate.

15·95. Special Problems in Management (A). For graduate students who desire to do advanced work or to carry out some special investigation of a management problem not specifically covered elsewhere and not qualifying as a thesis. Readings, conferences, laboratory and fieldwork, and reports.

15·96. Administrative Theory and Practice (A). Consideration of initial problems confronting business administrator whose responsibilities call for determination as well as execution of policy, and incorporate supervision over major functions of business. Formulation of method of approach to administrative problems. Outline of techniques of negotiation, mediation and group deliberation. Examination of relationships of business administrator to subordinates, investors, vendors and customers, associates, community, government and public. Comparison of administrative procedure in old and established organizations *vs.* newly organized companies. Review of underlying principles leading to continuity of administrative tenure. Administrative methods in political and military areas differentiated from those in industrial fields.

15·97. Seminar in Business Administration (A). Consideration of basic aspects of administrative responsibilities in relation to industrial development, operation and control. (Open only to qualified graduate students of other departments.)

Graduate Thesis (A). Original research in field of business administration. Purpose of such work is to ascertain student's ability to make a contribution to existing knowledge.

AERONAUTICAL ENGINEERING

Subjects 16·00 to 16·99

16·01, 16·02. Introduction to Aeronautical Mechanics (B). Dynamics applied to the various phases of aeronautical engineering. Presentation of dynamics of particles, fluids and solid bodies as branches of one comprehensive subject. Fixed and moving reference systems; impulse and momentum, work and energy; center of gravity theorems; kinetic theory of gases; fluids as continuous media; fundamental equations of fluid motion; Bernoulli's equation for compressible and incompressible fluids; jet propulsion; stream function and velocity potential; adaptation of streams to given boundaries; boundary layers and streamlining; lift on rotating cylinders; conformal transformation; lift and moment on airfoils in two-dimensional flows; start of circulation; airfoils in three dimensions; Fourier Series; viscosity; dimensional analysis; kinematics and kinetics of rigid bodies in three dimensions; gyro instruments; oscillations of linear systems with one degree of freedom; forced motions — resonance; oscillations of systems with several degrees of freedom; determinants and their use in the treatment of homogeneous simultaneous equations.

16·03. Aerodynamics — Non Viscous Fluids (A). Continuation of the aerodynamics part of 16·02. Extended treatment of two-dimensional airfoils, including v. Mises, Karman-Trefftz, and more general types. Modification of given profiles to forms with desired pressure distributions. Finite span theory, with particular attention to discontinuities of various sorts, including those due to fuselages and nacelles.

16·04. Aerodynamics — Viscous Fluids (A). Navier-Stokes equations, laminar boundary layer theory, single and multiple force systems, Reynolds number, Blasius solution, Pohlhausen solution, outer and inner solutions, separation. Turbulent boundary layer theory, Schlichting theory of damped and undamped oscillations, transition, Prandtl momentum mixing length, Karman law of similitude, logarithmic velocity distribution, Taylor vorticity mixing length, turbulent friction drag and layer thickness under pressure gradients, effects of surface roughness and heat transfer.

16·05. Aerodynamics — Compressible Fluids (A). Discussion and use of methods of studying the flow of air past bodies at high speeds. Critical Mach numbers, shock wave mechanics, compressibility burble.

16·07T. Introduction to Wing Flutter (B). Introduction to theory of wing flutter and methods of computing flutter speeds.

16·08T. Flutter Mechanics (A). Discussion of the flutter problem and of theoretical and experimental procedures for solving it.

16·10. Applied Aerodynamics (B). Application of aerodynamic theory to airplane design and aircraft propellers. Warner, *Airplane Design, Vol. I;* Weick, *Aircraft Propeller Design.*

16·105. Applied Aerodynamics (RA). Discussion of applied aerodynamic problems of particular interest to U. S. Naval Officers. (For students approved by U. S. Navy only.)

16·13. Airplane Stability and Control (B). General theory of longitudinal and lateral stability, controllability and maneuverability of airplanes.

16·14. Airplane Design Problems (B). Preparation of design proposals including preliminary design of an airplane to meet a specific performance and C.A.A. minimum requirements in performance, stability and control.

16·16. Power Plant Performance and Installation (B). General principles underlying the relationships between altitude, power output and fuel consumption of aircraft engines. Principles of heat tranfer applied to radiators and aircooled engines. Internal aerodynamics including drag or thrust due to cooling airflow, engine airflow and exhaust jets. Power plant vibration and vibration isolation.

16·17. Airplane Design Practice (B). Preparation by each student of a weight estimate, balance diagram, and general arrangement drawing of a training airplane and solution of certain stress analysis problems according to C.A.A. requirements.

16·18. Airplane Design Practice (RA). (Restricted to selected U. S. Army or Naval Officers only.)

16·20. Structures. Outer forces, reactions, shears and bending moments, influence lines, slopes and deflections of beams by elastic weights and moment areas, the three-moment equation and method of moment distribution, design of simple beams, and analysis of trusses by algebraic and graphical methods. Niles and Newell, *Airplane Structures.*

16·21. Structures (B). Analysis of unsymmetrical beams; beams having partially or totally "ineffective" material in their cross sections; beams having shear-resistant or tension-field web plates; torsion, or torsion and bending, on simple sections; fittings and connections; simple columns and compression members composed of sheet and stiffeners; beam-columns by the generalized three-moment equation and by the generalized method of moment distribution; deflections of beams and trusses by virtual work and by Castigliano's Theorem. Niles and Newell, *Airplane Structures.*

16·22. Aircraft Structures (B). Applications of methods of least work and deflections to the analysis of indeterminate structures; analysis of curved beams and rings, distribution of shear and effects of shear lag in stressed-skin structures; principles of the methods for determining the stability of systems of members and introduction to the equa-

Aeronautical Engineering Continued

tion of elasticity as applied to isotropic and anisotropic materials. Laboratory work on calibration and use of strain gages, with applications to actual wing structures, drop testing of a hydraulic shock strut, determination of the elastic axis of an airplane wing, and similar experimental investigations. Niles and Newell, *Airplane Structures*, and notes.

16·25. Advanced Aircraft Structures (A). Varying content from year to year as new methods for analysis of all-metal aircraft become available for examination. Emphasis on investigation and development of methods involving stability criteria or applications of elastic theory, and on probable effects on structural analysis methods to be expected from new trends in design.

16·30. Aircraft Instruments (B). Aircraft powerplant, flight and navigation instruments. An elective for students not specializing in instruments and a background for the more advanced problems treated in other instrument subjects.

16·31. Instrumentation (A). Discussion of static and dynamic behavior of instrument elements from the standpoint of functional performance. Particular emphasis on the theory of systems that can be described by means of first and second order differential equations with constant coefficients. Emphasis on the simplifications in analysis made possible by use of non-dimensional variables and application of the principles of dimensional analysis to a wide variety of problems.

16·32. Aircraft Instruments (A). Detailed dynamic analysis of various aircraft flight instruments using the methods developed in 16·31.

16·33T. Instruments Laboratory (A). To be taken simultaneously with 16·31. Laboratory exercises devoted to the application of principles developed in 16·31 to typical instrument problems.

16·34T. Flight Test Instruments (A). Principles and techniques used in making measurements in flight with emphasis on dynamic performance.

16·35. Special Problems in Aircraft Instruments (A). Problems of interest to qualified individual students in consultation with the instructor.

16·36. Vibration Measurements (A). Methods of measurement of mechanical vibrations. Detailed studies of the various components comprising vibration measuring systems and of standard equipment used for this purpose.

16·37T. Instrument Design Practice (A). Discussion and design of typical instrument components with emphasis on methods of manufacture used in the instrument field.

16·38T. Instrument Design Practice (A). Continuation of 16·37T, the student carrying out the design and construction of a working model of a complete instrument.

16·41T. Introduction to Fire Control Instruments (RA). Discussion of static and dynamic behavior of instrument elements from the standpoint of functional performance. Particular emphasis on the theory of systems that can be described by means of first and second order differential equations with constant coefficients. Emphasis on the simplifications in analysis possible by use of non-dimensional variables and application of the principles of dimensional analysis to a wide variety of problems. Vector analysis methods used to set up the general requirements of the problems for both airborne and antiaircraft fire control. (Restricted to selected U. S. Army and Naval Officers only.)

16·42T. Advanced Fire Control Instruments (RA). Continuation of the study of antiaircraft fire control in instruments started in 16·41T, with particular emphasis upon the approximations made in the design of existing equipment. Detailed discussion of the generalized engineering theory of gyroscopic instruments. Application of this theory to the analysis of various types of gyroscopic equipment including stable verticals, gyroscopic compasses, gyroscopic lead computers and angular rate measuring instruments. The theory of other components used in fire control computers is developed as necessary. Consideration of the dynamic characteristics of fire control equipment including solution time and smoothing action. Study of the design factors controlling dynamic performance with reference to possible methods for realizing satisfactory performance in actual systems. (Restricted to selected U. S. Army and Naval Officers only.)

16·43T. Fire Control Instrument Laboratory (RA). Laboratory work to demonstrate experimentally the principles developed in the lectures of 16·41T and taken concurrently with it. Experiments illustrating general static and dynamic performance of instrument systems following first and second order differential equations. Various experiments on the characteristics of fire control instrument components, including gyroscopic elements, data transmission systems, and integrating units. (Restricted to selected U. S. Army and Naval Officers only.)

16·44T. Advanced Fire Control Instruments (RA). Continuation of 16·41T with particular emphasis on the fire control problems associated with equipment to be carried in aircraft for operation either against ground targets or other aircraft. General subject matter similar to that of 16·42T, except that the theory developed is applied to airborne equipment. Consideration of special problems introduced by bombing, rocketfire and other modern developments. (Restricted to selected U. S. Army and Naval Officers only.)

16·45T. Advanced Fire Control Instruments (RA). Continuation of 16·42T or 16·44T. Extension of the theoretical work to cover the general design, details, and performance limitations of various types of fire control equipment to solve the problems introduced by current advances in armament. Comparison of the systems of various types, from the standpoint of ultimate possible performance. (Restricted to selected U. S. Army and Naval Officers only.)

16·46T. Advanced Fire Control Instrument Laboratory (RA). Continuation of 16·43T. Designed to demonstrate the principles of airborne fire control equipment developed in the lectures of 16·44T and taken concurrently with it. Experiments carried out on service fire control equipment and special demonstration units to study the static and dynamic performance characteristic of typical airborne computers. Particular attention given to the problems of solution time, smoothing and tracking. (Restricted to selected U. S. Army and Naval Officers only.)

16·50. Rotating Wing Aircraft (B). Discussion and problems of the rudiments of design of rotating wing aircraft.

16·501. Rotating Wing Aircraft (A). Discussion of problems of performance evaluation, control and stability, vibration and design, as applied to rotating wing aircraft.

16·52. Aircraft Propeller Design (A). Study in class and drafting room of aircraft propeller design including aerodynamics, strength and vibration problems.

16·53. Advanced Airplane Engine Design (A). Advanced problems in the design of airplane engines.

16·56. Jet Propulsion Engines (A). Review of the general principles of jet propulsion devices followed by a consideration of compressors, combustion chambers and turbines, which leads to evaluation of a jet power plant.

16·60. Advanced Aeronautical Problems (A). Individual advanced work by properly qualified graduate students. Problems selected in consultation with the instructor.

16·62. Aerodynamic Laboratory (B). Methods and equipment used for research in aerodynamics.

16·63. Aerodynamic Laboratory (B). Continuation of 16·62 including additional practice in the laboratory. Class discussions emphasizing solution of special problems in the wind tunnel and flight.

16·75. Construction Details of Aircraft (B). Detail design of the airplane structure, and power plant installation.

16·81. General Aeronautics (B). Characteristics of aircraft, engines, and propellers for non-aeronautical students.

16·82. Introductory Aeronautical Engineering. Introduction to aircraft, their components and general principles of flight.

BUILDING ENGINEERING AND CONSTRUCTION

SUBJECTS 17·00 TO 17·99

17·22. BUILDING CONSTRUCTION. Construction of Third Class Buildings, with particular reference to the residence. Assembly of various materials commonly used in such construction discussed together with proper relationship and sequence ordinarily used in the field. Consideration of the use of new materials. Class discussions and problem analysis in drafting room. Dietz, *Dwelling House Construction.*

17·31. BUILDING CONSTRUCTION. Second Class Buildings, including combinations of wood and masonry, or exposed steel, wood and masonry, in semi-fireproof or heavy timber construction. Foundation problems, exterior walls, interior frames and floor systems, and an integration of all factors into the finished building, studied same as in 17·22. *Departmental Notes.*

17·32. BUILDING CONSTRUCTION. Construction of First Class Buildings, special reference to those with reinforced concrete and structural steel frames. Heavy foundations, shoring, relation of frame to exterior walls, floor arches, interior partitions, mechanical equipment, electrical services and architectural balance studied same as in previous courses in Building Construction. *Departmental Notes.*

17·33. BUILDING CONSTRUCTION. Continuation of Third Class buildings, and application of Second Class construction to light construction. Building and zoning codes and their restrictions upon Housing studied and more rational approaches to flexible public controls for low-cost construction discussed and analyzed. Modern systems, materials and services for home construction coördinated with economic effects. Costs as affected by labor policies and field procedures analyzed. *Departmental Notes and Collateral Reading.*

17·34. BUILDING CONSTRUCTION. Application of principles of mass production to Housing. Various proposals for low-cost housing analyzed and possibilities for development of mass production procedures using structural and wall and floor panels explored. Development of plans on a modular basis with maximum of interchangeability and demountability. Effects of materials on details and methods.

17·40. ESTIMATING AND JOB MANAGEMENT (B). Two of the important functions exercised by the builder, consideration of basic units into which each estimate is divided, together with a breakdown of such units into man-hours and materials required. Lectures and discussions on job planning, contract relations, labor relations, safety in construction and business aspects of contracting. Pulver, *Construction Estimates and Costs.*

17·401. ADVANCED JOB MANAGEMENT (A). Development of the organization of large projects with particular reference to the initial economic survey, time schedules, job organization, and the integration of construction procedures. Particular emphasis on the character of contract instruments, legal requirements for job insurance and the expedition of materials to accomplish speed and quality.

17·41, 17·42. BUILDING MANAGEMENT (A). Especially designed to train graduate students in the field of property management. Study of the elements of first cost, expansion, maintenance, rentals, repairs and modernization as applied to commercial and industrial buildings. Work consists of lectures, field surveys, assigned readings and reports.

17·45. CONSTRUCTION PROBLEMS (B). Continuation of previous courses in Building Construction. Specifications, details and construction procedure for an actual job in progress, or for an approved project in the field. Discussion of original and alternate specifications and methods from those used or proposed in the actual project.

17·52. STRUCTURAL PROBLEMS. First part: establishment of a connection by graphical and analytical methods between the study of applied mechanics and structural theory. Graphical analysis actually illustrating stress distribution and affording a more visual concept of stress analysis. This procedure applied to forces, homogeneous and nonhomogeneous beams of wood and steel and reinforced concrete, trusses and masonry piers and arches. Latter part: an application of these studies to structural design in timber, including analysis of compound beams, trussed girders, floor frames of wood, roof trusses and details, timber and concrete-filled columns, and other details common to heavy timber construction. Wolfe, *Graphical Analysis;* Fuller and Johnston, *Applied Mechanics, Vol. II;* Voss and Varney, *Wood Construction.*

17·53. STRUCTURAL DESIGN (B). Structural design of reinforced concrete building frames, including development of the theory of design, consideration of specifications, and design of solid and ribbed slabs, beam and girder frames, flat-slab systems and columns. Design of footings and retaining walls including discussion of soil pressures. Peabody, *Design of Reinforced Concrete Structures.*

17·531. ADVANCED REINFORCED CONCRETE DESIGN (A). Retaining walls. Deflection and bending stiffness. Torsional stresses and stiffness. Continuous frame analysis, including irregular spans and members of variable thickness, and continuous frames in three dimensions. Members curved in the horizontal plane, such as bow girders. Members curved in the vertical plane, such as arches.

17·532. ADVANCED REINFORCED CONCRETE DESIGN (A). Effect of shrinkage and plastic flow. Prestressed members. Plastic theory of design. Special design problems such as balcony frames, ribbed barrel arches, chimneys, elevated tanks, and domes.

17·54. STRUCTURAL DESIGN (B). Design of structural steel building frames, including design of typical floor-arch systems, rolled and built-up beams and girders, design of details, truss analysis, columns and foundation problems. Special attention to general steel framing in its relation to architectural details and application of structural design to shoring and underpinning. Voss and Varney, *Steel Construction.*

17·542. ADVANCED STRUCTURAL STEEL DESIGN (A). Welded frames and wind bracing. Elastic frame analysis for welded and riveted frames. Torsion of structural shapes, members curved in horizontal or in vertical plane. Special problems involving balcony framing, elevated structures, arches and domes.

17·56. STRUCTURAL DESIGN. Structural design of simplified frames in steel and reinforced concrete. Theory of design of slabs, beams, columns and footings for light occupancy buildings. Engineering procedures for design and preparation of working drawings for such buildings. Abbreviation of work given in 17·53 and 17·54. Peabody, *Design of Reinforced Concrete Structures;* Voss and Varney, *Steel Construction.* (Not offered 1946–47.)

17·71. MATERIALS. Mechanical and physical properties of wood in relation to growth, major and minor-structure and other characteristics which influence its use in the construction and engineering fields. Volume changes, moisture content, preservative treatment, wood products, identification, and selection of species for various uses. Fundamental properties and uses of plastics, and basic characteristics of paints and fabrics used in construction. *Wood Handbook;* Leighou, *Chemistry of Engineering Materials; Departmental Notes.*

17·72. MATERIALS. Geological origin, sources and composition of masonry materials together with their conversion into usable building forms. Fundamental properties of clays and clay products, cements and lime, concrete aggregates, mortars, natural and cast stone, gypsum products and various masonry specialties used in construction. *Departmental Notes.*

17·73. MATERIALS (B). Alloy diagrams and their interpretation. Consideration of the more important non-ferrous alloys and a more detailed discussion of ferrous metals, their properties and heat treatment. Chemistry of corrosion and welding theory and practice. Williams and Homerberg, *Principles of Metallography; Departmental Notes.*

17·741. ENGINEERING PROPERTIES OF PLASTICS (B). Engineering attributes of plastics studied, with principal emphasis upon mechanical and structural properties. Work includes an introductory review of the chemistry of plastics to familiarize the student with the various types; the various strength properties; other properties important from an engineering standpoint such as dimensional stability and

Building Engineering and Construction Continued

durability; and methods of manufacture and fabrication, insofar as these modify and influence the engineering properties.

17·742. Engineering Laminates (A). Consideration of the general theory of composite materials. Followed by discussion of specific laminates such as plastics reinforced with paper, textiles, glass fibers, and various types of mats; sandwiches of soft cores and hard faces; plywood and laminated timber; and duplex metals. Considerable attention given the cements and adhesives employed in making up composite materials.

17·75. Materials. Portions of 17·71, 17·72 and 17·73 most essential for civil engineering structures, with particular reference to concrete, steel and wood. Physical and chemical characteristics of these engineering materials with respect to the effects of manufacture and use on their quality, behavior and durability. An elective for students in other departments who are unable to schedule the more comprehensive sequence of subjects in Materials.

17·76. Research in Organic Structural Materials (A). Opportunity for laboratory investigation amplifying the work done in courses 17·741 and 17·742.

17·771. Cementitious Materials (B). Continuation and a more advanced study of the cementitious materials covered in 17·72. Critical studies made of the production processes, including the conditions of calcination, the constitution of the calcined materials, the effect of treatment after calcination and the effect of interground accelerators, retarders and other additions.

17·772. Cement and Concrete (A). Advanced study of the processes of wetting, hydration, setting and hardening of portland cement. Considerable time devoted to the study of particulate materials together with the properties of pastes made with them. Characteristics of fresh and hardened pastes and their contribution to the properties of fresh and hardened concrete studied critically from the standpoint of placeability, shrinkage, strength, plastic flow and durability.

17·78. Research in Cementitious Materials (A). Opportunity for laboratory investigation amplifying the work done in courses 17·771 and 17·772.

METEOROLOGY

Subjects 19·00 to 19·99

19·01. Descriptive Meteorology I. Simplified treatment, with a minimum of mathematics, of composition and structure of the atmosphere; elementary thermodynamics and the heat balance of the atmosphere; the circulation principle (geostrophic, gradient, and frictional wind); formation and characteristic forms of atmospheric condensation phenomena. Willett, *Descriptive Meteorology.*

19·02. Descriptive Meteorology II. Continuation of 14·01, covering the general circulation of the earth's atmosphere; the secondary circulations, both tropical and extratropical, including the role of air masses and fronts; the tertiary (local) circulations, including drainage winds, local convection, whirlwinds, showers, thunderstorms, land and sea breeze, large scale turbulence eddies, föhn winds, etc. Willett, *Descriptive Meteorology.*

19·14. Long Range Weather Forecasting (A). Principal methods of long range weather forecasting. Detailed treatment of the present Weather Bureau five-day forecasting and verification techniques. Laboratory exercises in application of the five-day prognostic technique. Selected reading of special reports and articles.

19·21. Meteorological Observations. Observation, recording and coding of weather data; use and maintenance of station instruments; teletype circuit operation and procedure.

19·22. Meteorological Instruments (B). Lectures on methods and instruments used to obtain meteorological data, and on the fundamental principles involved. Laboratory exercises on calibration of typical anemometers, meteorographs and radiometeorographs. Field exercises on the measurement of upper air temperatures, humidities and wind velocities; reduction and plotting of meteorological data in suitable form for synoptic and dynamic studies.

19·30. General Climatology. Distribution of radiation, temperature, pressure and wind, hydrometeors and air masses and fronts at the surface of the earth and aloft and of the physical factors determining this distribution. Climatic zones and types. Microclimatology. Effect of climate on human life. Climatic changes. Haurwitz and Austin, *Climatology.*

19·31. Regional Climatology (B). Description of the climate of each continent and of the oceans in terms of dynamics of the atmosphere, of air mass types and frontal activity. Haurwitz and Austin, *Climatology.*

19·43. Synoptic Meteorology I (B). Principles of weather map analysis: the meteorological elements and their conservatism, classification of air masses, North American air mass properties, formation and characteristics of fronts. frontal disturbances, basis of upper air analysis, tropical hurricanes. Required reference reading.

19·44. Synoptic Meteorology II (B). Meteorological elements and their conservatism; practical rules and formulae for extrapolating the movement and development of surface and upper air pressure systems; hydrometeors, clouds and colloidal stability; stability and instability and their relation to weather phenomena. Petterssen, *Weather Analysis and Forecasting.*

19·45. Synoptic Meteorology III (A). Analysis of the field of motion with reference to divergence, convergence and vertical motion; fronts and frontogenesis; cyclone waves and structure of moving cyclones; survey of quantitative methods for the construction of surface and upper air prognostic charts. Petterssen, *Weather Analysis and Forecasting.*

19·50. Introductory Meteorology Laboratory. Explanation of international weather symbols and airways teletype code; decoding and plotting of daily weather reports; identification of cloud types; elementary principles of weather map analysis.

19·51. Synoptic Laboratory I (B). Analysis of weather maps. Application of practical rules for extrapolating the movement and development of pressure systems. Practice forecasting for selected stations.

19·52. Synoptic Laboratory II (B). Analysis of weather maps and practice weather forecasting for selected stations, together with practice in special airways forecasting, utilizing the teletype line sequences.

19·53. Synoptic Laboratory III (A). Continuation of 19·52. Advanced methods of analysis and forecasting with special emphasis on the use of aerological diagrams, cross sections, upper air charts, etc.

19·60. Thermodynamics of the Atmosphere. Review of classical thermodynamics. Thermodynamics of the atmosphere with special emphasis on the role of water vapor. Atmospheric statics. Theory and construction of the common thermodynamic diagrams used in meteorology.

19·61. Dynamic Meteorology I (B). Effects of the earth's rotation on motion. Simple atmospheric motions: geostrophic wind, gradient wind, thermal wind, and isallobaric wind. Surfaces of discontinuity. Equation of continuity,

Meteorology Continued

Pressure variations, convergence and divergence. Haurwitz. *Dynamic Meteorology.*

19·62. Dynamic Meteorology II (B). Hydrodynamic equations of motion. Streamlines and trajectories, circulation and vorticity, theory of atmospheric turbulence, its effects on the vertical distribution of wind and other meteorological elements. Energy transformations in the atmosphere. Survey of the wave theory of cyclones. Haurwitz, *Dynamic Meteorology.*

19·64. Dynamic Meteorology III (A). Advanced treatment of the dynamics of atmospheric motion, including a detailed study of atmospheric turbulence. Solution of the simpler problems connected with the wave theory of cyclones and with the study of large scale atmospheric motions.

19·65. Dynamic Meteorology IV (A). Continuation of Dynamic Meteorology III, placing emphasis on the problems arising because of the spherical shape of the earth. Atmospheric tides.

19·67. Graphical Analysis (B). Applications of graphical algebra and calculus to scalar and vector fields. V. Bjerknes, *Dynamic Meteorology and Hydrography II.*

19·70. Elementary Physics of the Atmosphere. Treatment of atmospheric radiation, the ozone layer and the upper atmosphere, atmospheric electricity, atmospheric optics, propagation of sound in the atmosphere, and icing of aircraft.

19·72. Physical Meteorology (A). More detailed study of radiation theory as applied to the atmospheric heat balance; structure and composition of the stratosphere with special reference to the ozone layer. Theory of the visual range; physical theory of atmospheric condensation and precipitation processes.

19·83. Oceanography (B). Principles and methods of physical and dynamical oceanography, and the current systems of the oceans with special emphasis on their meteorological significance. Sverdrup, *Oceanography for Meteorologists.*

19·91, 19·92. Meteorological Seminar I, II (A). Weekly reviews and discussions by staff members and students, of recent meteorological contributions published in current periodicals, and of original research.

19·911, 19·912. Meteorological Seminar I, II (A). Same as 19·91.

19·95. Special Problems in Meteorology (A). Reading, consultation and original investigation on meteorological problems.

FOOD TECHNOLOGY

Subjects 20·00 to 20·99

20·01, 20·02. Technology and Chemistry of Food Supplies. Chemical composition, production, consumption, statistics, and methods of treatment of food materials. General commercial methods of production and handling of raw foods, such as milk, eggs, meats, cereals and other vegetable food supplies, and their preparation for commercial distribution or for later manufacturing processes. Fundamental principles involved in physical processes such as refrigeration, dehydration, and salting, and the microbiology and chemistry of the processes. Laboratory work including numerous exercises involving the chemical analysis of various foods and food products. Prescott and Proctor, *Food Technology;* Woodman, *Food Analysis.*

20·04. Chemistry of Foods. Analytical methods, fundamental basis of nutrition; extent, character and legal status of food adulteration. Woodman, *Food Analysis.*

20·11. Technology of Food Products (B). Methods of food preservation and manufacture. Semi-plant scale operations in dehydration. Production of fruit juices and concentrates, canning processes, and quick-freezing of various foods. Cruess, *Commercial Fruit and Vegetable Products;* Tanner, *The Microbiology of Foods.*

20·12. Technology of Food Products (B). A continuation of 20·11 with reference to the products and technological processes of the meat-packing industry, fisheries, dairy products, and special technical procedures involving heat penetration, sterilization, and packaging. Tressler and Evers, *The Freezing Preservation of Fruits, Fruit Juices and Vegetables.*

20·32. Chemistry of Nutrition (B). The needs of man and animals for calories, carbohydrates, fats, proteins, amino acids, minerals, and vitamins.

20·322. Chemistry of Nutrition Laboratory (B). Analysis for nutrients of representative foods by chemical, colorimetric, fluorometric, and microbiological techniques.

20·34. Applied Nutrition (A). Nutrient requirements of man and animals; laboratory and clinical methods for determining requirements and nutritional status; techniques for measuring adequacy of dietaries; genetic and environmental factors influencing nutrient content of foods; food habits; population feeding programs; school lunches; communal feeding, etc.; international nutrition problems.

20·36. Advanced Nutrition (A). Digestion of food and metabolism of nutrients, including: occurrence of nutrients in plant and animal products; stability of essential nutrients during plant growth, harvesting, storage, manufacture, and preparation for serving; influence of diet on intestinal synthesis of vitamins; synergistic action of nutrients; absorbability of nutrients from alimentary tract; endocrines and nutrition; dynamics of body constituents; isotopic and radioactive techniques; measurement of food proteins; amino acid analysis; methods of research with animals.

20·41. Bacteriology. Biology, biochemistry, and biophysics of bacteria with emphasis on the study of selected types. Laboratory work including use of various methods for studying bacteria, and studies to determine effect of physical and chemical agents on bacteria. Zinsser and Bayne-Jones, *A Textbook of Bacteriology.*

20·42. Industrial Microbiology. Theory and practice involved in fermentation processes, and industrial and economic applications of microbiology in agriculture and manufacture of biochemical preparations. Industrial alcohol, vinegar, acetone, butyl alcohol, glycerin, fermentation acids, and applications in the leather and food industries.

20·43, 20·44. Advanced Industrial Microbiology (A). Current theories of the mechanisms of fermentations, and selected problems in the use of yeasts, bacteria and molds for the production of substances of industrial or potential value. Emphasis on the study of the most recent cultural and production methods and the biochemistry of the fermentations or the changes concerned. Biochemical activities of the acetic acid bacteria; preparation of organic acids, alcohols, alcoholic beverages, enzyme products, lipids, sterols, and other substances; and relation of certain biological agents to the textile, timber and leather industries. Prescott and Dunn, *Industrial Microbiology;* Smith, *Industrial Mycology;* Bernhauer, *Gärungschemisches Praktikum.*

20·46. Bacteriology of Foods (A). Quantitative study of the handling and storage of foods and their bacterial deterioration. Food storage in atmospheres of inert gases, food fumigation, recent advances in food packaging, and relation of bacteria thereto.

20·51, 20·52. Advanced Food Technology (A). Technical problems in special food industries, involving the use of dehydration, sterilization, homogenization equipment, and special applications of physics, chemistry, and biology in food technology. Clayton, *Colloid Aspects of Food Chemistry and Food Technology.*

20·61, 20·62. Food Technology Seminar (A). Presentation of recent advances in food technology and research and analysis of the fundamental principles involved.

GRAPHICS

SUBJECTS D1 TO D99

D11. ENGINEERING DRAWING. Instruction in correct use of drafting instruments and materials. Practice in lettering. Theory of projection drawing. Drawing in orthographic, isometric, oblique and perspective projection. Practice in dimensioning, making of dimensioned freehand sketches of machine parts and accurate detail and assembly drawings from sketches. Tracing in ink and pencil on cloth or paper of finished drawings.

D12. DESCRIPTIVE GEOMETRY. Fundamental concepts of descriptive geometry, including reference systems, representation of point, line and plane; fundamental problems of position, of perpendicularity and of measurement. Solutions of fundamental problems checked by methods of analytic geometry. Various surfaces and solids, their sections, developments and intersections. Application of descriptive geometry to certain problems arising in engineering practice. Especial emphasis on ability to visualize problems, and processes involved in their solution. Watts & Rule, *Descriptive Geometry*.

D31. NOMOGRAPHY. Nomographic method of solving equations in three or more variables and its application to scientific and engineering data. Functional scales, network charts, simple nomographic relationships derived from plane geometry.

ECONOMICS AND SOCIAL SCIENCE

SUBJECTS Ec1 TO Ec99

Ec11. ECONOMIC PRINCIPLES. Introduction to such fundamental economic concepts as national income, production, unemployment, public finance and public debt, money, banking, international trade, prices, business, labor, and stock market. Stress on current problems facing every citizen.

Ec12. INDUSTRIAL ECONOMICS. Examination of particular American industries with special attention to degree of monopoly and competition; means of restoring competition; patent question; regulation of public utilities; public policy in relation to private enterprise; impact of business cycle. Tools of analysis learned in preceding subject in Economic Principles applied in case studies.

Ec13. PRICES AND PRODUCTION (B). Synthesis of the various tools employed in different branches of economic analysis giving particular attention to the pricing process and to variations of output in the business cycle.

Ec15. PRINCIPLES OF ECONOMICS AND LABOR RELATIONS. Introduction to general economics combined with discussion of problems arising in employer-employee relations. *Economics:* discussion of the problem of full employment, involving a study of the national income and its determinants with considerable attention to the savings-investment process. *Labor relations:* brief surveys of the development of the labor movement and of trends in labor legislation. Consideration given to major concrete problems of labor relations as encountered in industry today — wage determination, seniority and layoff methods, grievance procedures, union management coöperation, etc.

Ec17, Ec18. ECONOMIC ANALYSIS (A). Interdependent growth of theory and fact, general theory of equilibrium under competition and monopoly. Findings revalued under conditions which more closely approach reality.

Ec19. MATHEMATICAL APPROACH TO ECONOMICS (A). Use of mathematical methods in all fields of economics.

Ec21. ECONOMICS OF SCIENCE AND ENGINEERING (A). Designed for engineers and economists who are interested in exploring the social function of science. Comparison of the organization and functioning of science in the United States and other countries, notably Russia. The role of science in American universities, the rise of industrial and government research, the possibilities of using science to combat business depressions, the operation of the patent system in relation to technical progress, and new problems arising from the development of atomic energy. Emphasis on historical and international aspects.

Ec22. ECONOMICS OF SCIENCE AND ENGINEERING SEMINAR (A). Discussion of the function of science in industry. Analysis of the process of invention and the special problems concerned with translating fundamental scientific discoveries into practical applications in industry. Exploration of the relationship between the organization of an industry and the level of its research practice, also the management of research in large and small companies. Discussion in several of these seminars led by directors of research in different types of companies.

Ec23. POSTWAR PROBLEMS (B). Economic problems involved in maintaining national income and employment under conditions likely to prevail after the war.

Ec24. SCHOOLS OF ECONOMIC THOUGHT (A). Economic ideas developed by different groups of economists in recent times.

Ec26. BUSINESS CYCLES (A). Statistical, historical, and theoretical examination of determinants of income, production and employment. Modern methods of analysis, forecasting, and control.

Ec27. ECONOMICS OF PATENTS AND INVENTION (B). Discussion of the process of research, invention and technical innovation and the operation of the patent system, also comparison with patent systems of other countries. Emphasis on the role of inventions in different types of industries. Cases used for illustrative purposes.

Ec28. ECONOMICS OF PATENTS AND INVENTION (B). Designed for students who hope to be inventors or technical innovators, or to participate in the launching of a scientific enterprise. Inventors and directors of research invited to lead some of the class discussions.

Ec32. INTRODUCTORY ECONOMIC STATISTICS. Frequency distributions, averages, index numbers, time series, simple correlation, and elementary analysis of variance.

Ec322. ELEMENTARY STATISTICS. Elementary statistical methods applied to social and economic problems. Some attention paid to the mathematics of statistics, to elementary probability theory, and to applications outside the social sciences.

Ec33. PSYCHOLOGICAL STATISTICS (B). Elementary probability theory; problems of sampling; statistical evaluation of means and frequencies. Emphasis on application to techniques of observation and experimentation in group psychology.

Ec 34. PSYCHOLOGICAL STATISTICS (A). Factorial design and analysis of variance and co-variance; correlational techniques; new statistical techniques; general problems of statistical evaluation. Emphasis on application to psychological and group problems.

Ec 35. INDUSTRIAL STATISTICS (B). Applications of statistical methods in sampling inspection and industrial quality control. Statistical Research Group, *Sampling Inspection;* Peach, *Industrial Statistics*.

Ec 36. EXPERIMENTAL STATISTICS (A). Application of statistical methods to the design and analysis of laboratory and factory experiments, and, more generally, to the planning

Economics and Social Science Continued

of scientific research. Freeman, *Industrial Statistics;* Statistical Research Group, (1) *Sequential Analysis of Statistical Data: Applications;* (2) *Studies in Applied Statistics.*

Ec37. THEORETICAL STATISTICS (B). Introduction to modern statistical theory. Mathematical exposition. Kendall, *The Advanced Theory of Statistics*, Volume 1.

Ec38. THEORETICAL STATISTICS (A). Continuation of Ec37. Kendall, *The Advanced Theory of Statistics*, Volume 1 and, if available, Volume 2.

Ec47. INVESTMENT FINANCE (A). Investment securities, corporate promotion, business expansion, working capital requirements, business failure and corporate reorganization examined from points of view of business executive and of investor. (Not open to Course XV students.)

Ec48. INVESTMENT ANALYSIS (A). Investment characteristics of enterprises and methods of analyzing their secuities. Corporate reports and their interpretation. Investmene canons and their limitations.

Ec49. PUBLIC FINANCE (B). Examination of expenditures and revenue systems of federal and local governments in the United States, and a study of effects of various fiscal policies and methods upon social and economic development of the community.

Ec50. BANKING AND FINANCE (B). Recent credit trends including international banks, government agencies, housing finance, and other timely topics.

Ec54. CORPORATIONS (B). For students whose professional interest may be in scientific or engineering fields, but who desire some knowledge of corporate organization and finance and social and political problems of business. (Not open to Course XV students)

Ec56. PROBLEMS IN INDUSTRIAL ECONOMICS (B). Economic problems faced by small and large enterprises, and public policies developed to meet these problems under conditions of competition and monopoly.

Ec57, Ec58. INTERNATIONAL RELATIONS. Basic factors in world politics, foundations of national power; influence of geography; relative power positions of the Great Powers; formation and execution of foreign policy; conduct of international affairs; plans for settlement of the war and establishment of a new world organization; and relationship of technology and international affairs.

Ec59. INTERNATIONAL ECONOMICS (A). International economic equilibrium and operation of adjusting mechanisms as they are affected by recent national policies with respect to trade, finance, money, and exchange.

Ec60. LABOR RELATIONS. Survey of personnel administration and relations with organized labor, intended primarily for those students who take no other work in labor relations. Discussion of the place and functions of personnel administration, nature of unionism, union policies and practices, and labor legislation. Development of a point of view and a method of analysis through cases presented to the class.

Ec65. INDUSTRIAL RELATIONS (B). Students will analyze and discuss case situations in current industrial relations.

Ec66. SEMINAR IN INDUSTRIAL RELATIONS (A). Constructive participation in developing "situational thinking" as a distinctive approach to industrial relations.

Ec67, Ec68. SEMINAR IN LABOR PROBLEMS (A). Labor problems in the United States.

Ec70. INTRODUCTORY PSYCHOLOGY. Systematic psychological approach to organized human effort. Use of basic psychological concepts drawn from everyday life to give the student a practical understanding of the behavior of people in organizations. Examination of principles underlying such typical organizational phenomena as leadership, management, organized group effort, coöperation, morale.

Ec71, Ec72. MOTIVATION AND PERSONALITY DEVELOPMENT [Ec71 (B), Ec72 (A)]. Aspects of the development of the individual which influence his adult relations to his fellows and his culture. Special emphasis on modern motivational theory.

Ec721. PSYCHOLOGY OF PERCEPTION AND ACTION (A). Problems of action, verbal expression and social perception. Stress on the relation to work efficiency, to interviewing procedures and to performing certain social functions (role playing).

Ec723. THEORY OF THE MANAGEMENT OF PEOPLE. Systematic examination of the basic requirements for directing and coördinating the activities of people. Continuation of Ec70 into the specialized problems involved in getting work done by others.

Ec724. TECHNIQUES OF MANAGING PEOPLE. Laboratory subject designed to give the student a practical understanding of methods for getting changes in the behavior of people in face-to-face group contacts.

Ec725. COMPARATIVE CONTEMPORARY CULTURES. Comparative study of contemporary cultures and sub-cultures. The influence of national, ethnic, and class membership on individual development and behavior. The role of culture in setting norms of behavior, standards of judgment, and patterns of social interaction. Case study of dynamics of selected social movements.

Ec73. ADVANCED PSYCHOLOGY. Analysis of factors in personal development and in the structure of the social and physical environment which determine the way in which we perceive, interpret, and react to events and persons. Study of the sources and types of bias or error in perceiving, judging, acting. Techniques of achieving objectivity in assuring that action is based on social and physical reality.

Ec731, Ec732. INTRODUCTION TO GROUP PSYCHOLOGY [Ec731 (B), Ec732 (A)]. A basic orientation to a systematic theory of group life: group structure and functioning, group interaction, group ecology, the relation between individual and group. Stress on the relation to industry, public administration, nutrition and other applied fields.

Ec735. ADVANCED GROUP PSYCHOLOGY (A). Group Psychology on a more advanced level with specific problems, such as leadership of different types and capacities and leadership training for different purposes.

Ec75, Ec76. LABORATORY IN RESEARCH METHODS (A). Basic experimental and observational techniques in individual and group problems; scientific methods of evaluation.

Ec77. SEMINAR ON TOPOLOGICAL PSYCHOLOGY (A). Scientific representation of psychological "force fields."

Ec781, Ec782. SOCIAL PSYCHOLOGY OF CHANGE (A). Conditions of change and constancy in individual and group life; factors determining the degree and permanence of change. Emphasis on practical methods of producing desired changes.

Ec791, Ec792, Ec793, Ec794. ADVANCED PSYCHOLOGICAL SEMINAR (A). Available to students after one year of graduate work and dealing with current research — an opportunity to participate in developing new concepts and theories.

Ec80. AMERICAN GOVERNMENT. Governmental process in United States viewed historically and functionally. Development of American system in relation to changes that have taken place in political ideas in this country and abroad.

Ec82. GOVERNMENT CONTROL OF INDUSTRY (A). Relationship of state to economic activity. Attention centered on the United States, but comparison made with medieval guild control, policies of mercantilism and with contemporary foreign systems.

Ec83. URBAN SOCIOLOGY. Social characteristics of urban and rural communities and problems which arise in cities in connection with provision of facilities for housing, industry, government, education, recreation, and transportation.

Ec85, Ec86. LAND ECONOMICS (B). Principles of classification and utilization of urban and rural land. Policies of conservation and control of land and their effects on social development.

Ec88. BUILDING ECONOMICS. Social, political, industrial, and economic factors affecting the location, construction, financing, and marketing of buildings — with emphasis on low cost housing.

Economics and Social Science Continued

Ec91, Ec92. Economics Seminar (A). Special social problems or economic problems of particular industries. (Open to graduate students only.)

Ec93, Ec94. Industrial Economics Seminar (A). Readings, discussions, reports on such topics as industrial price policies, government regulation of industry, competitive practices and other phases of industrial economics.

Ec95, Ec96. Social Science Seminar (A). Reading, discussion, and case work relating to non-economic aspects of human behavior and human relations in the perspective of modern social and industrial conditions.

For description of the following subjects see Division of General Studies.

G75. Human Relations.

G76. Human Relations.

ENGLISH AND HISTORY

Subjects E1 to E99

E1. Entrance English.

E11. English Composition. Principles of effective written and oral communication. Particular attention to logical organization of papers and talks and to precise and coherent expression of facts and opinions. Numerous papers and speeches required.

E12. English Composition. Continuation of E11.

E21, E22. The United States in World History. Historical development of the modern world, stressing the growth of the United States as a member of a general western civilization; evolution of governmental, social, and economic organization, intellectual trends, and influence of science and technology; experiences of the United States and other countries in dealing with related problems compared and contrasted. The first term covers the period from 1500 to 1870; the second term, 1870 to the present.

E25. English Composition. Students who in the collective judgment of members of the Department of English and History have failed in E22 to meet certain standards of expression and therefore have received a Composition D required to take this subject. It may be prescribed at any time for juniors and seniors whose use of English in their professional courses is unsatisfactory. Instruction carried on in frequent group meetings and in individual conferences, at hours to be determined by the instructor. No credit given for this subject.

E33. Report Writing. Practice in writing simple memoranda, business letters, and comprehensive scientific reports. Search of literature of subjects pertaining to thesis in Chemistry, arrangement of material, and its presentation in oral and written report form. (Open to Course V students only.)

E35. Reports. Preparation and presentation of business and engineering reports. Practice in investigation of subjects, arrangement of material and its presentation in report form. Subjects covered range from simple memoranda and business letters to longer, more comprehensive reports. Emphasis on written reports and on oral presentation before committees.

E41, E42. History of Thought. Traces historical connection between present day ideas, and theories of great thinkers in science, philosophy, government, and economics. The first term covers the period 1200–1789, the second term, the period from 1789 to present time.

E43, E44. Western World Literature. Comprehensive view of some of the writings of outstanding western world authors. Only men in the first rank are dealt with, and their works are studied with the object of showing their place in world literature. The first term begins with classical Greek literature and ends with the age of enlightenment, the second term, covers from the age of enlightenment to present time.

E46. Introduction to Music. Approach to the understanding of musical development. Many musical illustrations in the classroom. Lectures and outside reading to give simply nad clearly the knowledge needed by an intelligent listener.

E51, E52. Seminar in Economic and Industrial History (A). An historical study of the economic concepts and institutions which have governed the production and distribution of goods since the Middle Ages. Particular attention given to the evolutionary character of economic institutions and to the development of modern industrial organizations. Two full year subjects in Social Science will be required as preparation for admission to the subject.

E53. Reading Seminar. Independent reading for graduate students. Works read selected in conference with the instructor and discussed either in conference or in a small group meeting once a week.

For description of the following see Division of General Studies.

G7. Problems of Modern Philosophy.

G38. Public Speaking.

G39. Reading Seminar.

G67. Principles of Debating.

G68. Principles of Debating.

HUMANITIES AND SOCIAL SCIENCES

DURING each regular academic year, in addition to required courses in mathematics, science, engineering and modern languages, undergraduate students are expected to carry one course in the general field of the humanities and social sciences. In the second half of the third year and in the fourth year a limited number of options are permitted. The list of options may be modified or extended from year to year.

HUMANITIES I

First Year

First Term	E11	English Composition.....	3–5
Second Term	E12	English Composition.....	3–5

HUMANITIES II

Second Year

First Term	E21	U. S. in World History.....	3–5
Second Term	E22	U. S. in World History.....	3–5

HUMANITIES III

Third Year

First Term	Ec11	Economic Principles.....	3–5
Second Term	Ec12	Industrial Economics.....	3–5
(Choice of	Ec60	Labor Relations.....	3–5
one)	Ec70	Psychology, Introductory....	3–5

HUMANITIES IV

FOURTH YEAR

First Term (Choice of one)	(1)4·41	Fine Arts	3–5
	(2)Ec57	International Relations	3–5
	(3)E41	History of Thought	3–5
	(4)E43	Western World Literature	3–5
Second Term (Choice of one)	(1)E46	Music, Introduction	3–5
	(2)Ec58	International Relations	3–5
	(3)E42	History of Thought	3–5
	(4)E44	Western World Literature	3–5

It is expected that a student will desire to follow the same field through both terms.

GENERAL STUDIES

SUBJECTS G1 TO G99

THIS section includes subjects of a general and essentially non-vocational character which are offered for the purpose of giving the student an opportunity of broadening his education. When the coördinated program in the humanities and social sciences is in full effect, these studies will be *optional electives without credit.* So far as possible, the subjects offered in any term, and the hours and methods of instruction will be planned to meet the needs of students who request subjects of this type. The list will accordingly be modified from time to time.

G7. PROBLEMS OF MODERN PHILOSOPHY. The self and the will.

G8. HISTORY OF PHILOSOPHY. General survey of modern philosophy from the time of Descartes.

G9. GEOLOGY. Consideration of the forces now modifying the earth and its inhabitants, and history of changes produced by these forces throughout the past, upon the earth and its life. Shimer, *Introduction to Earth History.*

G28. ECONOMIC GEOGRAPHY. Seas and land masses of the world, with geography of human races, with the world's resources in mineral wealth and its resources of plant and animal origin; also with distribution of commodities, with manufactured products, with economic basis of world trade and with national control of raw materials.

G29. TOPOGRAPHY IN THE WORLD WAR. Influence of topography in directing military objectives considered in every theatre of the world war, and influence of topography in defense for areas which may reasonably become involved.

G38. PUBLIC SPEAKING. Designed, through practice and criticism, to afford knowledge of principles of public speaking and, to extend the range of student's intellectual interests.

G39. READING SEMINAR. Opportunity to read good books under direction. Readings will be chosen from a selected list of interesting and important works of past and present. Each student's selection, given unity of interest in a period or a subject. Written critical reviews, oral presentations, and group discussions. Group limited to fifteen students.

G67. PRINCIPLES OF DEBATING. In addition to discussion of fundamentals of argumentation and debating, a public question with important economic and political significance is selected for study and analysis. Individual instruction in collection of material and in oral presentation of conclusions. Class open to a selected group of students, after consultation with instructor, on basis of capacity and interest in debating and public speaking.

G68. PRINCIPLES OF DEBATING. Psychology of persuasive speech, separate assignments in argumentation, public speaking methods, and audience psychology being correlated to this end. One-half the subject devoted to the theory of persuasive speech; remainder devoted to training of student in practical application of this theory. Each student to write and deliver (on a recording machine) two examples of "persuasive speech." Robert Oliver, *The Psychology of Persuasive Speech.*

G75. HUMAN RELATIONS. Fundamental object a realization of necessity for good method in dealing with human relations, as well as grounding in what constitutes good method. Such basic influences as aptitudes, habits, attention, understanding, desires, and prejudices analyzed and applied to typical situations which arise in employment. Illustrative problems taken from actual cases with emphasis on that structural analysis which characterizes good method. Except by special permission of instructor, only juniors and seniors may elect the subject.

G76. HUMAN RELATIONS. Continuation of G75 which applies fundamentals already learned to job interviews, hiring, discipline cases, problems in coöperation, industrial conflict, etc. Case demonstrations of actual situations in which selected students act as executives presented in the classroom; the person taking the part of employee is brought in from industry and the technique of students handling the situation subsequently discussed, often by actual business men familiar with the original situation. Except by special permission of instructor, only juniors and seniors may elect the subject.

G79. COMPARATIVE POLITICAL INSTITUTIONS. Various theories of government viewed historically and comparatively. Modern trends as evidenced by Fascism, Communism, Socialism and the changes in constitutional democratic government discussed in detail in relation to social and economic changes.

MODERN LANGUAGES

SUBJECTS L1 TO L99

VARIOUS courses are offered in German, French, Spanish, and Russian. Those in French and German are of elementary and intermediate grade. At the elementary level a careful foundation is laid for reading, writing, speaking, and hearing the foreign language. Great care is taken to secure a good pronunciation, a mastery of the working essentials of grammar, and a reasonable vocabulary for the expression of common ideas. At the intermediate level, there is continued work in the spoken language with training of the ear and the development of a broad reading vocabulary. The reading texts include scientific matter, fiction, drama, historical or descriptive works of a nature to open up to the student the genius, institutions and social organizations of the country studied. Part of the work consists of assignments for written translation of articles from recent foreign journal sselected by each student according to his individual interests and needs. The elective courses in Spanish and Russian are given only on the elementary level.

Special intensive courses open to graduate students only are offered in addition to the above, and as opposed to the cul-

Modern Languages Continued

tural objective of the undergraduate courses, these have a narrowly limited purpose; namely, to prepare each student to read technical and scientific material in his own field.

L11, L12. Elementary German. Necessary foundation for German language for scientific and literary purposes. Training in pronunciation, elementary grammar, acquisition of useful vocabulary, reading of varied matter, some of which deals with science, and individual written translations from recent scientific works. Texts (subject to modification): Cowden and Van Eerden, *Introduction to College German;* Sepmeier, *Hans und Liese;* Wizinger, *German Science Readings.*

L21, L22. Intermediate German. Systematic review of grammar, miscellaneous prose and individual written translations from recent scientific works. Trains students to read understandingly any ordinary newspaper or magazine article of a literary or popular scientific nature, to understand simple spoken German, and to express simple thoughts in German. Texts (subject to modification): Wild, *Anthology of Scientific German;* Zeydel, *First Course in Written and Spoken German;* Kästner, *Drei Männer im Schnee.*

L41. Scientific German. Intensive preparation for doctoral language requirement in German. No previous study of German required. Group meetings for discussion of ways to facilitate comprehension of grammatical and syntactical difficulties. Tutorial conferences on reading material in the field of thei student. (Open to graduate students only.)

L51, L52. Elementary French Necessary foundation for French language and literature, or for scientific studies. Training in pronunciation, elementary grammar, acquisition of useful vocabulary and reading of varied matter, part of which deals with French institutions and the history of France, practice in hearing and speaking French; also individual written translations from recent scientific works. Fraser, Squair, and Parker, *Revised Elementary French Grammar;* Heath Chicago *French Readers I–V;* Haden and Trotter, *Science Francaise.*

L61, L62. Intermediate French. Continuation of pronunciation, and useful conversational forms; reading of matter dealing with France; some standard modern authors; reading of scientific French; individual written translations from recent scientific works.

L71. Scientific French. Intensive preparation for doctoral language requirement in French. No previous study of French required. Group meetings for discussion of ways to facilitate comprehension of grammatical and syntactical difficulties. Tutorial conferences on reading material in the field of the student. (Open to graduate students only.)

L81, L82. Elementary Spanish. Emphasis on spoken Spanish, pronunciation, intonation, vocabulary building, and essentials of grammar. Hills, Ford, Rivera, *Brief Spanish Grammar for Colleges;* Castillo and Sparkman, *Graded Spanish Readers;* Torres-Rioseco & Morby, *Cartilla Metjicana.*

L83, L84. Intermediate Spanish. Brief grammar review, conversational forms, composition and letter writing; reading of varied matter, a large part of which deals with Spanish-American countries. Texts (subject to modification): Seymour and Carnahan, *Alternate Spanish Review Grammar;* Castillo and Sparkman, *Volando por Sudamérica;* Crow, *Cuentos Hispánicos;* Quintero, *Doña Clarines.*

L95, L96. Elementary Russian. Elementary grammar; practice in reading Russian. Enables a good student by the end of year to read scientific articles in Russian, also laying the foundation for continued study of the language.

L97. Scientific Russian. Intensive preparation for doctoral language requirement in Russian. No previous study of Russian required. Group meetings for discussion of ways to facilitate comprehension of grammatical and syntactical difficulties. Tutorial conferences on reading material in the field of the student. (Open to graduate students only.)

MATHEMATICS

Subjects M1 to M99

M1. Entrance Algebra.

M3. Entrance Solid Geometry.

M4. Entrance Trigonometry.

M10. Calculus. Brief survey of Analytical Geometry and Calculus for graduate students in Architecture whose preparation in mathematics does not cover the requirements for admission to the Graduate School.

M11. Calculus. Fundamental ideas of calculus. Differentiation and graphical representation of algebraic, trigonometric, logarithmic and exponential functions. Integration of simple algebraic and transcendental functions. Maxima and minima applications to problems in geometry and mechanics, such as determination of velocity, acceleration, area, volume and pressure. Discussion of the analytic geometry of the straight line, and the conic sections.

M112. Mathematics (College Transfer). For college transfer students who have taken calculus prior to their transfer but whose preparation is not sufficient to cover first year requirements.

M12. Calculus. Parametric representation of curves, polar coördinates. Methods of integration including approximate integration. Further applications of derivatives and integrals, including arc length, curvature, surface area, center of gravity and moment of inertia. Average values. Elementary vector analysis in the plane, vector velocity and acceleration.

M21. Calculus. Partial differentiation. Infinite series. Complex numbers. Surfaces and vectors in three-dimensional space. Dot and cross products of vectors and their applications. Multiple integration and geometrical and physical applications.

M212. Mathematics (College Transfer). For college transfer students who have taken calculus prior to their transfer but whose preparation is not sufficient to cover second year requirements.

M22. Differential Equations. Treatment of ordinary differential equations including principal types of first and second order equations, simultaneous equations, and linear equations with constant coefficients. Illustrated by numerous applications to geometry, chemistry, physics and mechanics. Phillips, *Differential Equations, Third Edition.*

M31. Differential Equations. Complex numbers, Fourier series, partial differentiation, systems of ordinary differential equations and some simple partial differential equations with applications to the long line and heat flow. Laplace Transforms. Franklin, *Differential Equations for Electrical Engineers.*

M32. Elementary Statistics. General survey of practical application of statistical methods to scientific and engineering problems, covering frequency distributions, moments, precision of measurements, correlation, tests of significance, analysis of variability and experimental design.

M331. Mathematical Theory of Statistics (B). Mathematical methods of statistics and their application to scientific and engineering data, including systems of frequency curves and moments, theory of large and small sampling simple partial and multiple correlations, contingency, statistical estimation, and analysis of variance.

M332. Mathematical Theory of Statistics (B). Statistical principles applied to design and analysis of complex experiments. Discussion of mathematical theory underlying modern experimental arrangements. Practical problems in-

Mathematics Continued

volving Latin squares and their variations, factorial design, split plot experiments, confounding and partial confounding, etc.

M341, M342. Modern Statistical Theory (B). Topics varying from year to year. Discussion of papers taken from recent journals. Solution of scientific and industrial statistical problems.

M351, M352. Advanced Calculus for Engineers (A). Ordinary differential equations; numerical and graphical methods, integration by power series, Legendre and Bessel functions. Laplace transforms. Characteristic value problems; series of orthogonal functions, in particular, Fourier series. Vector analysis; orthogonal curvilinear coördinates. Partial differential equations of mathematical physics. Conformal mapping. Elements of linear integral equations. Calculus of variations with applications. *Mimeographed notes in preparation.*

M36, M37. Advanced Calculus (A). Complex variable, power series, partial differentiation, implicit functions, Gamma and Beta functions, line, surface and space integrals, vectors, ordinary differential equations, Bessel functions, partial differential equations, calculus of variations, elliptic integrals.

M381, M382. Theory of Functions (A). Course in complex variables emphasizing the aspects most useful in applications. Complex numbers, series, analytic functions, Cauchy's theorem, residues, contour integration, conformal mapping, Riemann surfaces, conjugate functions, integrals and products, entire functions, the gamma function, asymptotic series, linear differential equations, special functions, Fourier transforms in complex domain. Copson, *Theory of Functions of a Complex Variable.*

M441. Projective Geometry (B). Homogeneous coördinates. Point, line, and plane coördinates. Ranges and pencils. Principle of duality. Curves and surfaces of second order and of second class. Linear transformations. Projective measurement. Non-Euclidean geometry. Pentaspherical and Plücker coördinates. F. S. Woods, *Higher Geometry.* (Not offered 1946–47.)

M442. Elementary Differential Geometry (B). Plane and space curves. First and second differential form of a surface. Theorems of Meusnier and Euler. Lines of curvature, asymptotic lines, conjugate lines, geodesics. Theorems of Gauss and Codazzi. Developable surfaces, surfaces of rotation, Liouville surfaces. Differential parameters. Problems of mapping. W. C. Graustein, *Differential Geometry;* L. P. Eisenhart, *Differential Geometry.*

M451, M452. Fourier Series and Integrals (A). Elementary theory of Fourier series and integrals as developed along modern lines. Stress on practical applications and development of the necessary analysis from the beginning.

M461. Seminar in Applied Mathematics (A). Mathematical discussion of linear and non-linear problems arising in the field of mechanics of a continuum. (Not offered 1946–47.)

M481, M482. Topology (A). Discussion of basic concepts of Topology: topological spaces, metric spaces, closed sets, open sets, connected sets, mappings, general concept of dimension. Demonstration of classical theorems on the topology of Euclidean spaces (Invariance theorem, Jordan theorem, Fixed Point theorem), using the modern methods of mapping into spheres. Applications of two-dimensional topology to function theory and differential equations. Combinatorial topology: Complexes, Betti groups. Proof of the invariance of Betti groups. Duality theorems. Homology theory in topological spaces.

M54. Mathematical Laboratory (B). Practical instruction in numerical, graphical and mechanical calculation and analysis as required in the engineering or applied mathematical sciences, numerical solution of equations; graphical methods; nomography and the construction of graphical charts; curve fitting to empirical data, approximate methods of integration, differentiation and interpolation; use and principles of construction of instruments employed in calculation, and many kindred topics. Lipka, *Graphical and Mechanical Computation.*

M551, M552. Functions of a Real Variable (A). Theory of Lebesgue's integral with applications to important topics of the theory of functions of a real variable, such as trigonometric series, Fourier integrals, almost periodic functions, etc. Content varying from one year to another, so that graduate students taking the course for successive years can have an introduction to several important chapters of the theory of functions.

M561, M562. Functions of a Complex Variable (A). Complex integration, Cauchy's theorem, zeros, Jensen's theorem, Carleman's theorem, analytic continuation, maximum-modulus theorem, conformal mapping, power-series, entire functions. Content based upon the first eight chapters of Titchmarch, *Theory of Functions.* (Not offered 1946–47.)

M571, M572. Differential Equations (A). Existence theorems and approximation methods. Various aspects of the linear differential equations including boundary problems, solution of certain more common equations by series and integrals, singularities in complex domain. Relationship between integral and differential equations. Applications to the theory of filters and servo-mechanisms. Non-linear differential equations studied by analytical and topological methods. Singularities of various types with stress on physical interpretation. Poincaré-Liapunoff stability theory. Periodic orbits. Limit cycles. Perturbation methods. Constant reference to physical problems.

M581, M582. Continuous Groups (A). Basic concepts of group-theory, such as group, sub-group, invariant sub-group, finite and infinitesimal transformations; one-parameter groups and their applications to differential equations and geometry; r-parameter groups, structure constants, the fundamental theorems of Lie; invariant theories associated with continuous groups; differential invariants and applications to systems of partial differential equations. (Not offered 1946–47.)

M591, M592. Partial Differential Equations (A). Geometric approach to first and second order partial differential equations. Elliptic, hyperbolic, and parabolic equations. Singular solutions and their importance. Physical significance. Characteristics and wave fronts. Non-linear equations. Integral equation methods. Variational methods. Courant-Hilbert, *Methoden der Mathematischen Physik,* Vol. II.

M62. Modern Algebra (B). Polynomials, determinants, linear equations, linear transformation, matrices, linear independence, introduction to groups.

M631. Integral Equations (A). Objectives: (1) to show how to express physical problems in the form of integral equations, (2) to provide a treatment of the theory of integral equations, and (3) to describe the methods available for solving such equations. Applications to problems arising in several branches of physics and engineering.

M641, M642. Tensor Calculus (A). Elements of tensor algebra, followed by analysis of tensor fields, especially of those in which a metric is defined with the aid of a quadratic differential form. Applications to differential geometry, mechanics and physics.

M651, M652. Analytical Mechanics (A). Treatment of analytical dynamics of particles and rigid bodies, mainly by Lagrange's equations in generalized coördinates and Hamilton's canonical equations. Contact Transformation, Hamilton-Jacobi theory, theory of vibrations, and non-holonomic systems.

M681. Calculus of Variations (A). Extension of theory of maxima and minima as begun in calculus. Determination of functions, curves or surfaces with given maximum or minimum properties. Applications to geometry and physics; geodesics, minimal surfaces, isoperimetric properties of circle and sphere, Fermat's principle of least time (optics), Hamilton's principle, catenary, brachistochrone. Bolza, *Lectures on the Calculus of Variations;* Bliss, *Calculus of Variations;* Goursat, *Cours d'Analyse, vol. 2, chapter XXIII.*

M691, M692. Characteristic Value Problems (A). Linear algebra, orthogonal functions, linear integral equations; characteristic value problems of mathematical physics; applications of the calculus of variations; special functions defined

Mathematics Continued

by characteristic value problems. Courant-Hilbert, *Methoden der Mathematischen Physik.* (Not offered 1946-47.)

M73. Review of Mathematics. Review of college algebra, trigonometry, elementary calculus, differential equations. (Restricted to selected officers of the U. S. Army, Navy and Coast Guard only.)

M731, M732. Mechanics (B). Statics; point kinematics with applications to linkwork and mechanism; polar diagrams of velocity and acceleration; kinematics and dynamics of rigid bodies in three dimensions; dynamics of mechanisms; impact, theory of the gyroscope, with applications; Lagrange's equations; Hamilton's principle; theory of vibrations, with applications to engineering problems.

M76. Theory of Probability (A). Permutations and combinations. Elementary principles of theory of probabilities. Bernoulli's Theorem. Bayes' Theorem. Distributive functions and continuous variables. Averages. Curve fitting, H. Levy and L. Roth, *Elements of Probability;* T. C. Fry. *Probability and Its Engineering Uses.* (Not offered 1946-47.)

M77. Vector Analysis (B). Treatment of vector functions and operations required in theoretical work on electricty. Phillips, *Vector Analysis.*

M791, M792. Theoretical and Applied Elasticity (A). Analysis of stress and strain in three dimensions. Stress-strain relations. Minimum principles in elasticity, their theory and application to the approximate solution of boundary value problems. Theory of bending and torsion of bars. Theory of plane stress and strain, Airy's stress function, use of elements of complex variable theory. Bending of flat plates. Bending and stretching of thin shells. Elastic stability theory. Elements of the finite deformation theory of elasticity.

M831, M832. Analysis (B). Advanced calculus for those already familiar with elementary technique and desiring some knowledge of the logical development of calculus as a mathematical science. Real and complex number system, limits, continuity, convergence, series, integration, theory of functions of real and complex variables. Franklin, *A Treatise on Advanced Calculus.*

M90. Mathematical Reading (A). Reading of advanced mathematical treatises under the supervision of some member of the department. Choice of treatise and allotment of time according to individual cases. For graduate students finding it desirable to do advanced work not provided for in the regular subjects. Open to undergraduates only under exceptional circumstances.

For description of the following see Division of General Studies.

G8. History of Philosophy.

MILITARY SCIENCE AND TACTICS

Subjects MS11 to MS225

MS11. Military Science. (Required in all courses.) National Defense Act and the ROTC; world military situation; military organization; leadership drill and exercise of command; individual weapons and marksmanship.

MS12. Military Science. (Required for all courses.) World military situation; military organization; hygiene and first aid; leadership drill and exercise of command; maps and aerial photographs.

MS21. Military Science. (Required for all courses.) World military situation, physical development methods; maps and aerial photographs; military administration; evolution of warfare; military law and boards. Opportunity is given the student to choose the unit in which he desires to continue his training.

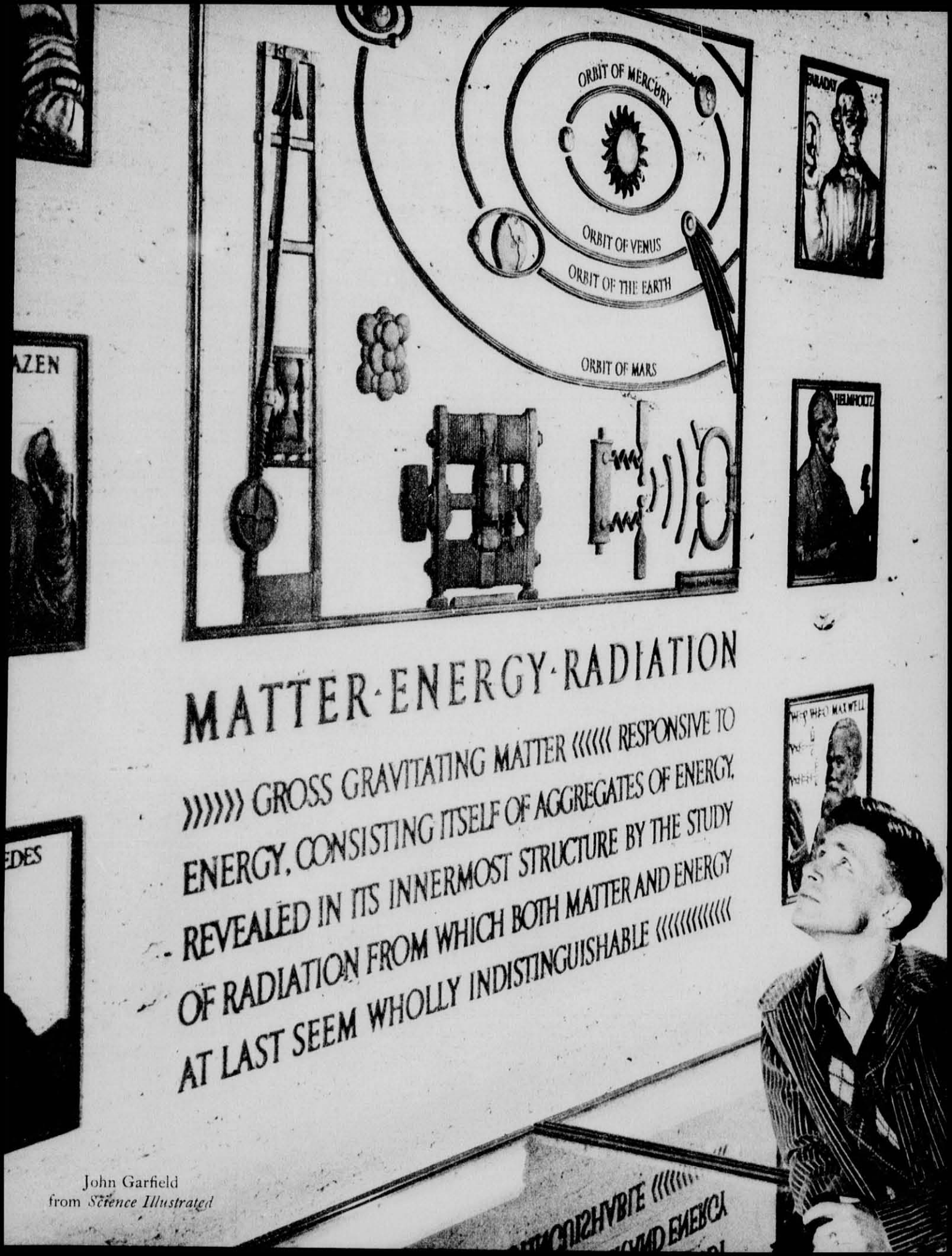
MS221. Military Science. Coast Artillery (Antiaircraft). Elements of antiaircraft artillery; organization and tactics; gunnery and fire control; target recognition; ammunition; Service of the Piece.

MS222. Military Science. Corps of Engineers. Bridge design and classification; military roads; organization of the ground and field fortifications; explosives and demolitions; camouflage; selected lectures on engineer amphibious and airborne operations.

MS223. Military Science. Signal Corps. Principles of signal communication; telephone, telegraph and radio equipment, codes and ciphers; International Morse code practice.

MS224. Military Science. Ordnance Department. General characteristics of ordnance material and ammunition.

MS225. Military Science. Chemical Warfare Service. General characteristics of chemical warfare material and agents.



John Garfield
from *Science Illustrated*

SUBJECTS OF INSTRUCTION TABULATED

The information below is necessarily subject to change. The list of subjects actually to be given will be published with the Class Schedule prior to the beginning of each term.

The number at the left is the subject number.

The numbers following the names of subjects indicate the prerequisite subjects (those in italics may be taken simultaneously).

To the right of the prerequisites are noted the year and term and the Professional Courses in which the subjects are required.

(A) following the year indicates that the subject is primarily for Graduate students. (B) indicates subjects for Graduate as well as Undergraduate students. (R) means that the subject is restricted to the special groups indicated at the end of the description of the subject.

Some "B" subjects will not be credited toward a graduate degree in Courses in which they are required subjects of the undergraduate schedule.

Then follows the time distribution of the subject in units (a unit representing fifteen hours work). The total credit for a subject is the sum of the units allotted to Exercise (Recitation, Lecture, Laboratory, Drawing or Fieldwork), and Preparation. One unit of Recitation or Lecture credit is equivalent to one semester hour. Two units of Drawing or Laboratory credit are equivalent to one semester hour.

At the extreme right is given the name of the Instructor in charge of the subject.

CIVIL AND SANITARY ENGINEERING — 1·00–1·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
1·00	Surveying	D12	–	–	–	2	0	2	Shea
1·00T	Surveying Fieldwork	D12	2	S	I, IV-B	0	13	0	Shea
			3	S	XVII				
1·01	Topographical Drawing	D12	–	–	–	0	4	0	Shea
1·01T	Survey. Fieldwork, Adv.	1·00T	2	S	I, IV-B	0	4	0	Shea
1·03‡	Surveying, Adv.	1·01T	2	1	I	3	3	6	Shea
1·04	Const. Survey. Fldwk.	1·00T	3	S	XVII	0	10	0	Shea
1·05	Surveying	D12	2	1	(Elective)	1	2	1	Shea
1·054	Surveying Fieldwork	1·00	–	–	–	0	8	0	Shea
1·06	Photogrammetry	1·03 or 1·05	4(B)	2	(Elective)	2	—	4	Shea
1·07	Geodetic Surveying	1·03	4(B)	S	(Elective)	0	23	0	Shea
1·08	Navigation	M11	3	2	(Elective)	2	—	4	Shea
1·13T	Surveying, Adv.	1·054	–	–	–	3	—	5	Shea
1·141	Geodesy, Adv.	1·03	G(A)	1	(Elective)	2	—	4	Shea
1·142	Geodesy. Adv.	1·141	G(A)	2	(Elective)	3	—	6	Shea
1·15‡	Vibration Theory, Int.	M22	G(A)	1	(Elective)	3	—	6	Ruge
1·16‡	Vibration Problems	1·15	G(A)	2	(Elective)	3	—	6	Ruge
1·20	Route Survey. Fldwk.	1·00T	2	S	I, IV-B	0	6	0	Babcock
1·21	Route & Const. Surveys	1·00	2	2	I	2	—	4	Babcock
1·24	Municipal Eng.	——	3	2	IV-B	3	—	3	Bone
1·26	Railway Signaling	——	4(B)	1 or 2.	(Elective)	2	—	4	Babcock
1·271	Transportation Eng.	1·21	4(B)	1	I(b)	3	3	6	Babcock, Bone
1·272	Transportation Eng.	1·271	4(B)	2	I(b)	3	3	3	Babcock, Bone
1·28	Highways & Airports	1·21	4(B)	1	I(d)	3	—	3	Bone
1·29	Transportation	——	4(B)	1 or 2	(Elective)	2	—	4	Babcock, Bone
1·301	Railway Transport., Adv.	1·272	G(A)	1	(Elective)	2	—	4	Babcock
1·302	Railway Transport., Adv.	1·301	G(A)	2	(Elective)	2	—	4	Babcock
1·311	High. Transport., Adv.	1·272 or 1·28	G(A)	1	(Elective)	2	—	4	Bone
1·312	High. Transport., Adv.	1·311	G(A)	2	(Elective)	2	—	4	Bone
1·32	Airport Design	——	G(A)	2	(Elective)	0	6	0	Bone
1·35	Soil Mech. & Found. Eng.	2·04	4(B)	1	I	3	3	6	D. W. Taylor
1·351	Soil Mech. & Found. Eng.	2·04	4(B)	1	XVII_1	2	2	4	D. W. Taylor
1·361	Soil Mechanics	2·04	G(A)	1	(Elective)	3	—	6	D. W. Taylor
1·362	Soil Mechanics	1·361	G(A)	2	(Elective)	3	—	6	D. W. Taylor
1·37	Soil Mech. Lab.	*1·35, 1·351* or *1·361*	G(A)	1	(Elective)	0	3	3	D. W. Taylor
1·38	Soil Eng. Spec. Studies	*1·361*	G(A)	1 or 2	(Elective)		★		D. W. Taylor
1·40	Structures	2·04	3	2	I	3	3	6	Fife
1·401	Structures	2·04	3	2	XVII	3	—	6	Fife
1·41	Structures	1·40 or 1·401	4(B)	1	$I, XVII_1$	3	—	6	Mirabelli
1·42	Structures	1·41	4(B)	2	$I, XVII_1$	3	—	6	Norris
1·43	Reinforced Concrete Design	*1·40*	3	2	I	0	6	0	Mirabelli
1·441	Bridge Design	*1·41*	4(B)	1	I	0	6	0	Mirabelli
1·442	Structural Design	1·441	4(B)	2	I	0	6	0	Mirabelli

★ Time specially arranged. ‡ Not offered 1946–47.

Civil and Sanitary Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
1·443	Structural Design	*1·401*	G(B)	–	(Elective)	0	6	0	Mirabelli
1·521	Structural Lab.	1·42	G(A)	1	(Elective)		★		Norris
1·522	Structural Lab.	*1·42*	G(A)	2	(Elective)		★		Norris
1·541	Reinf. Conc. Des., Adv.	1·42	G(A)	1	(Elective)	0	6	0	Mirabelli
1·542	Reinf. Conc. Des., Adv.	1·43 or 1·541	G(A)	2	(Elective)	0	6	0	Peabody
1·551	Structural Design, Adv.	1·41	G(A)	1	(Elective)	0	6	0	Wilbur
1·552	Structural Design, Adv.	1·41	G(A)	2	(Elective)	0	6	0	Wilbur
1·561	Structural Theory, Adv.	1·41	G(A)	1	(Elective)	4	—	8	Fife
1·562	Structural Theory, Adv.	1·561	G(A)	2	(Elective)	2	—	4	Fife
1·571	Stat. Indet. Structures	1·42 or *1·561*	G(A)	1	(Elective)	3	—	6	Wilbur
1·572	Stat. Indet. Structures	1·42 or 1·561	G(A)	2	(Elective)	3	—	6	Wilbur
1·61	Fluid Mechanics	*2·01*	2	2	I	2	—	4	Russell
1·62	Fluid Mechanics	1·61	3	1	I	3	—	6	Russell
1·63	Hydraulics	2·01	4	1	XV-A	2	—	4	Ippen
1·64	Hydraulics	2·01	4	1	VI_1, VI-A$(A)_1$	3	—	6	Ippen
1·66	Hydraulics, Adv.	1·62	G(A)	1 or 2	(Elective)	2	—	4	Russell
1·67‡	Des. of Harbor Works	1·35 or 1·351	G(A)	1	(Elective)	0	6	0	——
1·681	Theory of Models	1·62	G(A)	1	(Elective)	2	—	4	Ippen
1·682	River Hydraulic Lab.	1·62, 1·681	G(A)	2	(Elective)	0	9	0	Ippen
1·69‡	River Engineering	1·62	G(A)	2	(Elective)	2	—	4	——
1·70	Hydrology & Flood Cont.	1·62	4(B)	1	I(c)	3	3	6	Gifford
1·701	Hydrology & Flood Cont.	——	4(B)	1	(Elective)	3	—	6	Gifford
1·71	Water Power Eng.	1·40, 1·43, 1·70	4(B)	2	I(c)	3	3	3	Gifford
1·711	Water Power Eng.	1·62 or 1·64; 1·70 or 1·701	4(B)	2	(Elective)	3	—	3	Gifford
1·72	Hydrology & Water Power Eng.	1·62 or 1·64; 2·04	4(B)	1	I(d)	3	—	3	Gifford
1·731	Water Power Eng., Adv.	1·42, 1·71, *1·741*	G(A)	1	(Elective)	3	—	6	Gifford
1·732	Water Power Eng., Adv.	1·731, *1·742*	G(A)	2	(Elective)	3	—	6	Gifford
1·741	Water Power Des., Adv.	*1·731*	G(A)	1	(Elective)	0	8	0	Gifford
1·742	Water Power Des., Adv.	*1·732*, 1·741	G(A)	2	(Elective)	0	8	0	Gifford
1·75	Water Supply & Purif.	1·62	4(B)	1	I(a)	3	3	6	Stanley
1·76	Sewer. & Sew. Treatment	1·62	4(B)	2	I(a)	3	3	3	Stanley
1·77	Water Sup. & Sewerage	1·62	4(B)	2	I(d)	3	3	3	Stanley
1·771	Sanitation	——	3	1	IV, IV-B	2	—	4	Stanley, Horwood
1·78	Sanitary Analysis	5·02	3	1	(Elective)	0	6	2	Sawyer
1·79	Sanitary Eng. Design	1·75 or *1·76*	4(B)	2	(Elective)	0	6	0	Stanley
1·811	Sanitary Eng., Adv.	*1·75*	G(A)	1	(Elective)	3	—	6	Stanley
1·812	Sanitary Eng., Adv.	*1·76*	G(A)	2	(Elective)	3	—	6	Stanley
1·821	Sanitary Eng. Lab.	*1·75*	G(A)	1	(Elective)	2	3	4	Sawyer, A. A. Thomas
1·822	Sanitary Eng. Lab.	*1·76*	G(A)	2	(Elective)	2	3	4	Sawyer, A. A. Thomas
1·831	Sanitary Chemistry	5·02	4(B)	1	(Elective)	2	4	4	Sawyer
1·832	Sanitary Chemistry, Adv.	1·831	G(A)	2	(Elective)	2	4	4	Sawyer
1·84	Bact. Ex. of Wat. & Sew.	1·78	4(B)	1	(Elective)	2	4	4	Horwood
1·85	San. Bacteriology, Adv.	1·84	G(A)	2	(Elective)	2	4	4	Horwood
1·86	Sanitary Science, Prin.	*1·84*	G(A)	1	(Elective)	3	—	6	Horwood
1·871	Pub. Health Admin. Prac.	1·86	G(A)	2	(Elective)	3	—	6	Horwood
1·872	Pub. Health Eng. Fldwk.	1·86	G(A)	2	(Elective)	2	3	4	Horwood
1·881	Sanitary Design, Adv.	*1·811*	G(A)	1	(Elective)	0	6	0	Stanley
1·882	Sanitary Design, Adv.	*1·812*	G(A)	2	(Elective)	0	6	0	Stanley
1·891	San. Eng. Seminar	*1·811* or *1·812*	G(A)	1	(Elective)	1	—	2	Stanley
1·892	San. Eng. Seminar	*1·812* or *1·811*	G(A)	2	(Elective)	1	—	2	Stanley
1·91	Professional Prob.	——	4(B)	1	I	2	—	4	Wilbur
1·92	Eng. Construction	——	4(B)	2	I	3	—	3	Babcock

MECHANICAL ENGINEERING — 2·00–2·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·00	Statics	8·02, M12	2	1	I, II, VI, XIII, XIII-C, XIV (a, b), XV-A, XVI, XVII, XIX	3	—	5	Adkins
2·001	Statics & Dynamics	——	2	1 or 2	——	3	—	5	Sloane
2·01	Dynamics	2·00	2	2	I, II, VI, XIII, XIII-C, XIV (a, b), XV-A, XVI, XVII, XIX	3	—	5	Adkins

★Time specially arranged. ‡Not offered 1946–47.

Mechanical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·011	Statics & Dynamics	8·02, M12	2	1	III, IV	3	—	5	Adkins
			2	2	X				
2·04	Strength of Materials	2·01, 2·011	2	2	III, IV	3	—	6	MacGregor
			3	S	VI-A(A)				
			3	1	I, II, VI(1, 3, 4), IX-B, X, XIII, XIII-C, XIV(a,b), XV-A, XVI, XVII				
2·046	Strength of Mat. & Dynamics	2·01	4	1	XIII-A	3	1	5	Hrones
2·06	Dynamics	2·04	3	2	II	3	—	6	Adkins
			4	2	XIV(a)				
2·062	Strength of Mat. & Dynamics	2·04	3	2	XIII	3	—	6	Arnold
2·07	Dynamics	2·04	3	2	VI (1, 4), VI-A(A)$_{1,4}$	3	—	6	Hrones
2·081	Strength of Materials	2·04	4(B)	1	II	3	—	6	Soderberg
			G	1	XIII-A				
2·082	Dynamics	2·081	4(B)	2	II$_{2,3}$	3	—	6	Soderberg
2·10	Ordnance Engineering	2·04	4(B)	1	(Elective)	3	—	6	Holmes
2·11	Industrial Plant Eng.	2·04	4(B)	2	(Elective)	4	—	5	Holmes
2·121	Photoelasticity	2·04	4(B)	1 or 2	(Elective)	1	2	3	Murray
2·125	Res. in Exp. Stress Anal.	2·121	G(A)	1 or 2	(Elective)		★		Murray
2·126	Exp. Stress Analysis	2·081	4(B)	2	(Elective)	2	3	4	Murray
2·128	Exp. Stress Analysis	2·081	4(B)	2	(Elective)	2	6	4	Murray
2·211	Mechanics, Adv. I	2·081	G(A)	1	(Elective)	3	—	9	Den Hartog
			G	1	XIII-A				
2·212	Mechanics, Adv. II	2·211	G(A)	2	(Elective)	3	—	9	Den Hartog
2·213	Gas Turbines I	2·082, 2·43	G(A)	1	(Elective)	3	—	9	Soderberg
			G	2	XIII-A				
2·214	Gas Turbines II	2·213	G(A)	2	(Elective)	3	—	9	Soderberg
2·221	Plasticity	2·081	G(A)	1	(Elective)	3	—	9	MacGregor
2·222	Plasticity Prob., Adv.	2·221	G(A)	2	(Elective)	3	—	9	MacGregor
2·223	Plasticity Research	2·221	G(A)	1 or 2	(Elective)		★		MacGregor
2·231	Elasticity, Theory	2·081	G(A)	1	(Elective)	3	—	9	Adkins
2·232	Elasticity, Theory	2·231	G(A)	2	(Elective)	3	—	9	Adkins
2·251	Fluid Mechanics	2·01, M22	3	1	II, XIII, XIX	3	—	6	Rightmire
			4	1	VI$_4$, VI-A(A)$_4$, XIV(a)				
2·252	Fluid Mechanics	2·251	3	2	II	3	—	6	Rightmire
			4	2	XIV(a)				
2·256	Fluid Mechanics	2·046, 2·402	4(B)	2	XIII-A	3	—	6	Rightmire
2·257	Fluid Mechanics	——	3	1 or 2	——	3	—	6	Rightmire
2·258	Hyd. Trans. & Control	2·07, M22	G	1	——	2	—	4	Rightmire
2·261	Lubrication & Friction	2·252, 2·731	4(B)	2	(Elective)	2	—	4	Burwell
2·262	Lubrication, Research	2·261	G(A)	1 or 2	(Elective)		★		Burwell
2·271	Hydromechanics	2·252	G(A)	1	(Elective)	3	—	9	Rightmire
2·30	Engineering Materials	——	2	1	XIII, XVI	4	1	4	Wulff and Staff
			2	2	II				
			3	2	XIV(a, b), XV-A				
2·301	Engineering Materials	——	3	1	——	3	—	3	Bartholomew
2·302	Engineering Metals	——	4	1	(Elective)	2	—	2	Burton
2·31	Engineering Metals	2·30	4(B)	1	II	2	2	4	Burton, H. F. Taylor
2·32	Engineering Metals	2·31	4(B)	2	(Elective)	3	—	6	F. R. Evans H. F. Taylor
2·322	Engineering Metals	2·31	4(B)	2	(Elective)	3	3	6	F. R. Evans H. F. Taylor
2·33	Metal Processing	3·32	4(B)	1	III$_1$	2	2	4	Bartholomew
2·34	Mech. Prop. of Metals	2·31, 2·37	4(B)	2	(Elective)	3	—	6	Lessells
2·351	Dynamic Strength of Metals	2·081, 2·34	G(A)	1	(Elective)	3	—	9	Lessells
2·352	Dynamic Strength of Metals	2·351	G(A)	2	(Elective)	3	—	9	Lessells
2·37	Test. Materials Lab.	2·04, 2·30	3	2	II	2	2	4	Cowdrey
2·371	Test. Materials Lab.	2·04	3	1	XVI	0	2	2	Cowdrey
			4	1	III$_1$, X, XIII				
2·373	Test. Materials Lab.	2·04	3	2	I	0	5	2	Cowdrey
			4	2	IV, XVII				
2·40	Heat Engineering	8·02, M21	3	S	VI-A(A)$_1$	4	—	5	Svenson
			3	1	II, VI(1), IX-B, XIII, XIII-C, XIV(a, b), XVI, XIX				
2·401	Heat Engineering	8·02, M21	3	1	——	4	—	5	Svenson
2·402	Heat Engineering	——	4	1	XIII-A	4	2	7	Keenan
2·41	Heat Engineering	8·02, M21	3	1	I, XV-B, XVII	4	—	5	Svenson
			3	2	XV-A				

★ Time specially arranged.

Mechanical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·42	Heat Engineering	2·40	3	2	II, VI(1), VI-A(A)$_1$, IX-B, XIII, XIII-C, XIV(a, b), XVI	3	—	6	Svenson
2·422	Heat Engineering	2·402	4	2	XIII-A	2	—	4	Keenan
2·43	Heat Engineering	2·251, 2·40	4(B)	1	II	3	—	6	Keenan
2·44	Heat Engineering	2·43	4(B)	2	II$_2$	3	—	6	Shapiro
2·45	Eng. Thermodyn., Adv.	2·43, M36	G(A)	1	(Elective)	3	—	9	Keenan
2·47	Steam Turbine Eng.	2·42	4(B)	2	(Elective)	3	—	6	Keenan
2·48	Gas Turbine Eng.	2·42, 2·43	4(B)	2	(Elective)	3	—	6	Keenan
2·482	Gas Turbine Eng.	2·42, 2·43	4(B)	2	(Elective)	3	3	6	Keenan
2·491	Flow of Compressible Fluids	2·252 or 16·02; 2·42; M37	G(A)	1	(Elective)	3	—	9	Shapiro
2·492	Flow of Compressible Fluids	2·491	G(A)	2	(Elective)	3	—	9	Shapiro
2·50	Heat Measurements	8·04	3	2	III(1)	1	2	1	Wilkes
2·501	Heat Measurements	8·04	3	1	(Elective)	0	2	1	Wilkes
2·53	Heat Measurements	2·50 or 2·501	4(B)	1 or 2	(Elective)		★		Wilkes
2·56	Mech. Eng. Practice	2·43	4(B)	2	II$_1$	3	—	6	Holt
2·562	Mech. Eng. Practice	2·43	4(B)	2	(Elective)	3	3	6	Holt
2·57	Power Plants, Adv.	2·56	G(A)	1 or 2	(Elective)	3	—	9	Holt
2·601	Food Engineering	8·04	4	1	XX, XX-A	2	2	2	Hesselschwerdt
2·602	Food Engineering	2·601	4	2	XX, XX-A	2	2	2	Hesselschwerdt
2·621	Refrigeration	2·43	4(B)	2	(Elective)	3	—	6	Svenson
2·622	Refrigeration, App.	2·42	4(B)	2	(Elective)	3	—	6	Jones
2·641	Refrigeration Eng.	2·42, 2·43	G(A)	2	(Elective)	3	—	6	Svenson
2·642	Low Temp. Refrigeration	2·42, 2·43	G(A)	1 or 2	(Elective)	3	3	6	Collins
2·66	Air Conditioning	2·40 or 2·41	4(B)	1	(Elective)	3	—	6	Hesselschwerdt
2·661	Heating & Ventilation	—	3	1	IV	2	—	4	Hesselschwerdt
2·662	Heating & Ventilation	2·661	3	2	IV	2	—	4	Hesselschwerdt
2·671	Air Conditioning, Adv.	2·66	G(A)	1	(Elective)	3	—	9	Hesselschwerdt
2·681	Engineering Lab.	2·40 or 2·41 or 10·29	4	1	II, VI$_1$, VI-A(A)$_1$, X	0	3	3	Holt
2·682	Engineering Lab.	2·681	4(B)	2	II$_1$	0	3	3	Holt
2·683	Engineering Lab.	2·40	3	2	XIII-C	0	4	4	Holt
			4	1	XIII				
2·687	Hydraulic Lab.	1·62	3	2	I	0	2	2	Holt
2·693	Ref. & Air Cond. Lab.	2·66, 2·681	4	2	(Elective)	0	3	6	Hesselschwerdt
2·701	Machine Drawing	D12	2	1	II	0	6	0	Lent
			2	2	XVI				
2·72	Machine Design	—	G	1	—	3	—	6	Hrones
2·730	Machine Design	*2·01*, D12	3	1	II, XVI	1	3	2	Sloane
2·731	Machine Design	2·04, 2·30, *2·730*	3	2	II	2	2	2	Hrones
2·732	Machine Design	2·731	4(B)	2	(Elective)	2	3	4	Hrones
2·751	Machine Design	2·732	G(RA)	1	—	2	4	4	Swett
2·752	Machine Design	2·751	G(RA)	2	—	2	4	4	Hrones
2·761	Machine Design	—	G(RB)	2	—	4	4	3	Swett
2·78	Hydraulic Machinery, Des.	2·251	4(B)	2	(Elective)	2	3	4	Hrones
2·782	Mech. Systems, Des.	2·731, 6·19	4(B)	2	(Elective)	3	3	6	Hrones
2·783	Control Prob. in Mech. Eng.	2·082, 2·43	G(A)	1	(Elective)	3	—	9	Hrones
2·79	Int. Comb. Eng., Elem.	2·04; 2·41 or 2·42 or 10·29	4(B)	1	(Elective)	3	—	6	Rogowski
2·791	Internal Combustion Eng.	2·06, 2·42	4(B)	1	II$_3$	3	—	6	Rogowski
2·792	Internal Combustion Eng.	2·791	4(B)	2	II$_3$	3	—	6	Rogowski
2·794	Int. Comb. Eng. Lab.	2·791	4(B)	2	II$_3$	0	4	2	Ku
2·7941	Int. Comb. Eng. Lab.	2·791	4(B)	1	—	0	2	1	Ku
2·7942	Int. Comb. Eng. Lab.	2·7941	4(B)	2	—	0	2	1	Ku
2·796	Int. Comb. Eng. Des.	2·791	4(B)	2	(Elective)	3	—	6	C. F. Taylor
2·797	Int. Comb. Eng. Des.	2·792, *2·796*	G(A)	1	(Elective)	3	3	6	C. F. Taylor
2·798	Int. Comb. Eng. Des.	2·797	G(A)	2	(Elective)	3	3	6	C. F. Taylor
2·799	Automotive Dynamics	2·082, 2·792	G(A)	1 or 2	(Elective)	3	—	9	Den Hartog
2·801	Int. Comb. Eng. Prob., Adv.	2·792	G(A)	1	(Elective)	3	—	9	E. S. Taylor
2·802	Int. Comb. Eng. Prob., Adv.	2·2792	G(A)	2	(Elective)	3	—	9	E. S. Taylor
2·805	Diesel Engines	2·046, 2·42	4(B)	2	(Elective)	3	—	6	Eppes
			G	2	XIII-A				
2·851	Machine Tool Lab.	—	2	1	II, VI, XIII, XIV(a, b), XV-A, XIX	0	4	0	English
			2	2	XVI				
			3	S	III				
			3	1	XIII-C				
			4	S	XIII-A				

★ Time specially arranged.

Mechanical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·852	Machine Tool Practice	2·851	2	2	II, XIII	0	4	0	English
			4	S	XIII-A				
2·871	Manufacturing Eng.	2·731	4(B)	2	(Elective)	3	—	6	Buckingham
2·872	Prep. for Manufacturing	2·731, 2·852	4(B)	1 or 2	(Elective)	3	—	6	Buckingham
2·901	Fabric Struct., Prin.	8·02	4	1	(Elective)	3	—	6	Schwarz
2·902	Fabric Struct., Prin.	2·901	4(B)	2	(Elective)	3	—	6	Schwarz
2·903	Textile Manufact., Elem.	8·02	4	1	(Elective)	3	—	6	Schwarz
2·904	Textile Manufact., Prin.	2·903	4(B)	2	(Elective)	3	—	6	Schwarz
2·905	Textile Tech. Anal.	8·04	G(A)	1	(Elective)	3	—	6	Schwarz
2·906	Textile Tech. Anal.	2·905	G(A)	2	(Elective)	3	—	6	Schwarz
2·907	Textile Microscopy	8·04	G(A)	1	(Elective)	2	3	2	Schwarz
2·908	Textile Microscopy	2·907	G(A)	2	(Elective)	2	3	2	Schwarz
2·911	Textile Testing Lab.	2·905	G(A)	1	(Elective)	0	6	2	Schwarz
2·912	Textile Research Lab.	2·906	G(A)	2	(Elective)	0	6	2	Schwarz
2·913	Textile Tech. Seminar	2·905, 2·907	G(A)	1	(Elective)	2	—	2	Schwarz
2·914	Textile Tech. Seminar	2·906, 2·908	G(A)	2	(Elective)	2	—	2	Schwarz
2·991	Mechanical Eng. Seminar	——	G(A)	1	(Elective)	2	—	2	Soderberg
2·992	Mechanical Eng. Seminar	——	G(A)	2	(Elective)	2	—	2	Soderberg

METALLURGY — 3·00–3·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
3·01	Non-Ferrous Met. I	5·02	3	2	III	4	—	4	Schuhmann
3·02‡	Non-Ferrous Met. II	3·01	4	1	(Elective)	2	—	4	Schuhmann
3·04	Metallurgical Lab.	——	3	2	III	0	4	0	Schuhmann
3·041‡	Electric Furnaces	5·02, 8·04	4(B)	1	(Elective)	0	3	2	Schuhmann
3·05T‡	General Metallurgy	*3·02*, 3·12	4(B)	1	(Elective)	3	0	6	Bever
3·06	Non-Ferrous Met., Adv.	3·05	G(A)	1	(Elective)	2	—	6	Hayward
3·07‡	Metal. Com. Metals	5·02	4	2	(Elective)	2	—	4	——
3·08	General Metallurgy, Adv.	3·05	G(A)	2	(Elective)	2	—	6	Hayward
3·09	Metal. Calculations	*3·01*, 3·12	3	2	III(1)	2	—	4	Bever
3·10‡	Metal. Plant Visits	——	3	—	(Elective)	0	3	1	Floe
3·12	Met.: Iron & Steel	5·02	3	1	III	2	—	4	Grant
3·20	Metal. Thermodynamics	5·62	4(B)	1	III	4	—	4	Chipman
3·21	Steelmaking, Prin.	3·20	G(A)	2	(Elective)	2	—	4	Chipman
3·30	Metallography	8·04	3	2	XV-A	2	2	2	Floe
3·31	Physical Metallurgy I	5·12, 8·04	3	1	III	2	3	4	Cohen
3·32	Physical Metallurgy II	3·31	3	2	III(1)	2	3	4	Floe
3·33	Industrial Phys. Met.	3·30 or 3·32	4(B)	1	III_1	0	3	2	Homerberg
3·34	Physical Metal., Adv.	3·33, 3·50	G(A)	1	(Elective)	2	—	4	Cohen
3·35	Physical Metal., Adv.	3·33, 3·50	G(A)	2	(Elective)	2	—	4	Cohen
3·38	Physical Metal., Adv.	——	G	1	——	0	3	3	Homerberg
3·39	Physical Metal., Adv.	3·38	G	2	——	2	3	3	Homerberg
3·391	Properties of Metals	——	4	1	XIII-A	2	1	3	Homerberg
3·392	Properties of Metals	3·391	4	2	XIII-A	2	1	3	Homerberg
3·394	Metallurgy	——	3	2	——	3	2	4	——
3·395	Metallurgy	3·394	4	1	——	3	2	4	——
3·40	Cor. & Heat Res. Alloys	3·30 or 3·32	4(B)	1	(Elective)	2	—	4	Uhlig
3·41	Industrial Non-Fer. Alloys	3·30 or 3·31	3	2	III(1)	2	—	2	R. S. Williams
3·42	Powder Metallurgy	3·30 or 3·32	4(B)	2	(Elective)	2	—	4	Wulff
3·422	Powder Metal. Lab.	3·30 or 3·32	4(B)	2	(Elective)	0	4	2	Wulff
3·43	Corrosion of Metals	5·62	G(A)	2	(Elective)	2	3	4	Uhlig
3·44	Metal. Heat Res. Alloys	3·33	G(A)	2	(Elective)	2	—	4	Grant
3·50	X-ray Metallography	3·30 or 3·31; M22	4(B)	1	(Elective)	2	2	4	J. T. Norton
3·51	Physics of Metals	3·50	4(B)	2	(Elective)	2	—	4	J. T. Norton
3·52	Physics of Metals, Adv.	3·50, 3·51	G(A)	1 or 2	(Elective)		★		J. T. Norton
3·55	Phys. Prin. of Metals Treat.	3·30 or 3·32	4(B)	1	(Elective)	2	—	4	Rosenthal
3·56	Sp. Prob. in Phys. Prin. of Metals Treat.	3·35	4(B)	2	(Elective)		★		Rosenthal
3·60‡	Ferromagnetism	3·51	G(A)	1	(Elective)	2	—	4	Kaufmann
3·62	Sp. Prob. in Metallurgy	——	G(A)	1	(Elective)		★		Staff
3·63	Sp. Prob. in Metallurgy	——	G(A)	2	(Elective)		★		Staff
3·65‡	Theory of the Solid State	8·04, M22	4(B)	2	(Elective)	3	—	6	Kaufmann
3·70	Ceramics	5·02, 8·04	4(B)	1	(Elective)	2	3	4	F. H. Norton
3·71	Optical Ceramics	8·04	4(B)	1	(Elective)	0	6	2	F. H. Norton
3·73	Geramic Process, Fund.	3·50, 3·70, 5·61	G(A)	1	(Elective)	3	4	4	F. H. Norton

★Time specially arranged. ‡Not offered 1946-47.

Metallurgy Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
3·74	Phys. Prop. Cer. Prod.	3·73	G(A)	2	(Elective)	2	3	4	F. H. Norton
3·75	Spec. Prob. Ceramics	3·70, 3·71	G(A)	1	(Elective)		★		F. H. Norton
3·76	Spec. Prob. Ceramics	3·70, 3·71	G(A)	2	(Elective)		★		F. H. Norton
3·81	Mineral Dressing I	8·04, *12·011*	3	1	III	3	3	4	Gaudin, Spedden
3·82	Mineral Dressing II	3·81	3	2	III(2)	2	—	4	Schuhmann
3·83	Mineral Dressing III	3·81	4(B)	1	III_2	2	—	4	Schuhmann
3·84	Mineral Dressing IV	3·81	4(B)	2	III_2	2	—	4	Schuhmann
3·86	Quantitative Mineragraphy	3·81	3	2	III(2)	1	6	2	Spedden
3·87	Ore Testing	3·81	4(B)	1	III_2	0	10	0	Spedden
3·88‡	Mineral Dressing Prac.	3·81	4(B)	2	III_2	2	—	4	——
3·89	Mineral Dressing Design	3·88	G(A)	1 or 2	(Elective)		★		Gaudin
3·90	Mineral Dressing, Adv.	3·82; 3·83 or 3·84	G(A)	1 or 2	(Elective)	2	—	4	Gaudin
3·901	Mineral Dressing Lab., Adv.	3·86 or 3·87	G(A)	1 or 2	(Elective)		★		Gaudin
3·902	Mineral Dressing Lab., Adv.	3·901	G(A)	1 or 2	(Elective)		★		Gaudin

ARCHITECTURE AND PLANNING — 4·00–4·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
4·031	Visual Fundamentals	——	3	1	IV	0	4	0	Kepes
4·032	Visual Fundamentals	4·031	3	2	IV	0	4	0	Kepes
4·041	Light and Color	4·032	4	1	(Elective)	0	4	0	Kepes
4·042	Light and Color	4·032	4	2	IV	0	6	0	Kepes
4·051	Graphic Presentation	4·042	5(B)	1	IV	0	6	0	Kepes
4·052	Graphic Presentation	4·051	5(B)	2	IV	0	6	0	Kepes
4·053	Painting	4·052	G(A)	1	(Elective)	0	6	0	Kepes
4·054	Painting	4·053	G(A)	2	(Elective)	0	6	0	Kepes
4·07	Shop	——	2	2	IV	0	4	0	Anderson
4·10	Arch. Illumination	——	4	2	(Elective)	0	9	0	Anderson
4·41	Fine Arts	——	4	1 or 2	(Elective)	3	—	5	H. L. Seaver
4·451	Hist. of Architecture	E22	5	1	IV	3	—	6	H. R. Hitchcock
4·452	Hist. of Architecture	4·451	5	2	IV	3	—	6	H. R. Hitchcock
4·461	Europ. Civilization & Art	*4·451*	5(B)	1	(Elective)	3	—	6	Seaver
4·462	Europ. Civilization & Art	4·461	5(B)	2	(Elective)	3	—	6	Seaver
4·50	Office Practice	——	4	S	IV–B		40 h.p.w.		F. J. Adams
4·52	Office Practice	4·50	G(A)	1	(Elective)	0	30	0	F. J. Adams
4·541	Housing Seminar	4·683 or 4·751	G(A)	1	(Elective)	2	—	4	Burchard
4·542	Housing Seminar	4·541	G(A)	2	(Elective)	2	—	4	Burchard
4·59	Govt. & Public Admin.	——	3	1	IV-B	2	—	4	Schaefer
4·60	Plan. Legis. & Admin.	4·59	4(B)	2	IV-B	2	—	4	Shurtleff
4·62	Site Plan. & Const.	4·681	4	1	IV-B	0	9	3	Bender
4·621	Site Plan. & Const.	4·741	5(B)	1	IV	0	9	3	Bender
4·641	City Planning, Principles	——	2	2	IV-B	2	—	4	Shurtleff
			4	2	IV				
4·651	City Plan., Th. & Prac.	4·641	3	1	IV-B	3	—	6	F. J. Adams
4·652	City Plan., Th. & Prac.	4·651	3	2	IV-B	3	—	6	F. J. Adams
4·661	City Planning Research	4·683	G(A)	1	(Elective)	2	—	4	F. J. Adams
4·662	City Planning Research	4·661	G(A)	2	(Elective)	2	—	4	F. J. Adams
4·681	City & Regional Planning	4·672	3	1	IV-B	0	12	6	Greeley, Bender
4·682	City & Regional Planning	4·681	3	2	IV-B	0	12	6	Greeley, Bender
4·683	City & Regional Planning	4·682	4(B)	1	IV-B	0	9	3	Adams, Greeley
4·691	City & Reg. Plan., Adv.	4·683	G(A)	1	(Elective)	0	30	0	F. J. Adams, Greeley
4·692	City & Reg. Plan., Adv.	4·691	G(A)	2	(Elective)	0	30	0	F. J. Adams, Greeley
4·721	Architectural Design	——	2	1	IV, IV-B	0	9	3	Anderson
4·722	Architectural Design	4·721	2	2	IV, IV-B	0	9	3	Anderson
4·731	Architectural Design	4·722	3	1	IV	0	12	6	Anderson
4·732	Architectural Design	4·731	3	2	IV	0	12	6	Anderson
4·741	Architectural Design	4·732, 4·811, 4·812	4	1	IV	0	12	6	Anderson
4·742	Architectural Design	4·741	4	2	IV	0	12	6	Anderson
4·751	Architectural Design	4·742	5(B)	1	IV	0	9	3	Anderson
4·761	Architectural Design	4·751	G(A)	1	(Elective)	0	30	0	Anderson
4·762	Architectural Design	4·761	G(A)	2	(Elective)		★		Anderson
4·78	Planning Principles	——	2	2	XVII	0	4	0	Anderson
4·811	Structural Analysis	2·04, 4·722	3	1	IV	2	6	0	Gelotte

★ Time specially arranged. ‡ Not offered 1946–47.

Architecture and Planning Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
4·812	Structural Analysis	4·731, 4·811	3	2	IV	2	6	0	Gelotte
4·91	Arch. Acoustics, Spec. Prob.	8·053	G(A)	1 or 2	(Elective)		★		Anderson, Bolt

CHEMISTRY — 5·00–5·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
5·00	Chemistry, Entrance	——	–	–		3	3	6	Young
5·01	Chemistry, General	——	1	1	All courses	4	3	4	Beattie
5·02	Chemistry, General	5·01	1	2	All courses	4	3	4	Beattie
5·061	Inorganic Chem., Adv.	5·13	4(B)	1	V	2	—	4	Schumb
5·062	Inorganic Chem., Adv.	5·061	4(B)	2	V	2	—	4	Schumb
5·071	Sp. Topics Inorg. Chem.	5·062	G(A)	1	(Elective)	2	—	4	Schumb
5·072	Sp. Topics Inorg. Chem.	5·071	G(A)	2	(Elective)	2	—	4	Schumb
5·08	Inorganic Lab., Adv.	5·062	G(A)	1, 2	(Elective)	0	6	0	Young
5·09	Applied Radiochemistry	5·12, 5·061	G(A)	2	(Elective)	2	3	3	Coryell, Irvine
5·10	Qualitative Analysis	5·02	2	S	V	3	12	3	Simpson
			2	1	(Elective)				
5·11	Qualitative Analysis	5·02	2	1	III, VII, VIII, X, XII, XIV(c), XV-B, XVIII, XX	3	4	3	Marvin
5·12	Quantitative Analysis	5·10 or 5·11	2	1	V	3	4	3	Marvin
			2	2	III, VII, X, XII, XIV(c), XV-B, XX				
5·13	Quantitative Analysis	5·12	2	1	(Elective)	3	4	3	Marvin
			2	2	V				
5·141	Anal. Chemistry	5·12, 8·04	3	1	V, XX	0	4	2	Gibb
			3	2	(Elective)				
5·35	Applied Chemistry	5·02	3, 4	1, 2	(Elective)	2	—	4	Marvin
5·41	Organic Chemistry I	5·12, 8·04	3	S	VII, XX	4	—	4	Ashdown
			3	1	V, IX-A, X, XIV(c), XV-B				
			4	1	III_2				
5·414	Organic Preparations	5·12, *5·41*	3	1	V	0	9	0	Ashdown
5·416	Organic Preparations	5·12, *5·41*	3	1	X	0	6	0	Ashdown
5·417	Quant. Org. Anal.	5·41	3	2	V	0	4	0	Huntress
			4(B)	1, 2	(Elective)				
5·42	Organic Chemistry II	5·41	3	2	V, IX-A, X	4	—	4	Huntress
5·424	Org. Compounds, Ident.	5·414	3	2	V	0	9	0	Ashdown
5·426	Org. Compounds, Ident.	5·416	3	2	X	0	6	0	Ashdown
5·428	Organic Chemistry Lab.	*5·41*	3	S	VII, XX	0	10	0	Ashdown
5·43	Organic Chemistry III	5·42	4(B)	1	V	2	—	4	Roberts
5·44	Organic Chemistry IV	5·43	4(B)	2	V	2	—	4	Sheehan
5·51T	Organic Chem: Synth., Adv.	5·44	G(A)	1	(Elective)	2	—	4	Cope
5·52T	Organic Chem: Mech., Adv.	5·44	G(A)	2	(Elective)	2	—	4	Morton
5·53	Organic Chem: Iden., Adv.	5·44	G(A)	1	(Elective)	2	—	4	Huntress
5·581T	Organic Lab: Methods, Adv.	5·44	G(A)	1	(Elective)	0	9	0	Morton
5·582T	Organic Lab: Iden., Adv.	5·53, 5·581T	G(A)	2	(Elective)	0	9	0	Huntress
5·591T	Recent Adv. in Org. Chem.	5·44	G(A)	1	(Elective)	2	—	4	Huntress
5·592T	Recent Adv. in Org. Chem.	5·44	G(A)	2	(Elective)	2	—	4	Huntress
5·61	Physical Chem. I	5·12, 8·03, M21	3	1	III, V, VII, X, XII, XIV(c), XV-B, XX	4	—	4	Millard
5.611	Physical Chem. Lab. I	*5·61*	3	1	V, VII, XX	0	4	0	Dietrichson
5·612	Physical Chem. Lab. I	*5·61*	3	1	X	0	2	0	Dietrichson
5·62	Physical Chem. II	5·61	3	2	III, V, VII, X, XII, XIV (c), XV-B, XX	4	—	4	Millard
5·621	Physical Chem. Lab. II	5·611, *5·62*	3	2	V, VII, XX	0	4	0	Dietrichson
5·622	Physical Chem. Lab. II	5·612, *5·62*	3	2	X	0	2	0	Dietrichson
5·63	Thermodynamics, Int.	5·62	4(B)	1	V	2	—	4	Stephenson
5·64	Rad. Chemistry, Int.	5·62	4(B)	2	V	2	—	4	L. Harris
5·65	Kinetics of Chem. Reactions	5·62	4(B)	1	V	2	—	4	Amdur
5·66	Surface & Colloid Chem.	5·63	4(B)	2	V	2	—	4	Scatchard

★ Time specially arranged.

Chemistry Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
5·71‡	Physico-Chem. Exp. Tech.	*5·63*	G(A)	1	(Elective)	0	4	2	Beattie
5·72T	Mole. Spec. & Mole. Struct.	5·64	G(A)	2	(Elective)	2	—	4	Lord
5·73	Radiation Chem., Adv.	5·64	G(A)	1	(Elective)	2	—	4	L. Harris
5·74	Statistical Mechanics	5·73	G(A)	2	(Elective)	2	—	4	Stockmayer
5·75	Chem. Thermodynamics	5·63	G(A)	1	(Elective)	3	—	6	Beattie
5·76	Chem. Thermodynamics	5·75	G(A)	2	(Elective)	3	—	6	Scatchard
5·77	Kinetic Theory	*5·63*	G(A)	1	(Elective)	2	—	4	Amdur
5·79	Physical Chem. of High Polymers	5·42, 5·63, *5·65*	G(A)	1	(Elective)	2	—	4	Stockmayer
5·90	Spec. Prob. in Chem.	—	G(A)	1, 2	(Elective)		★		Huntress
5·911	Journal Meeting in Inorganic Chem.	5·062	G(A)	1	(Elective)	1	—	2	Schumb
5·912	Journal Meeting in Inorganic Chem.	5·911	G(A)	2	(Elective)	1	—	2	Schumb
5·913	Journal Meeting in Organic Chem.	5·44	G(A)	1	(Elective)	1	—	2	Morton
5·914	Journal Meeting in Organic Chem.	5·913	G(A)	2	(Elective)	1	—	2	Morton
5·931	Physical Chem. Seminar	*5·63*	G(A)	1	(Elective)	1	—	2	Scatchard
5·932	Physical Chem. Seminar	5·931	G(A)	2	(Elective)	1	—	2	Scatchard
5·941	Research Conf. in Inorganic Chem.	5·062	G(A)	1	(Elective)	1	—	2	Schumb
5·942	Research Conf. in Inorganic Chem.	5·941	G(A)	2	(Elective)	1	—	2	Schumb
5·943	Research Conf. in Organic Chem.	5·44	G(A)	1	(Elective)	1	—	2	Morton
5·944	Research Conf. in Organic Chem.	5·943	G(A)	2	(Elective)	1	—	2	Morton
	Research	—	G(A)	1, 2	(Elective)		★		Huntress
	Inorganic Chemistry								Schumb
	Organic Chemistry								Morton
	Physical Chemistry								Scatchard

ELECTRICAL ENGINEERING — 6·00–6·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
6·00T	Elec. Eng., Prin.	8·03, *M22*	2	2	VI, VIII	4	—	8	Frazier
6·002	Elec. Eng., Prin.	8·03, *M22*	2	2	—	2	—	4	Frazier
6·01T	Elec. Eng., Prin.	6·00	3	S	VI-A(A)	3	—	6	Kingsley
			3	1	VI				
6·02T	Elec. Eng., Prin.	6·00	3	1	VI-A(A)	3	—	6	T. S. Gray
	(Eng. Electronics)		3	2	VI				
6·03T	Elec. Eng., Prin.	6·01T	4(B)	S	VI-A(A)	3	—	6	Lyon
	(A-C Rot. Mach.)		4	1	VI				
6·04	Elec. Eng., Prin.	6·03T	4(B)	1	VI-A(A)$_1$	3	—	6	Dwight
	(Elec. Power Trans.)		4	2	VI$_1$				
6·05	Elec. Eng., Prin.	M12	2	1	VI	2	1	5	Frazier, T. S. Gray
6·11T	Elec. Eng., Prin.	6·00	3	1	VIII	3	—	6	T. S. Gray
6·16	Electricity	8·03	4	1	IV	3	—	6	Dawes
6·17	Illumination	8·03	4	2	IV	2	—	4	Moon
6·18	Elec. Eng., Fund.	8·04	3	1	II, XIV(a, b), XV-A	3	1	6	Fitzgerald
			3	2	I, XIV(c), XV-B				
			4	1	III$_1$, X, XIII, XVI				
			5	1	XIII-C				
6·19	Elec. Eng., Fund.	6·18 or 6·40	3	2	XIV(a, b), XV-A	3	1	6	Fitzgerald
			4	1	II$_2$				
			4	2	III$_1$				
6·191	Electrical Eng.	—	4	2	—	3	2	6	Fitzgerald
6·20	Electronic Cont. & Meas.	6·02T	3	2	VI-A(A)$_4$	3	—	6	T. S. Gray
			4(B)	1	VI$_4$				
6·202	Electronic Control & Meas.	6·20	4(B)	2	(Elective)	3	—	6	T. S. Gray
6·211	App. Elec. to Industry	6·02T	4(B)	1	XIV(b)	3	—	6	Dawes
			4	1	(Elective)				
6·212	App. Elec. to Industry	6·03T	4(B)	2	XIV(b)	3	—	6	Dawes
			4	2	(Elective)				
6·213	Ind. App. of Servomechanisms	6·01T or 6·18 or 6·40; M22	4(B)	2	(Elective)	3	—	6	D. P. Campbell

★ Time specially arranged. ‡ Not offered 1946–47.

Electrical Engineering Continued

No.	Subject	Prerequisite	Year	Term		Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
6·221	Power Syst. Meas., Anal. & Control	2·42	4(B)	1		(Elective)	3	—	6	Balsbaugh
6·222	Power Syst. Meas., Anal. & Control	6·03T	4(B)	2		XIV(b)	3	—	6	Balsbaugh
			4	2		(Elective)				
6·23	Electrical Implementation	6·02T	4(B)	1		VI-A(A)$_4$	3	—	6	Frazier
			4	2		VI$_4$				
6·251	Elec. Mach. Design	*6·03T*	4(B)	1		(Elective)	3	—	6	Dwight
6·252	Elec. Mach. Design	6·03T	4(B)	2		(Elective)	3	—	6	Dwight
6·26	Insulators & Semi-Conductors	8·04	4(B)	1		(Elective)	3	—	6	von Hippel
6·27	Illum. Eng., Prin	8·04	3	2		VI(2)	3	—	6	Moon
6·271	Illum. Eng., Prin.	6·27	4(B)	1		VI$_3$	3	—	6	Moon
6·272	Illum. Eng., Prin.	6·271	4(B)	2		VI$_3$	3	—	6	Moon
6·281	Wire Com., Prin.	6·02T	4(B)	1		(Elective)	3	—	6	C. E. Tucker
6·291	Radar, Prin.	6·20 or 6·311	4(RB)	1 or 2		——	3	4	6	Zimmermann
6·292	Radar, Prin. & App.	6·291	4(RB)	1 or 2		——	3	4	6	Zimmermann
6·293	Radar, Prin. & App.	6·19 or 6·20, 6·83	G(R)	—		——	3	3	6	Zimmermann
6·294	Radar, Prin. & App.	6·293	G(RB)	2		——	3	4	6	Radford
6·295	Radar, Prin. & App.	6·294	G(RA)	1		——	3	4	6	Coate
6·30	Elec. Com., Prin.	6·00	3	2		VI(3), VI-A(A)$_3$	3	—	6	Guillemin
6.311	Elec. Com., Prin.	6·02T	4(B)	1		VI$_3$, VI-A(A)$_3$	3	—	6	Radford
6·312	Elec. Com., Prin.	6·311	4(B)	2		(Elective)	3	—	6	Arguimbau
6·313	Shipboard Radio Com. Equip.	6·311, 6·331	4(RB)	2		——	3	3	4	Radford
6·314	Radio Navigational Systems	6·313, *6·291*	4(RB)	1 or 2		——	2	3	4	Radford
6·315	Aircraft Electronic Equip.	6·291, 6·313	4(RB)	1 or 2		——	2	3	4	Zimmermann
6·321	Elec. Com., Prin.	*6·30*	4(B)	1		VI$_3$	3	—	6	Guillemin
			3	2		VI-A(A)$_3$				
6·322	Elec. Com., Prin.	6·321	4(B)	1		VI-A(A)$_3$	3	—	6	Guillemin
			4	2		(Elective)				
6·331	Elec. Com. Lab.	6·02T, *6·311*	4(B)	1		VI$_3$, VI-A(A)$_3$	0	3	3	Radford
6·332	Elec. Com. Lab.	6·331	4(B)	2		VI$_3$	0	4	5	Radford
6·34	Elec. Com. Lab.	——	4(B)	1 or 2		(Elective)		★		Radford
6·36	Sonar, Prin. & App.	8·13	4(RB)	1 or 2		——	2	3	4	Horton
6·40	Elec. Eng., Elem.	8·04	3	1		XVII	4	—	6	Hudson
			3	2		IX-B				
6·43	Electrical Eng.	——	G	1		XIII-A	3	—	6	Kingsley
6·44	Electrical Eng.	6·43	G	2		XIII-A	3	1	7	Kingsley
6·45	Electrical Eng.	6·44	G(RB)	1		XIII-A	3	1	7	Kingsley
6·46	Electrical Eng.	6·45	G(RB)	2		XIII-A	3	1	7	Fitzgerald
6·48	Elec. Equip. Bldgs.	8·04	4	2		(Elective)	2	—	4	Hudson
6·501	Elec. Eng. Seminar	6·04 or 6·321	G(A)	1		(Elective)	2	—	10	Fitzgerald
			4	2		VI-A(A)				
6·502	Elec. Eng. Seminar	6·501	G(A)	2		(Elective)	2	—	2	Fitzgerald
			G(A)	S		VI-A(A)				
6·511	Elec. Power Circuits	6·04	G(A)	1		(Elective)	3	—	6	Wildes
6·512	Elec. Power Circuits	6·04	G(A)	2		(Elective)	3	—	6	Wildes
6·515	Power Systems Lab.	6·511, 6·516, 6·651 or 6·652	G(A)	1 or 2		(Elective)		★		Fitzgerald
6·516	Power System Analysis	6·04	G(A)	2		(Elective)	3	2	6	Fitzgerald
6·521	A-c. Machinery, Adv.	6·03, M31	G(A)	1		(Elective)	3	—	6	Lyon
6·522	A-c. Machinery, Adv.	6·04, M31	G(A)	2		(Elective)	3	—	6	Lyon
6·531	Power System Economics	6·04, Ecl2	G(A)	1		(Elective)	3	—	6	Balsbaugh
6·532	Power System Economics	6·04, Ecl2	G(A)	2		(Elective)	3	—	6	Balsbaugh
6·541	Electric Power Gen.	6·03T, Ecl2	G(A)	1		(Elective)	3	—	6	Balsbaugh
6·542	Electric Power Gen.	6·03T, Ecl2	G(A)	2		(Elective)	3	—	6	Balsbaugh
6·551	Railroad Elec. Trac.	6·03T, Ecl2	G(A)	1		(Elective)	3	—	6	Balsbaugh
6·552	Railroad Elec. Trac.	6·551	G(A)	2		(Elective)	3	—	6	Balsbaugh
6·561	Network Theory, Adv.	6·322	G(A)	1		(Elective)	3	—	6	Guillemin
6·562	Network Theory, Adv.	6·561	G(A)	2		(Elective)	3	—	6	Guillemin
6·571	Illum. Eng., Prin.	6·272	G(A)	1		(Elective)	3	—	6	Moon
6·572	Illum. Eng., Prin.	6·571	G(A)	2		(Elective)	3	—	6	Moon
6·58	Trans. in Linear Systems	6·04 or 6·321; M31	G(A)	1 or 2		(Elective)	3	—	9	M. F. Gardner
6·585	Int. Equa. in Elec. Eng., App.	6·03T, M22	G(A)	1		(Elective)	3	—	6	Moon
6·586	Eng. App. of Field Theory	M22	G(A)	2		(Elective)	3	—	6	Moon
6·59	Communications Lab.	6·332	G(A)	1 or 2		(Elective)		★		Radford
6·602	Math. Anal. by Mech. Meth.	M22	G(A)	1		(Elective)	2	2	6	S. H. Caldwell
6·605	Servomechanisms	6·04, M22	G(A)	1		(Elective)	3	—	6	G. S. Brown
6·606	Servomechanisms	6·605	G(A)	2		(Elective)	3	3	6	G. S. Brown

★ Time specially arranged.

Electrical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
6·607	Servomechanisms Lab.	6·605	G(A)	2	(Elective)	0	12	0	G. S Brown
6·608	Servomechanisms	6·605	G(A)	2	(Elective)	3	—	6	G. S. Brown
6·61	Eng. of High Volt. & High-Energy Part.	6·04	G(A)	2	(Elective)	3	—	6	Trump
6·621	Radio Lines, Ant. & Prop.	6·322	G(A)	1	(Elective)	3	—	6	Guillemin
6·622	Radio Lines, Ant. & Prop.	6·621	G(A)	2	(Elective)	3	—	6	Guillemin
6·623	Pulse Circuits, Prin.	6·311 & 6·331; or 6·20 & 6·83; or 6·11 & 8·11	G(A)	1 or 2	(Elective)	3	—	6	Zimmermann
6·631	Engineering Electronics	6·03T	G(A)	1	(Elective)	3	—	6	Gray
6·632	Engineering Electronics	6·631	G(A)	2	(Elective)	2	2	6	Gray
6·633	Electronic-Circuit Theory	6·02, 6·20	G(A)	1 or 2	(Elective)	3	—	6	Coate
6·64	Dielectric Materials	6·26	G(A)	2	(Elective)	3	—	6	von Hippel
6·651	Power Syst. Meas., Anal. & Econ.	6·04	G(A)	1	(Elective)	3	—	6	Balsbaugh
6·652	Power Syst. Meas., Anal. & Econ.	6·04	G(A)	2	(Elective)	3	—	6	Balsbaugh
6·661	Elec. Mach. Dev., Prin.	6·03T	G(A)	1	(Elective)	3	1	6	Dwight
6·662	Elec. Mach. Dev., Prin.	6·03T	G(A)	2	(Elective)	3	1	6	Dwight
6·663	Aircraft Elec. Syst. & Mach.	6·03T	G(A)	1	—	3	1	6	Fitzgerald, Kingsley
6·664	Aircraft Elec. Syst. & Mach.	6·663	G(A)	2	—	3	1	6	Fitzgerald, Kingsley
6·671	Vibrations	M31; or 2·082 and M22	G(A)	1	(Elective)	3	1	6	Woodruff
6·672	Vibrations	6·671	G(A)	2	(Elective)	3	1	6	Woodruff
6·68	Sp. Prob. in Elec. Eng.	—	G(A)	1 or 2	(Elective)		★		Hazen, Gardner
6·681	Spec. Prob. in Fire Control	6·606	G(RA)	1	—	6	—	12	Hazen
6·69	Sound in Elec. Com.	6·04 or 6·332; 8·13; M31	G(A)	2	(Elective)	2	2	6	Fay
6·73	Elec. Meas. Lab., Adv.	6·02T, 6·76	G(A)	1 or 2	(Elective)		★		T. S. Gray
6·74	Elec. Mach. Lab., Adv.	6·04, 6·79T	G(A)	1 or 2	(Elective)		★		C. E. Tucker
6·75	Elec. Meas. Lab.	*6·01T*	3	S	VI-A(A)	1	3	5	T. S. Gray
			3	1	VI				
6·756	Elec. Meas. Lab.	—	3	1 or 2	—	1	3	5	T. S. Gray
6·76	Elec. Electronics Lab.	*6·02T*, 6·75	3	2	VI, VI-A(A)	1	2	3	T. S. Gray
6·77	Elec. Mach. Lab.	6·01T	3	2	VI(1, 3, 4), VI-A(A)	2	2	4	C. E. Tucker
6·78	Elec. Mach. Lab.	*6.03T*, 6·77	4	1	VI_1, VI-A$(A)_1$	1	3	4	C. E. Tucker
6·781	Elec. Mach. Lab.	6·03T, 6·77	4	1	VI-A$(A)_{3,4}$	1	2	3	C. E. Tucker
			4	2	$VI_{3,4}$				
6·79T	Elec. Mach. Lab.	*6·04*, 6·78	4	1	VI-A$(A)_1$	1	2	3	C. E. Tucker
			4	2	VI_1				
6·80	Elec. Meas. Lab.	6·00 or 6·40	4(B)	1 or 2	(Elective)		★		T. S. Gray
6·82T	Elec. Electronics Lab.	*6·11*	3	1	VIII	1	2	3	T. S. Gray
6·83	Electronic Eng. Lab.	6·76	4	1	VI_4, VI-A$(A)_4$	1	2	3	T. S. Gray
6·84	Elec. Implement Lab.	6·76	4	1	VI-A$(A)_4$	1	3	5	T. S. Gray, Frazier
			4	2	VI_4				
6·85	Elec. Eng. Lab.	6·18 or 6·40	4	2	X	0	2	3	C. E. Tucker
6·86	Elec. Mach. Lab.	6·01T, 6·18 or 6·40	4(B)	1 or 2	(Elective)		★		C. E. Tucker
6·89	Elec. Eng. Lab.	6·40	3 or 4	1 or 2	(Elective)	0	2	2	C. E. Tucker
6·901 — 6·904	General Electric Industrial Prac.	—	—	—	VI-A	40 h.p.w.			Timbie
6·911 — 6·914	Boston Edison Pub. Util. Prac.	—	—	—	VI-A	40 h.p.w.			Timbie
6·941 — 6·944	Bell System Com. Prac.	—	—	—	VI-A	40 h.p.w.			Timbie
6·951 — 6·954	General Radio Ind. Prac.	—	—	—	VI-A	40 h.p.w.			Timbie
6·961 — 6·964	Philco Corp. Ind. Prac.	—	—	—	VI-A	40 h.p.w.			Timbie

BIOLOGY — 7·00–7·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
7·01	General Biology I	—	2	1	VII, XX	3	3	4	Johnson
7·02	General Biology II	7·01	2	2	VII, XX	3	3	4	Johnson
7·03	Genetics	7·02	4(B)	2	VII, VII-A	2	—	4	Blake
7·11	Embryology	7·02	3	2	VII	2	6	4	Bennett
7·12	General Cytology	7·19, *7·20*	G(A)	2	(Elective)	2	4	2	Waugh

★Time specially arranged.

Biology Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
7·14	Comparative Anatomy	7·02	3	1	VII	2	6	4	Blake
7·19	General Physiology I	5·62, 7·80	4(B)	1	VII, VII-A	2	—	4	Bear
7·20	General Physiology II	7·19	4(B)	2	VII, VII-A	2	—	4	Schmitt
7·211	Gen. Physiol. Lab. I	*7·19*	4(B)	1	VII, VII-A	0	4	0	Bear, Waugh
7·212	Gen. Physiol. Lab. II	7·211	4(B)	2	VII, VII-A	0	4	0	Sizer
7·31‡	Biol. of Bacteria	7·02, 7·80	4	1	VII-A	3	4	4	——
7·321‡	Bacteriology, Adv.	7·31, 7·80	G(A)	1	(Elective)	2	—	4	——
7·322‡	Bacteriology, Adv.	7·321	G(A)	2	(Elective)	2	4	2	——
7·80	Biochemistry	5·41	4(B)	1	XX, XX-A	2	6	4	Gould
			3	1	VII				
7·81	Enzymology	*7·19*	G(A)	1	XX-A	2	4	4	Sizer
7·82	Biochemistry, Adv.	*7·20*, 7·80	G(A)	2	(Elective)	2	4	4	Gould
7·831	Biochem. of Microörganisms	5·428, 7·31	4(B)	1	(Elective)	0	6	0	Gould, Johnson
7·832	Biochem. of Microörganisms	7·831	G(A)	2	(Elective)	0	6	0	Gould
7·85	Biophysics I	*7·19*, 8·04	G(A)	1	VII-A	2	—	2	Bear
7·86	Biophysics II	7·85	G(A)	2	VII-A	2	—	2	Bear
7·87	Spectr. of Biol. Materials	*7·19*	G(A)	1	(Elective)	2	—	2	Loofbourow
7·871	Spectr. of Biol. Mater. Lab.	*7·87*	G(A)	1	(Elective)	0	4	0	Loofbourow
7·881	Biophysics Lab. I	*7·19*	G(A)	1	VII-A	0	4	0	Bear
7·882	Biophysics Lab. II	7·881	G(A)	2	VII-A	0	4	0	Bear
7·91	Instrument. in Biol. I	*7·19*	G(A)	1	VII-A	2	4	4	Lion
7·92	Instrument. in Biol. II	7·91	G(A)	2	VII-A	2	4	4	Lion
7·93	Selected Topics in Biology	*7·19*	G(A)	1 or 2	(Elective)		★		Staff
7·941	Research Problems	——	G(A)	1	(Elective)		★		Staff
7·942	Research Problems	——	G(A)	2	(Elective)		★		Staff

PHYSICS — 8·00–8·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
8·00	Physics, Entrance	——	—	S	——	2	—	5	——
8·001	Physics	——	—	1	——	3	—	6	——
8·01	Physics (Mechanics)	——	1	1	All courses	4	2	5	Livingston
8·012	Physics (College Transfer)	M11	1	1	——	5	—	6	Harvey
8·02	Physics (Mech. and Heat)	8·01	1	2	All courses	4	2	5	Warren
8·03	Physics (Electricity)	8·01, M12	2	1	All courses	4	1	5	Sears
8·034	Physics (College Transfer)	M11	2	2	——	5	—	6	Bitter
8·04	Physics (Elec., Optics & Modern Physics)	8·03	2	2	All courses except IV	4	1	5	Duntley
8·061	Intermediate Physics	8·04	3	S	VI-A(A)$_{3,4}$	3	—	6	Allis
	(Thermodynamics & Kinetic Theory)		3	1	VI(2,3,4), VIII, IX-A				
8·062	Intermediate Physics (Electronics)	8·04	3	2	VI(2,3,4), VI-A(A)$_{3,4}$ VIII, IX-A	3	—	6	Livingston
8·09	Physical Measurements	8·04	3	1	VIII	0	3	2	Stockbarger
			4	1	VII-A				
8·11	Experimental Physics	8·202, 8·312	4(B)	1	VIII	2	6	4	S. C. Brown
8·13	Vibration and Sound	8·04, M22	4(B)	1	VI$_3$, VI-A(A)$_3$	3	—	6	Bolt
8·131	Experimental Acoustics	8·13	4(B)	1	(Elective)	0	3	4	Bolt
8·132	Architectural Acoustics	8·02	4(B)	1	IV	3	2	3	Bolt
8·135	Sp. Problems in Acoustics	8·13	G(A)	1 or 2	(Elective)		★		Bolt
8·15	*Photography*	8·04	3	2	(Elective)	2	—	1	Hardy
8·152	Photography, Adv.	8·15 or 8·161	—	2	(Elective)	0	3	2	Hardy
8·161	Optics	8·04	3	1	VI(2), VIII	3	—	6	Hardy
8·162	Optical Measurements	*8·161*	3	1	VIII	0	3	2	Hardy
8·173	Color Measurements	8·04	4(B)	2	(Elective)	0	3	2	Hardy
8·183	Sp. Problems in Optics	8·161	G(A)	1 or 2	(Elective)		★		Hardy
8·202	Electronics Lab.	8·061	3	2	VIII	0	3	2	Kip
8·21	Physical Electronics	8·062	G(A)	1	(Elective)	3	—	6	Nottingham
8·212	Physical Electronics Lab.	8·21	G(A)	2	(Elective)	2	3	3	Nottingham
8·23	Electrical Discharges in Gases	8·462	G(A)	2	(Elective)	3	—	6	Allis
8·25	Sp. Prob. in Electronics	8·062, *8·21*	G(A)	1 or 2	(Elective)		★		Nottingham
8·261‡	Macro. Prop. of Matter I	8·462	G(A)	1	(Elective)	3	—	6	Mueller
8·262	Macro. Prop. of Matter II	8·462	G(A)	1	(Elective)	3	—	6	Mueller
8·27	X-rays & Crys. Phys.	8·04, M22	4(B)	1	(Elective)	3	1	6	Warren
8·28‡	X-ray Diffraction	8·27	G(A)	2	(Elective)	3	—	6	Warren
8·29	Th. of the Solid State	8·512	G(A)	2	(Elective)	3	—	6	Tisza

★ Time specially arranged.

‡ Not offered 1946–47.

Physics Continued

No	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
8·30	Sp. Prob. in Crys. Phys.	8·27	G(A)	1 or 2	(Elective)		★		Warren
8·311	Atomic Structure	8·04	3	2	VIII	3	—	6	Mueller
			4	2	VII-A				
8·312	Atomic Struct. Lab.	8·09, *8·311*	3	2	VIII	0	3	2	Buechner
			4	2	VII-A				
8·32	Line Spectra	8·311	G(A)	2	(Elective)	3	—	6	McNally
8·343	Sp. Prob. in Spectros.	8·32	G(A)	1 or 2	(Elective)		★		Harrison
8·40	Nuclear Physics, Int.	8·311	4(B)	1	(Elective)	3	—	6	M. Deutsch
8·411	Nuclear Physics I	8·311, 8·461	G(A)	1	(Elective)	3	—	6	R. D. Evans
8·412	Nuclear Physics II	8·411	G(A)	2	(Elective)	3	—	6	R. D. Evans
8·413	Nuclear Physics Lab.	8·411	G(A)	2	(Elective)	0	3	3	Peacock
8·42	Cosmic Rays & High Energy Phenomena	8·461, 8·462	G(A)	2	(Elective)	3	—	6	Rossi
8·43	Th. of Nuclear Struct.	8·521	G(A)	1	(Elective)	3	—	9	Weisskopf
8·441	Sp. Prob. in Nuclear Phys.	8·411	G(A)	1 or 2	(Elective)		★		R. D. Evans
8·461	Int. to Th. Physics I (Mechanics)	M37 or M77	4(B)	1	VI_2, VIII	4	—	8	Slater
8·462	Int. to Th. Physics II (Electromagnetic Theory)	M37 or M77	4(B)	2	VI_2, VIII	4	—	8	Slater
8·463	Int. to Quantum Th. I	8·461, 8·462	G(A)	1	(Elective)	3	—	9	Feshbach
8·464	Int. to Quantum Th. II	8·463	G(A)	2	(Elective)	3	—	9	Feshbach
8·48‡	Adv. Mechanics	8·461, 8·462	G(A)	2	(Elective)	3	—	9	Harvey
8·491	Meth. of Theoret. Phys.	8·461, 8·462	G(A)	1	(Elective)	3	—	9	Morse
8·512‡	Statistical Mechanics	8·463	G(A)	2	(Elective)	3	—	9	Tisza
8·521	Adv. Quantum Mech. I	8·491	G(A)	2	(Elective)	3	—	9	Weisskopf
8·522‡	Adv. Quantum Mech. II	8·521	G(A)	1	(Elective)	3	—	9	Feshbach
8·56	Electromag. Wave Theory	8·462	G(A)	2	(Elective)	3	—	9	Stratton
8·60	Sp. Prob. Theoret. Phys.	8·491	G(A)	1 or 2	(Elective)		★		Morse

CHEMICAL ENGINEERING — 10·00–10·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
10·17	Industrial Chemistry	5·41, 5·61	3	2	X, XIV(c), XV-B	3	—	4	Broughton
10·18	Industrial Chemistry	5·62, 10·17	4	1	X, XIV(c), XV-B	3	—	6	Broughton
10·21	Industrial Chemistry	10·18	4(B)	2	X	3	—	6	Meissner
10·25	Industrial Chemistry	5·42, 5·62	G(A)	1	(Elective)	5	—	7	Meissner
10·26	Industrial Chem. Lab.	10·17	4(B)	S	X	0	20	0	W. K. Lewis
‡10·27	Industrial Chem. Lab.	10·18	G(A)	1	(Elective)	2	6	0	W. K. Lewis
10·28	Chemical Eng.	*5·61*	3	1	X, XIV(c)	4	—	6	C. S. Robinson
			4	1	XX, XX-A				
10·29	Chemical Eng.	10·28	3(B)	2	X	4	—	6	C. S. Robinson
			4	2	XX, XX-A				
10·30	Eng. Equipment	10·32	4	2	(Elective)	0	6	0	Vivian
10·31	Chemical Eng.	10·17, 10·29; or 2·41, 10·17; or *3·20*	4(B)	1	III_2, X, XIV(c), XV-B	4	—	6	McAdams
10·311	Heat Transfer	——	G(RB)	1	XIII-A	3	—	3	McAdams
10·32	Chemical Eng.	10·31	4(B)	2	III_2, X, XIV(c), XV-B	4	—	6	McAdams
10·33	Anal. Treat. of Chem. Eng. Processes	5·62, M22	G(A)	1	(Elective)	3	—	6	Mickley
10·40	Chem. Eng. Thermodyn.	5·62, 10·29	G(A)	1	(Elective)	4	—	8	Weber
10·41	Distillation	10·32	G(A)	2	(Elective)	3	—	6	Gilliland
10·45	Distil. & Absorption	10·32	G(A)	1	(Elective)	4	—	8	Gilliland
10·46	Absorption & Extraction	10·32	G(A)	2	(Elective)	3	—	6	G. C. Williams
10·50	Heat Transmission	10·31	G(A)	2	(Elective)	2	—	4	McAdams
10·52	Chemical Eng. II	10·32	G(A)	1	(Elective)	4	—	5	G. C. Williams
10·53	Chem. Eng. Design	10·81, 10·82, 10·83	G(A)	—	(Elective)	0	12	0	Vivian
10·54	Econ. Balance in Chem. Ind.	10·32	G(A)	1	(Elective)	4	—	8	Quinn
10·55	Economic Balance	10·32	G(A)	2	(Elective)	3	—	6	A. M. Smith
10·62	App. Chem. Thermodyn.	5·62, 10·29	G(A)	2	(Elective)	3	—	6	Weber
10·63	Industrial Chemistry II	10·661 or 10·663	G(A)	2	(Elective)	3	—	6	W. K. Lewis
10·65	Catal. & High Pres. Proc.	5·62, 10·29	G(A)	2	(Elective)	3	—	6	Gilliland
10·661	Colloid Chem., Int.	5·42, 5·62	G(A)	1	(Elective)	2	—	4	Hauser
10·662	Colloid Chemistry	10·661	G(A)	2	(Elective)	2	—	4	Hauser
10·663	Applied Colloid Chem., Int.	5.42, 5·62	G(A)	2	(Elective)	2	—	4	Hauser

★Time specially arranged. ‡Not offered 1946–47.

Chemical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
10·673	Colloid Chem. Lab.	10·63 or 10·661	G(A)	1, 2	(Elective)	0	3	3	Hauser
10·674	Colloid Chem. Lab.	10·763	G(A)	1, 2	(Elective)	0	3	3	Hauser
10·68	Corrosion	5·62	G(A)	1	(Elective)	2	—	4	Broughton
10·69	Plastics and Other High Polymeric Substances	—	G(A)	1	(Elective)	2	—	4	Hauser
10·70	Combustion, Prin.	—	G(A)	1	(Elective)	3	—	9	Hottel
10·71	Fuel Engineering	10·70	G(A)	2	(Elective)	3	—	6	Hottel
10·74	Furnace Design	10·31	G(A)	1 or 2	(Elective)	3	—	6	Hottel
10·76	Sem. Rad. Heat Trans.	10·31	G(A)	2	(Elective)	2	—	4	Hottel
10·79	Automotive Fuels	5·42; 5·62; 2·42 or 10·29	G(A)	1	(Elective)	2	2	4	Hottel
10·81	Sch. Chem. Eng. Practice (Bangor Station)	10·32	G(A)	—	(Elective)	0	12	0	Vivian
10·82	Sch. Chem. Eng. Practice (Parlin Station)	10·32	G(A)	—	(Elective)	0	12	0	Vivian
10·83	Sch. Chem. Eng. Practice (Buffalo Station)	10·32	G(A)	—	(Elective)	0	12	0	Vivian
10·84	Sch. Chem. Eng. Practice (Bangor Station)	10·32	4	2	(Elective)	0	12	0	Vivian
10·85	Sch. Chem. Eng. Practice (Parlin Station)	10·32	4	2	(Elective)	0	12	0	Vivian
10·86	Sch. Chem. Eng. Practice (Buffalo Station)	10·32	4	2	(Elective)	0	12	0	Vivian
10·90	Exp. Research Problem	—	G(A)	1, 2	(Elective)		★		Meissner
10·911	Research Conf.	5·42, 5·62	G(A)	1	(Elective)	1	—	2	Meissner
10·912	Research Conf.	10·911	G(A)	2	(Elective)	1	—	2	G. C. Williams
10·991	Seminar Chem. Eng.	10·32	G(A)	1	(Elective)	2	—	4	Gilliland
10·992	Seminar Chem. Eng.	10·32	G(A)	2	(Elective)	2	—	4	Gilliland

GEOLOGY — 12·00–12·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
12·011	Mineralogy	5·02, *12·20*	3	1	III, XII	0	3	1	Buerger
12·012	Mineralogy	12·011	3	2	XII	0	4	2	Buerger
12·05	Mineral. Seminar	12·012, 12·24	G(A)	1	(Elective)	2	—	4	Buerger
12·06	Mineral. Research	—	G(A)	2	(Elective)		★		Buerger
12·15	Petrography	12·23	3	2	XII	0	6	2	Fairbairn
12·161	Petrology Seminar	12·15	G(A)	1	(Elective)	2	—	4	Fairbairn
12·162	Petrology Seminar	12·15	G(A)	2	(Elective)	2	—	4	Fairbairn
12·17	Petrography, Adv.	12·15	G(A)	1	(Elective)	0	4	0	Fairbairn
12·20	Elem. Crystallog.	M12	3	1	III, XII	2	—	2	Buerger
12·23	Optical Crystallog.	*12·20*	3	1	*XII*	2	3	4	Buerger
12·24	Theoretical Crystallog.	12·20	4(B)	2	III_2	2	—	4	Buerger
12·26	X-ray Crystallog.	12·24	G(A)	2	(Elective)	2	—	4	Buerger
12·27	Crystallog. Research	—	G(A)	1 or 2	(Elective)		★		Buerger
12·301	General Geology	—	2	1	XII	3	4	3	Morris
12·302	General Geology	12·301	2	2	XII	3	4	3	Morris
12·321	Engineering Geology	—	2	1	IV-B	2	2	4	Mead
			3	1	*I*				
12·322	Engineering Geology	12·321	G(B)	2	(Elective)	2	—	4	Mead
12·36	Econ. Geog. of World	—	2	2	XIII-C	2	—	4	Morris
12·37	Geomorphology	12·301	4(B)	2	XII	3	—	6	Morris
12·38	Geomorphology, Adv.	12·37	G(A)	2	(Elective)	3	—	6	Morris
12·39	Reg. Geomorph. of Earth	12·37	4	1 or 2	(Elective)	2	—	4	Morris
12·40	Economic Geology	12·011, 12·302	4(B)	1	XII	3	—	6	—
12·41	Econ. Geology Lab.	*12·40*	4(B)	1	XII	0	6	0	—
12·42‡	App. Econ. Geology	12·40	4(B)	2	(Elective)	3	—	6	—
12·431	Econ. Geol. Lab., Adv.	12·41	G(A)	1	(Elective)	0	4	1	—
12·432	Econ. Geol. Lab., Adv.	12·41	G(A)	2	(Elective)	0	4	1	—
12·433	Econ. Geol. Sem., Adv.	12·40	G(A)	1	(Elective)	2	—	4	—
12·434	Econ. Geol. Sem., Adv.	12·40	G(A)	2	(Elective)	2	—	4	—
12·44	Econ. Geol. of Fuels	G9	4(B)	2	(Elective)	3	—	6	Whitehead
12·511	Paleontology	12·301 or G9	4	1	(Elective)	0	4	4	Shrock
12·512	Paleontology	12·511	4	2	(Elective)	0	4	4	Shrock

★ Time specially arranged.

‡ Not offered 1946–47.

Geology Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
12·52	Paleontology, Adv.	12·512	G(A)	1 or 2	(Elective)	1	3	2	Shrock
12·53‡	Index Fossils	12·511	G(A)	2	(Elective)	1	4	2	Shrock
12·581	Sedimentation	12·301	4(B)	2	XII	2	3	4	Shrock
12·582	Sedimentation	12·581	G(A)	1	(Elective)	2	3	4	Shrock
12·60	Glacial Geology	12·302	4(B)	1	(Elective)	2	—	4	Morris
12·63	Physical Geol. Sem.	12·702	G(A)	1	(Elective)	2	—	4	Staff
12·64‡	Geology of N. America	12·302	G	2	(Elective)	2	—	4	Whitehead
12·66	Research	——	4(B)	1 or 2	(Elective)		★		Staff
12·671	Prob. in Geol. Seminar	12·15	G(A)	1	(Elective)	1	—	2	Staff
12·672	Prob. in Geol. Seminar	12·15	G(A)	2	(Elective)	1	—	2	Staff
12·701	Structural Geology	12·301 or 12·321	3(B)	1	XII	3	—	6	Mead
12·702	Structural Geology	12·701	3(B)	2	XII	3	—	6	Whitehead
12·71	Structural Geology, Adv.	12·702	G(A)	2	(Elective)	3	—	6	Mead
12·80	Geology Coal & Petrol.	12·302 or G9	4(B)	1	(Elective)	2	—	4	Whitehead
12·81	Geology Petrol., Adv.	12·80	G(A)	2	(Elective)	3	—	6	Whitehead
12·851	Th. Geophysics, Adv.	8·461	G(A)	1	(Elective)	3	—	6	J. Adkins
12·852	Th. Geophysics, Adv.	8·461	G(A)	2	(Elective)	3	—	6	J. Adkins
12·86	Seismology, Elem.	M22	4(B)	2	(Elective)	2	—	4	J. Adkins
12·87	Geophys. Prospecting, Int.	12·302	4(B)	1	(Elective)	2	—	4	J. Adkins
12·91	Mining, Elements	12·40	4(B)	2	(Elective)	3	—	5	Parks
			3	2	III(2)				
12·92	Mining Meth. & Practice	12·91	4(B)	2	(Elective)	3	—	6	Parks
12·94	Mineral Economics	12·40	4(B)	1	(Elective)	2	—	4	Parks
12·95	Mine Valuation	12·92	G(A)	2	(Elective)	3	—	6	Parks
12·96	Mineral Econ. Sem.	12·94	G(A)	2	(Elective)		★		Parks

NAVAL ARCHITECTURE AND MARINE ENGINEERING — 13·00–13·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
13·01	Naval Architecture	8·01, M21	3(B)	1	XIII, XIII-C	3	—	6	Manning
			4	1	XIII-A				
13·02	Naval Architecture	13·01	3(B)	2	XIII	3	—	6	Manning
			4	2	XIII-A				
13·021	Naval Architecture	13·01	3	2	XIII-C	2	—	4	Turner
13·022	Naval Architecture	——	G	1	——	2	—	4	Manning
13·03T	Naval Arch. and Ship Design	13·46	G(A)	1	(Elective)	3	—	6	Manning
13·031	Ship Design	13·03T	G(A)	2	(Elective)	0	8	0	Manning
13·04‡	Naval Arch. and Ship Design	13·03	G(A)	2	(Elective)		★		Manning
13·12	Th. of Warship Design	13·01	4(RB)	2	XIII-A	2	—	4	Wheelock
13·13	Th. of Warship Design	2·046	G(RA)	1	XIII-A	4	—	8	Wheelock
13·15	Th. of Warship Design	13·13	G(RA)	1	XIII-A	3	—	6	Manning
13·16	Th. of Warship Design	13·15	G(RA)	2	XIII-A	3	—	6	Wheelock
13·21	Warship Design	——	4(RB)	1	XIII-A	0	5	0	Robertson
13·22	Warship Design	13·01	4(RB)	2	XIII-A	0	5	0	Wheelock
13·24	Warship Design	13·13	G(RA)	2	XIII-A	0	5	0	Wheelock
13·25	Warship Design	13·24	G(RA)	1	XIII-A	0	5	0	Wheelock
13·26	Warship Design	13·15	G(RA)	2	XIII-A	0	8	0	Manning
13·34	Ship Construction	——	3	1	XIII, XIII-C	3	—	3	Burtner
13·40	Ship Construction, Elem.	——	2	2	XIII	2	3	2	Turner
13·42	Ship Drawing	13·01	3	2	XIII	0	6	0	Turner
13·45	Ship Design	13·02, 13·34, 13·42	4(B)	1	XIII	3	4	3	Turner
13·46	Ship Design	13·45	4	2	XIII	1	6	0	Manning
13·47	Ship Design	13·021, 13·34	5	2	XIII-C	1	6	1	Turner
13·52	Marine Engineering	2·40	3	2	XIII, XIII-C	3	—	6	Burtner
13.54	Marine Engineering	2·062, 13·52	4(B)	1	XIII	2	—	4	F. M. Lewis
13·55	Marine Engineering	2·42, 13·52	4	2	XIII	2	—	4	Burtner
13·56†	Marine Engineering	13·52	5	1	XIII-C	3	—	6	Chapman
13·61	Marine Eng. Design	2·04, 2·40, 13·52	4(B)	1	XIII	0	6	0	Burtner
13·62	Marine Eng. Design	13·61	4(B)	2	XIII	1	6	1	Burtner
13·71	Naval Engineering	13·57, 13·58, 13·64	G(A)	1	(Elective)	3	2	8	L. P. Smith
13·72	Naval Engineering	13·71	G(A)	2	(Elective)	2	4	4	L. P. Smith
13·73	Mechanical Vibration	2·046 or 2·06 or 2·062	G(A)	2	XIII-A	3	—	6	F. M. Lewis
			G	2	(Elective)				

★ Time specially arranged. ‡ Not offered 1946–47.

† Open only to students in Course XIII-C who have had one year's practical work with a Steamship Company with nine months spent at sea.

Naval Architecture and Marine Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
13·74	Mechanical Vibration	13·73	G(A)	1	XIII-A	3	—	6	F. M. Lewis
			G	1	(Elective)				
13·75	Naval Engineering	2·422	G(RA)	1	XIII-A	3	2	6	L. P. Smith
13·76	Naval Engineering	13·75	G(RA)	2	XIII-A	2	4	4	L. P. Smith
13·78‡	Propeller Th. & Exp. Res.	13·02	G(A)	2	(Elective)	2	—	4	F. M. Lewis
13·79‡	Propeller Design	13·02	G(RA)	1	XIII-A	1	1	2	F. M. Lewis
13·791	Propeller Design	2·251, 13·02	G(A)	1	(Elective)	1	1	2	F. M. Lewis
13·81†	Ship Operation	13·021, 13·52, 13·84	5(B)	1	XIII-C	3	—	6	Chapman
13·82†	Ship Operation	13·81	5(B)	2	XIII-C	3	—	6	Chapman
13·83	Ports and Port Facilities	12·36	3	1	XIII-C	3	—	4	Chapman
13·84	Cargo Handling and Stowage	13·83	3	2	XIII-C	3	2	3	Chapman

BUSINESS AND ENGINEERING ADMINISTRATION — 15·00–15·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
15·11	Bus. Manage., Int.	Ec11	4(B)	2	XIII	3	—	6	Cunningham
			3	2	XX				
15·20‡	Ocean Ship. Admin.	—	5	2	XIII-C	2	—	4	—
15·30	Personnel Management	15·70	2	2	XV-A, XV-B	3	—	5	Pigors
15·41	Finance	15·50, Ec11	4(B)	1	XV-A, XV-B, XVII$_2$	3	—	6	R. E. Freeman,
15·42	Financial Problems	15·41	4(B)	2	(Elective)	3	—	6	D. S. Tucker
15·46	Fin. Adm. of Industry	15·41 or Ec47	G(A)	2	(Elective)	3	—	6	R. E. Freeman, D. S. Tucker
15·50	Accounting	*Ec11*	3	1	XIV, XV-B	3	2	4	Robnett
			3	2	XV-A, XVII				
15·51	Indust. Accounting	15·50	4(B)	2	(Elective)	3	2	4	Robnett
15·52‡	Accounting	*Ec11*	4	2	(Elective)	2	2	2	Robnett
			5	1	XIII-C				
15·55	Prob. in Account. Policy	15·41	G(A)	1	(Elective)	3	—	6	Robnett
15·58	Prob. in Account. Control	15·51	G(A)	2	(Elective)	3	—	6	Robnett
15·61	Law of Contracts	*Ec11*	3(B)	1	XV-A, XV-B	3	—	6	Schaefer
			4	1	XVII$_2$				
			5	1	XIII-C				
15·62	Law of the Market	15·61	4(B)	2	(Elective)	3	—	6	Schaefer
15·63	Industrial Law	15·61	4(B)	1	(Elective)	3	—	6	Schaefer
15·64	Patent Law	15·61	4(B)	1	(Elective)	3	—	6	Schaefer
15·65	Labor Law	15·61	4(B)	2	(Elective)	3	—	6	Schaefer
15·70	Production	—	2	1	XV-A, XV-B	3	—	6	Schell
			3	2	XIV(1)				
			4	2	(Elective)				
15·71	Production	15·70	4(B)	1	(Elective)	3	—	6	Schell
15·72	Tech. of Ex. Control	15·70	4(B)	2	(Elective)	3	—	6	Schell
15·73	Management Lab.	2·731 or 15·70	4(B)	1, 2	(Elective)	3	3	3	Goodwin
15·74	Management Lab., Adv.	15·73	4(B)	2	(Elective)	3	3	3	Goodwin
15·75	Manufact. Analysis	15·71	G(A)	1	(Elective)	3	—	6	Schell
15·76	Mass Production Methods	2·851, 15·70	4(B)	1 or 2	(Elective)	3	—	6	—
15·81	Marketing and Reports	*Ec11*	3	1	XV-A	4	—	8	Bartlett,
			3	2	XV-B				Tallman
			4	1	XVII$_2$				
15·82	Sales Promotion: Strategy & Methods	15·81	4(B)	2	XVII$_2$	3	—	6	Cunningham, Tallman
15·83	Marketing Research: Field Surveys	15·81	4(B)	2	(Elective)	3	—	6	—
15·84	Marketing Research: Sales Anal. & Poten.	15·81	4(B)	2	(Elective)	3	—	6	—
15·86	New Prod. Appraisal & Development	15·82 or 15·83 or 15·84	G(A)	1	(Elective)	3	—	6	—
15·88	Marketing Seminar	15·82 or 15·83 or 15·84	G(A)	2	(Elective)	3	—	6	—
15·92	Industrial Problems	15·30, 15·41, 15·61, 15·70, 15·81	4(B)	2	XV-A, XV-B	3	—	6	Schell
15·94	Contemp. Prob. Seminar	15·92	G(A)	2	(Elective)	3	—	6	Schell
15·95	Sp. Prob. in Management	—	G(A)	1, 2	(Elective)		★		Schell
15·96	Adm. Th. & Practice	15·92	G(A)	2	(Elective)	3	—	6	Schell
15·97	Seminar in Bus. Adm.	—	G(A)	2	(Elective)	3	—	6	Schell
	Graduate Thesis	—	G(A)	—	XV		★		Cunningham

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BUILDING ENGINEERING AND CONSTRUCTION

AERONAUTICAL ENGINEERING — 16·00–16·99

No.	Subject	Prerequisite	Year	Term		Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
16·01	Aero. Mech., Int.	M22	3(B)	1		XVI	4	2	6	Rauscher
16·02	Aero. Mech., Int.	16·01	3(B)	2		XVI	4	2	6	Rauscher
16·03	Aerodyn. Non-Viscous Fluids	16·02	G(A)	1		(Elective)	3	—	6	Bicknell
16·04	Aerodyn. Viscous Fluids	16·03	G(A)	2		(Elective)	3	—	6	Tsien
16·05	Aerodynamics — Compressible Fluids	16·02	G(A)	1		(Elective)	3	—	6	Rauscher
16·07T	Wing Flutter, Int.	16·02	4(B)	2		(Elective)	2	—	4	Rauscher
16·08T	Flutter Mechanics	16·02	G(A)	1		(Elective)	3	—	6	Rauscher
16·10	Applied Aerodynamics	16·01, 16·82	3(B)	2		XVI	4	—	8	Ober
16·105	Applied Aerodynamics	16·10	G(RA)	1 or 2		——	3	—	6	Ober
16·13	Airpl. Stab. & Control	16·10	4(B)	1		XVI	3	—	6	Koppen
16·14	Airpl. Design Prob.	16·13, 16·17	4(B)	2		(Elective)	2	6	4	Koppen
16·16	Power Plant Perform. & Install.	2·42, 2·06 or 16·02	4(B)	2		XVI	3	—	6	E. S. Taylor
16·17	Airpl. Des. Practice	16·10, *16.13*	4(B)	1		XVI	0	6	0	Koppen
16·18	Airpl. Des. Practice	——	G(RA)	2		——	0	8	0	Newell
16·20	Structures	2·04	3	2		XVI	3	—	6	Newell
16·21	Structures	16·20	4(B)	1		XVI	3	—	6	Newell
16·22	Aircraft Structures	16·21	4(B)	2		(Elective)	3	2	6	Newell
16·25	Aircraft Struct., Adv.	16·21	G(A)	1		(Elective)	3	—	6	Newell
16·30	Aircraft Instruments	8·04, M22	4(B)	2		(Elective)	3	2	6	McKay
16·31	Instrumentation	2·06 or 2·07 or 16·02	G(A)	1		(Elective)	3	—	9	Draper
16·32	Aircraft Instruments	16·31	G(A)	2		(Elective)	3	—	9	McKay
16·33T	Instruments Laboratory	16·31	G(A)	1		(Elective)	0	3	6	Forbes
16·34T	Flight Test Instruments	16·30, 16·31	G(A)	2		(Elective)	3	3	9	McKay
16·35	Special Problems in Aircraft Instruments	16·32 or 16·34T or 16·36	G(A)	1 or 2		(Elective)		★		McKay
16·36	Vibration Measurements	2·06 or 2·07 or 6·671 or 8·05 or 13·73; 16·31	G(A)	2		(Elective)	2	3	6	Forbes
16·37T	Instrument Design Practice	16·31	G(A)	1		(Elective)	2	6	2	McKay
16·38T	Instrument Design Practice	16·37T	G(A)	2		(Elective)	2	6	2	McKay
16·41T	Introduction to Fire Control Instruments	2·06	G(RA)	1		——	3	—	6	Draper
16·42T	Advanced Fire Control Instruments	16·41T	G(RA)	2		——	3	—	8	Draper
16·43T	Fire Control Instrument Laboratory	16·41T	G(RA)	1		——	0	8	0	Weems
16·44T	Advanced Fire Control Instruments	16·41T	G(RA)	2		——	4	—	8	Draper
16·45T	Advanced Fire Control Instruments	16·42T or 16·44T	G(RA)	1		——	4	—	8	Draper
16·46T	Advanced Fire Control Instrument Laboratory	16·42T, 16·44T	G(RA)	2		——	0	8	0	Weems
16·50	Rotat. Wing Aircraft	16·10	4(B)	2		(Elective)	3	—	6	Miller
16·501	Rotating Wing Aircraft	16·10	G(A)	2		(Elective)	3	—	6	Miller
16·52	Aircraft Propeller Des.	16·10, 16·20	G(A)	2		(Elective)	2	2	4	Ober
16·53	Airplane Eng. Des., Adv.	2·792	G(A)	2		(Elective)	2	3	3	C. F. Taylor
16·56	Jet Propulsion Engines	2·48 or 2·213	G(A)	2		(Elective)	3	—	9	Hawthorne, E. S. Taylor
16·60	Aero. Prob., Adv.	16·13 or 16·25 or 16·63	G(A)	1 or 2		(Elective)		★		Staff
16·62	Aerodynamic Lab.	16·01, 16·10	4(B)	1		XVI	2	2	4	Ober
16·63	Aerodynamic Lab.	16·62	4(B)	2		(Elective)	2	2	4	Ober
16·75	Constr. Details of Aircraft	16·17	4(B)	2		XVI	2	3	4	Koppen
16·81	Aeronautics, General	1·40 or 2·06; 2·252; M21	4(B)	1 or 2		(Elective)	3	—	6	Markham
16·82	Aeronautical Eng., Int.	M21	2	2		XVI	3	—	1	Markham

BUILDING ENGINEERING AND CONSTRUCTION — 17·00–17·99

No.	Subject	Prerequisite	Year	Term		Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
17·22	Building Construction	D12	2	1		XVII	2	3	4	Dietz
17·31	Building Construction	17·22	3	1		XVII(1)	2	3	4	Staley
17·32	Building Construction	17·31	3	2		XVII(1)	2	3	4	Staley
17·33	Building Construction	17·22	3	1		XVII(2)	2	3	4	Dietz
17·34	Building Construction	17·33	3	2		XVII(2)	2	3	4	Voss

★ Time specially arranged.

Building Engineering and Construction Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
17·40	Estimating & Job Manage.	17·32 or 17·34	4(B)	2	XVII	2	3	4	Voss
17·401	Job Management, Adv.	17·40	G(A)	1	(Elective)	3	—	6	Voss
17·41	Building Management	17·40, 17·73	G(A)	1	(Elective)	3	—	6	Voss
17·42	Building Management	17·41	G(A)	2	(Elective)	3	—	6	Voss
17·45	Construction Problems	17·32 or 17·34	4(B)	1 or 2	(Elective)		★		Voss
17·52	Structural Problems	2·04	3	2	XVII	3	4	5	Peabody
17·53	Structural Design	17·52	4(B)	1	XVII_1	4	4	6	Peabody
17·531	Reinf. Concrete Des., Adv.	1·42 or 17·53	G(A)	1	(Elective)	3	—	6	Peabody
17·532	Reinf. Concrete Des., Adv.	17·531	G(A)	2	(Elective)	3	—	6	Peabody
17·54	Structural Design	17·53	4(B)	2	XVII_1	3	4	5	Peabody
17·542	Structural Steel Des., Adv.	1·42 or 17·54	G(A)	2	(Elective)	3	—	6	Peabody
17·56‡	Structural Design	17·52	4	2	XVII_2	3	4	5	Peabody
17·71	Materials	5·02, 8·02	2	2	IV, XVII	2	—	4	Dietz
17·72	Materials	17·71	3	2	IV, XVII	2	—	4	Staley
17·73	Materials	17·72	4(B)	1	IV, XVII	2	—	4	Dietz
17·741	Eng. Prop. of Plastics	5·02 and 2·371 or 2·373	4(B)	1	(Elective)	2	—	4	Dietz
17·742	Eng. Prop. of Plastics	17·741	G(A)	2	(Elective)	3	—	6	Dietz
17·75	Materials	5·02, 8·02	3	1	I	3	—	6	Voss
17·76	Res. in Organic Struct. Mat.	17·742	G(A)	1 or 2	(Elective)		★		Dietz
17·771	Cementitious Materials	17·72 or 17·75	4(B)	1	(Elective)	2	—	4	Staley
17·772	Cement and Concrete	17·771	G(A)	2	(Elective)	3	—	6	Staley
17·78	Res. in Cementitious Mat.	17·772	G(A)	1 or 2	(Elective)		★		Staley

METEOROLOGY — 19·00–19·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
19·01	Descriptive Meteorol. I	8·02, M12	3	1	XIX	3	—	6	Willett
19·02	Descriptive Meteorol. II	19·01	3	2	XIX	3	—	6	Willett
19·14	Long Range Weather Fore.	19·02, 19·45, 19·53, 19·61	G(A)	2	(Elective)	3	8	6	Willett
19·21	Meteorological Observations	8·02, M12	3	1	XIX	1	3	2	Keily
19·22	Meteorological Inst.	8·02, 19·11, M21	4(B)	1 or 2	(Elective)	2	2	6	Keily
19·30	General Climatology	19·01	3	2	XIX	2	—	4	Malone
19·31	Regional Climatology	19·02, 19·30, *19·51*	4(B)	1	(Elective)	2	—	4	Malone
19·43	Synoptic Meteorol. I	19·01	4(B)	1	XIX	3	—	6	Willett
19·44	Synoptic Meteorol. II	19·43, 19·51, 19·61	4(B)	2	XIX	3	—	6	Austin
19·45	Synoptic Meteorol. III	19·44	G(A)	1	(Elective)	3	—	6	Austin
19·50	Meteorol. Lab., Int.	*19·01*	3	2	XIX	0	9	3	Malone
19·51	Synoptic Lab. I	19·50	4(B)	1	XIX	0	15	0	Austin
19·52	Synoptic Lab. II	19·51	4(B)	2	XIX	0	15	0	Austin
19·53	Synoptic Lab. III	19·43, 19·52	G(A)	1 or 2	(Elective)	0	15	0	Malone
19·60	Thermodyn. of Atmos.	8·02, M22	3	2	XIX	3	—	6	Houghton
19·61	Dynamic Meteorol. I	19·60	4(B)	1	XIX	2	—	4	Haurwitz
19·62	Dynamic Meteorol. II	19·61	4(B)	2	XIX	3	—	6	Haurwitz
19·64	Dynamic Meteorol. III	19·62	G(A)	1	(Elective)	3	—	9	Haurwitz
19·65	*Dynamic Meteorol. IV*	*19·64*	G(A)	2	(Elective)	3	—	6	Haurwitz
19·67	Graphical Analysis	*19·62*	4(B)	2	(Elective)	0	3	0	Haurwitz
19·70	Phys. of Atmos., Elem.	19·01	3	2	XIX	2	—	4	Houghton
19·72	Physical Meteorology	8·04, 19·61	G(A)	1	(Elective)	3	—	6	Houghton
19·83	Oceanography	*19·43, 19·61*	4(B)	1	XIX	2	—	4	Houghton
19·91	Meteorol. Seminar I	19·44, 19·62	G(A)	1	(Elective)	2	—	4	Houghton
19·911	Meteorol. Seminar I	19·44, 19·62	G(A)	1	(Elective)	1	—	2	Houghton
19·912	Meteorol. Seminar I	19·911	G(A)	2	(Elective)	1	—	2	Houghton
19·92	Meteorol. Seminar II	19·91	G(A)	2	(Elective)	2	—	4	Houghton
19·95	Sp. Prob. in Meteorol.	19·44, 19·62	G(A)	1 or 2	(Elective)		★		Staff

FOOD TECHNOLOGY—20·00–20·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
20·01	Tech. & Chem. Food Supplies	5·41, *20·41*	3	1	XX	2	4	2	Proctor
20·02	Tech. & Chem. Food Supplies	*20·42*	3	2	XX	2	4	4	Proctor
20·04	Chemistry of Food	5·12	3	2	(Elective)	2	4	2	R. S. Harris
20·11	Tech. Food Products	20·02	4(B)	1	XX, XX-A	2	4	4	Proctor
20·12	Tech. Food Products	20·11	4(B)	2	XX, XX-A	2	4	4	Proctor

★ Time specially arranged. ‡ Not offered 1946–47.

Food Technology Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
20·32	Chemistry of Nutrition	5·41, 7·80	4(B)	2	XX, XX-A	2	—	2	R. S. Harris
20·322	Chem. of Nutrition Lab.	5·41, 7·80	4(B)	2	XX-A	1	4	0	R. S. Harris
20·34	Applied Nutrition	20·32	G(A)	2	(Elective)	2	2	4	R. S. Harris
20·36	Nutrition, Adv.	20·32	G(A)	2	(Elective)	2	4	2	R. S. Harris
20·41	Bacteriology	7·02	3	1	XX	2	4	2	——
20·42	Industrial Microbiol.	20·41	3	2	XX	2	4	4	Dunn
20·43	Ind. Microbiol., Adv.	20·42	G(A)	1	(Elective)	2	4	4	Dunn
20·44	Ind. Microbiol., Adv.	20·43	G(A)	2	(Elective)	2	4	4	Proctor, Dunn
20·46	Bacteriology of Foods	20·42, 7·80	G(A)	2	(Elective)	2	4	2	Proctor
20·51	Food Technology, Adv.	20·12	G(A)	1	XX-A	2	6	4	Proctor
20·52	Food Technology, Adv.	20·51	G(A)	2	XX-A	2	4	4	Proctor
20·61	Food Technology Sem.	20·12	G(A)	1	XX-A	2	—	2	Proctor
20·62	Food Technology Sem.	20·61	G(A)	2	XX-A	2	—	2	Proctor

GRAPHICS — D1–D99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
D11	Engineering Drawing	——	1	1	All courses	0	6	0	Rule
D12	Descriptive Geometry	D11	1	2	All courses	0	6	0	Rule
D31	Nomography	D12, M12	2, 3	1, 2	(Elective)	2	—	4	D. P. Adams

ECONOMICS AND SOCIAL SCIENCE — EC1–EC99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
Ec11	Economic Principles	E12	2	1	XIV	3	—	5	Samuelson
			3	S	VI-A(A)				
			3	1	All except VI-A and XIV				
Ec12	Industrial Economics	Ec11	2	2	XIV(2)	3	—	5	Bishop
			3	2	(Elective)				
Ec13	Prices & Production	Ec12	4(B)	1	XIV_2	3	—	6	Samuelson
Ec15	Econ. & Labor Rel., Prin.	E12	G	2	XIII-A	4	—	8	R. E. Freeman
			G	2	(Elective)				
Ec17	Economic Analysis	Ec50	G(A)	1	(Elective)	3	—	6	Samuelson
Ec18	Economic Analysis	Ec17	G(A)	2	(Elective)	3	—	6	Samuelson
Ec19	Math. Approach to Econ.	Ec18	G(A)	1	(Elective)	3	—	6	Samuelson, H. A. Freeman
Ec21	Econ. of Science & Eng.	Ec27	G(A)	1	(Elective)	3	—	6	Maclaurin
Ec22	Econ. of Science & Eng. Seminar	Ec21	G(A)	2	(Elective)	2	—	4	Maclaurin
Ec23	Postwar Problems	Ec12	4(B)	1	(Elective)	3	—	6	Bissell
Ec24	Schools of Econ. Thought	Ec50	G(A)	2	(Elective)	3	—	6	D. V. Brown, Bissell
Ec26	Business Cycles	Ec50	G(A)	2	(Elective)	3	—	6	Samuelson
Ec27	Econ. of Patents and Invention	Ec11	4(B)	1	(Elective)	3	—	6	Maclaurin
Ec28	Econ. of Patents and Invention	15·64 or Ec27	4(B)	2	(Elective)	2	—	4	Maclaurin
Ec32	Int. Econ. Statistics	M12	2	2	IV-B	3	—	6	H. A. Freeman
Ec322	Elementary Statistics	M12	3	2	XIV	2	—	4	H. A. Freeman
Ec33	Psych. Statistics	M12	4(B)	1	(Elective)	3	—	6	Festinger
Ec34	Psych. Statistics	Ec33	G(A)	2	(Elective)	3	—	6	Festinger
Ec35	Industrial Statistics	M12	4(B)	1	XV-A	3	—	6	H. A. Freeman
Ec36	Experimental Statistics	Ec35	G(A)	2	(Elective)	3	—	6	H. A. Freeman
Ec37	Theoretical Statistics	M21	4(B)	1	(Elective)	3	—	6	H. A. Freeman
Ec38	Theoretical Statistics	Ec37	G(A)	2	(Elective)	3	—	6	H. A. Freeman
Ec47	Investment Finance	Ec50	G(A)	1	(Elective)	3	—	6	D. S. Tucker
Ec48	Investment Analysis	15·42 or Ec47	G(A)	2	(Elective)	3	—	6	D. S. Tucker
Ec49	Public Finance	Ec11	4(B)	1	IV-B	2	—	4	Samuelson
Ec50	Banking & Finance	Ec11	4(B)	2	(Elective)	2	—	4	R. E. Freeman
			3	2	XIV(2)				
Ec54	Corporations	Ec11	5(B)	2	XIII-C	2	—	4	D. S. Tucker
Ec56	Industrial Econ., Prob.	Ec12	4(B)	2	(Elective)	3	—	6	Bishop
Ec57	International Relations	Ec11	4	1	(Elective)	3	—	5	Padelford
Ec58	International Relations	Ec57	4	2	(Elective)	3	—	5	Padelford
Ec59	International Economics	Ec58	G(A)	1	(Elective)	3	—	6	R. E. Freeman

Economics and Social Science Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
Ec60	Labor Relations	Ec11	3	2	XIV	3	—	5	Myers
			3	2	(Elective)				
Ec65	Industrial Relations	15·30 or Ec60	4(B)	1	XIV_1	3	—	6	D. V. Brown
			4	1	(Elective)				
Ec66	Seminar in Indust. Rel.	Ec65	G(A)	2	(Elective)	3	—	6	Pigors
Ec67	Seminar in Labor Probs.	Ec65	G(A)	1	(Elective)	3	—	6	D. V. Brown, Myers
Ec68	Seminar in Labor Probs.	Ec67	G(A)	2	(Elective)	3	—	6	D. V. Brown, Myers
Ec70	Introductory Psychology	—	3	2	(Elective)	3	—	5	McGregor, Knickerbocker
			2	2	XIV(1)				
			3	1	XIV(2)				
Ec71	Motivation & Pers. Dev.	1 yr. Psych.	4(B)	1	(Elective)	3	—	6	Festinger
Ec72	Motivation & Pers. Dev.	Ec71	G(A)	2	(Elective)	3	—	6	Festinger
Ec721	Psych. Perception & Action	Ec72	G(A)	1	(Elective)	3	—	6	Cartwright
Ec723	Manage. of People, Th.	Ec70	3	1	XIV(1)	2	—	4	McGregor
Ec724	Managing People, Tech.	Ec723, Ec725, Ec73	4	2	XIV_1	0	4	0	Knickerbocker, Lippitt
Ec725	Comp. Contemp. Cultures	Ec11	3	1	XIV	2	—	4	Cartwright
Ec73	Psychology, Adv.	Ec70	4	1	XIV_1	3	—	6	Lippitt
Ec731	Group Psych., Int.	Ec71	4(B)	1	(Elective)	3	—	6	Lippitt
Ec732	Group Psych., Int.	Ec731	G(A)	2	(Elective)	3	—	6	Cartwright
Ec735	Group Psychology, Adv.	Ec77	G(A)	1	(Elective)	3	—	6	Bavelas
Ec75	Lab. in Research Methods	Ec72	G(A)	1	(Elective)	3	9	0	Lippitt
Ec76	Lab. in Research Methods	Ec75	G(A)	2	(Elective)	3	9	0	Cartwright
Ec77	Seminar in Topol. Psych.	1 yr. Psych.	G(A)	1	(Elective)	3	—	6	Lewin
Ec781	Social Psych. of Change	1 yr. Psych.	G(A)	1	(Elective)	3	—	6	Radke
Ec782	Social Psych. of Change	Ec781	G(A)	2	(Elective)	3	—	6	Radke
Ec791	Psychological Seminar, Adv.	Ec71	G(A)	1	(Elective)	2	—	4	Lewin, Radke
Ec792	Psychological Seminar, Adv.	Ec71	G(A)	2	(Elective)	2	—	4	Lewin
Ec793	Psychological Seminar, Adv.	Ec71	G(A)	1	(Elective)	2	—	4	Lewin
Ec794	Psychological Seminar, Adv.	Ec71	G(A)	2	(Elective)	2	—	4	Lewin
Ec80	American Government	Ec11	3	2	(Elective)	3	—	6	Schaefer
Ec82	Govt. Control of Industry	Ec50	G(A)	2	(Elective)	3	—	6	D. S. Tucker
Ec83	Urban Sociology	—	2	2	IV	2	—	4	Pigors
			3	2	IV-B				
Ec85	Land Economics	4·651, Ec11	4(B)	1	IV-B	2	—	4	F. J. Adams
			5	1	IV				
Ec86	Land Economics	Ec85	4(B)	2	IV-B	3	—	6	F. J. Adams
Ec88	Building Economics	Ec11	5	2	IV	2	—	4	D. S. Tucker
Ec91	Economics Seminar	Ec17	G(A)	1	(Elective)	3	—	6	R. E. Freeman
Ec92	Economics Seminar	Ec91	G(A)	2	(Elective)	3	—	6	R. E. Freeman
Ec93	Ind. Econ. Seminar	Ec56	G(A)	1	(Elective)	3	—	6	D. V. Brown
Ec94	Ind. Econ. Seminar	Ec93	G(A)	2	(Elective)	3	—	6	D. V. Brown
Ec95	Social Science Seminar	Ec50	G(A)	1	(Elective)	3	—	6	McGregor
Ec96	Social Science Seminar	Ec95	G(A)	2	(Elective)	3	—	6	Knickerbocker

ENGLISH ANL HISTORY — E1–E99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
E1	English, Entrance	—	—	S	—	2	—	5	—
E11	English Composition	—	1	1	All courses	3	—	5	Bryant
E12	English Composition	E11	1	2	All courses	3	—	5	Bryant
E21	U. S. in World History	—	2	1	All courses	3	—	5	Rae
E22	U. S. in World History	—	2	2	All courses	3	—	5	Rae
E25	English Composition	—	3, 4	1 or 2	(Elective)		★		Urbach
E33	Report Writing	E22	4	1	(Elective)	2	—	4	Bartlett
E35	Reports	E22	3	2	(Elective)	2	—	4	Bartlett
E41	History of Thought	E22	4	1	(Elective)	3	—	5	Deutsch
E42	History of Thought	E22	4	2	(Elective)	3	—	5	Deutsch
E43	Western World Literature	E22	4	1	(Elective)	3	—	5	Greene
E44	Western World Literature	E22	4	2	(Elective)	3	—	5	Greene
E46	Music, Int.	—	4	1 or 2	(Elective)	3	—	5	D. M. Fuller
E51	Seminar Ec. and Ind. Hist.	Ec50	G(A)	1	(Elective)	3	—	6	Deutsch
E52	Seminar Ec. and Ind. Hist.	Ec51	G(A)	2	(Elective)	3	—	6	Deutsch
E53	Reading Seminar	—	G	1 or 2	(Elective)	2	—	4	Urbach

★Time specially arranged.

GENERAL STUDIES — G1–G99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
G7	Prob. of Modern Philos.	—	—	1	—	2	—	2	de Santillana
G8	History of Philosophy	—	—	2	—	2	—	2	Wiener
G9	Geology	—	—	1	—	2	—	4	Morris
G28	Economic Geography	—	2	2	—	2	—	4	Morris
G29	Topog. in the World War	—	—	1	—	2	—	2	Morris
G38	Public Speaking	—	2	1	IV-B	3	—	3	Copithorne
G39	Reading Seminar	—	—	1 or 2	—	2	—	4	Chalmers
G67	Debating, Prin.	—	—	1	—	2	—	2	Leggett
G68	Debating, Prin.	—	—	2	—	2	—	2	Leggett
G75	Human Relations	—	—	1	—	3	—	3	Magoun
G76	Human Relations	—	—	2	—	3	—	3	Magoun
G79	Comp. Political Inst.	—	—	1	—	2	—	4	Schaefer

MODERN LANGUAGES — L1–L99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
L11	German, Elem.	—	—	1, 2	(Elective)	3	—	5	Currier
			2	1	XIX				
L12	German, Elem.	L11	—	1, 2	(Elective)	3	—	5	Currier
			2	2	XIX				
L21	German, Int.	L12, or Elem. Entrance German	—	1, 2	(Elective)	3	—	5	Kurrelmeyer
L22	German, Int.	L21	—	1, 2	(Elective)	3	—	5	Kurrelmeyer
L41	Scientific German	—	G	1 or 2	(Elective)	3	—	6	Currier
L51	French, Elem.	—	—	1, 2	(Elective)	3	—	5	W. N. Locke
L52	French, Elem.	L51	—	1, 2	(Elective)	3	—	5	W. N. Locke
L61	French, Int.	L52 or Elem. Entrance French	—	1, 2	(Elective)	3	—	5	Koch
L62	French, Int.	L61	—	2	(Elective)	3	—	5	Koch
L71	Scientific French	—	G	1 or 2	(Elective)	3	—	6	W. N. Locke
L81	Spanish, Elem.	—	—	1	(Elective)	3	—	5	Koch
L82	Spanish, Elem.	L81	—	2	(Elective)	3	—	5	Koch
L83	Spanish, Int.	L82	—	1	(Elective)	3	—	5	Koch
L84	Spanish, Int.	L83	—	2	(Elective)	3	—	5	Koch
L95	Russian, Elem.	—	—	1	—	3	—	5	Znamensky
L96	Russian, Elem.	L95	—	2	—	3	—	5	Znamensky
L97	Scientific Russian	—	G	2	(Elective)	3	—	6	Znamensky

MATHEMATICS — M1–M99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
M1	Algebra, Entrance	—	—	S	—	2	—	5	—
M3	Solid Geom., Entrance	—	—	S	—	2	—	5	—
M4	Trigonometry, Entrance	—	—	S	—	2	—	5	—
M10	Calculus	—	—	1	—	3	—	6	Phillips
M11	Calculus	Entrance Algebra, Solid Geometry, Trigonometry	1	1	All courses	3	—	6	Douglass
M112	Mathematics (College Transfer)	—	1	1	—	3	—	6	Douglass
M12	Calculus	M11	1	2	All courses	3	—	6	Douglass
M21	Calculus	M12	2	1	All courses except IV-B	3	—	6	Zeldin
M212	Mathematics (College Transfer)	—	2	1	—	3	—	6	Douglass
M22	Diff. Equations	*M21*	2	2	(All courses except IV & IV-B)	3	—	6	Zeldin
M31	Diff. Equations	M22	3	S	VI-A(A)	2	—	4	Franklin
			3	1	VI				
M32	Statistics, Elementary	M21	2	2	XVIII	3	—	6	Wadsworth
M331	Math. Th. of Statistics	M22	3(B)	1	XVIII(2), XIX	3	—	6	Wadsworth
M332	Math. Th. of Statistics	M331	3(B)	2	XVIII(2)	3	—	6	Wadsworth
M341	Modern Statistical Th.	M332	4(B)	1	XVIII_2	3	—	6	Wadsworth
M342	Modern Statistical Th.	M341	4(B)	2	XVIII_2	3	—	6	Wadsworth

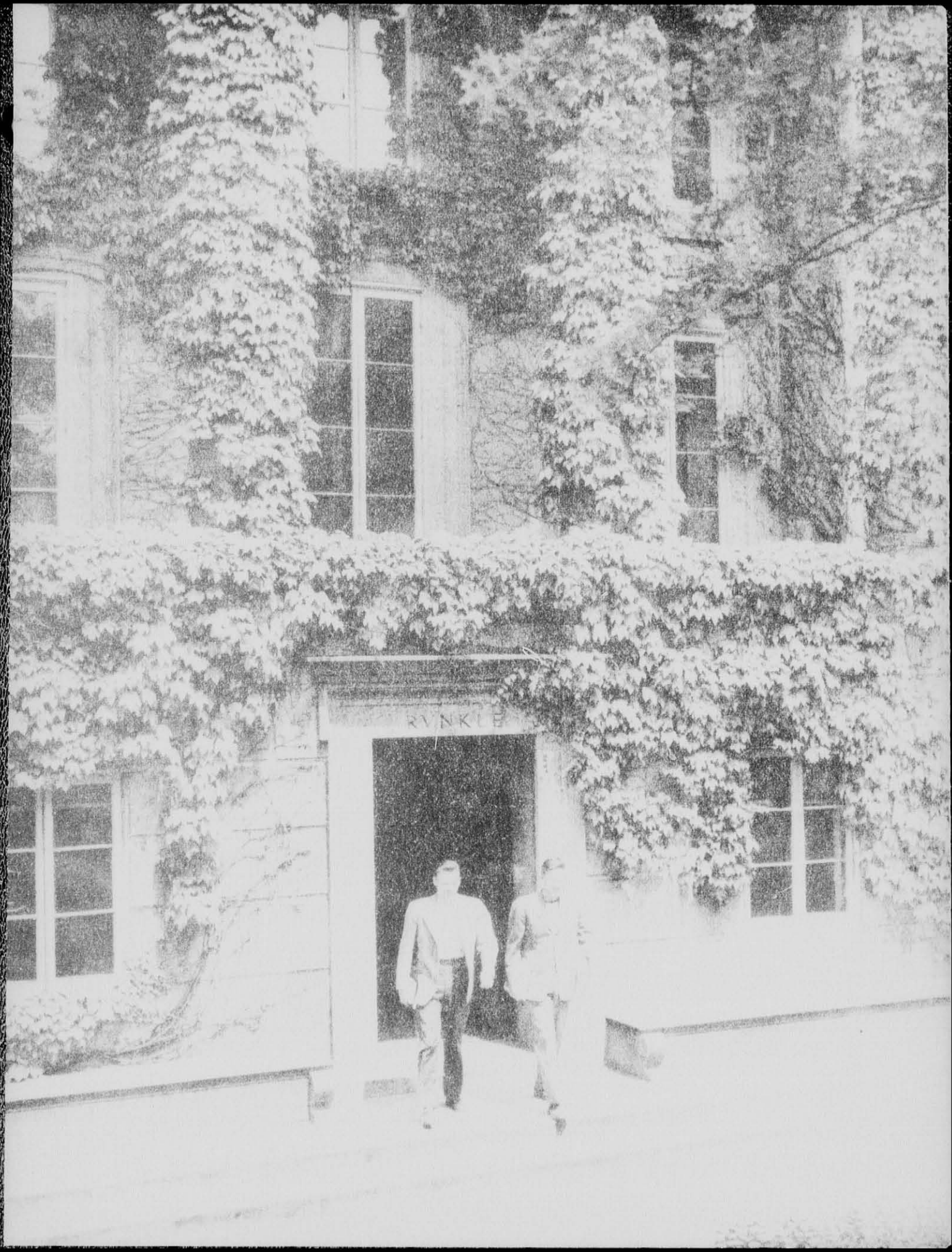
Mathematics Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
M351	Adv. Calculus for Engineers	M22	G(A)	1	(Elective)	3	—	6	Hildebrand
M352	Adv. Calculus for Engineers	M351	G(A)	2	(Elective)	3	—	6	Hildebrand
M36	Advanced Calculus	M22	G(A)	1	(Elective)	3	—	6	Douglass
			3	1	IX-A				
			4	1	XIII-A				
M37	Advanced Calculus	M36	G(A)	2	(Elective)	3	—	6	Douglass
			3	2	IX-A				
			4	2	XIII-A				
M381	Theory of Functions	M22	G(A)	1	(Elective)	3	—	9	Wallman
M382	Theory of Functions	M381	G(A)	2	(Elective)	3	—	9	Wallman
M441‡	Projective Geometry	M22	3(B)	1	(Elective)	3	—	6	Struik
M442	Diff. Geometry, Elem.	M22	4(B)	2	XVIII_1	3	—	6	Struik
M451	Fourier Series & Integrals	M22	G(A)	1	(Elective)	3	—	9	Wiener
M452	Fourier Series & Integrals	M451	G(A)	2	(Elective)	3	—	9	Wiener
M461‡	Seminar in App. Math.	M22	G(A)	1	(Elective)	3	—	9	Reissner
M481	Topology	M22	G(A)	1	(Elective)	3	—	9	Hurewicz
M482	Topology	M481	G(A)	2	(Elective)	3	—	9	Hurewicz
M54	Mathematical Lab.	M22	3(B)	2	(Elective)	3	—	6	Douglass
M551	Funct. of Real Variable	M22	G(A)	1	(Elective)	3	—	9	Salem
M552	Funct. of Real Variable	M551	G(A)	2	(Elective)	3	—	9	Salem
M561‡	Functions of a Complex Variable	M22	G(A)	1	(Elective)	3	—	9	Levinson
M562‡	Functions of a Complex Variable	M561	G(A)	2	(Elective)	3	—	9	Levinson
M571	Diff. Equations	M22	G(A)	1	(Elective)	3	—	9	Hurewicz
			4	1	XVIII_1				
M572	Diff Equations	M571	G(A)	2	(Elective)	3	—	9	Hurewicz
			4	2	XVIII_1				
M581‡	Continuous Groups	M22	G(A)	1	(Elective)	3	—	9	Zeldin
M582‡	Continuous Groups	M581	G(A)	2	(Elective)	3	—	9	Zeldin
M591	Partial Differential Equations	M22	G(A)	1	(Elective)	3	—	9	Levinson
M592	Partial Differential Equations	M591	G(A)	2	(Elective)	3	—	9	Levinson
M62	Modern Algebra	M22	3(B)	2	XVIII(1)	3	—	6	Thomas
M631	Integral Equations	M22	G(A)	1	(Elective)	3	—	9	Crout
M641	Tensor Calculus	M22	G(A)	1	(Elective)	3	—	9	Struik
M642	Tensor Calculus	M641	G(A)	2	(Elective)	3	—	9	Struik
M651	Analytical Mechanics	M22	G(A)	1	(Elective)	3	—	9	Franklin
M652	Analytical Mechanics	M651	G(A)	2	(Elective)	3	—	9	Franklin
M681	Calculus of Variations	M22	G(A)	2	(Elective)	3	—	9	Martin
			4	1	XVIII_1				
M691‡	Charact. Value Prob.	M22	G(A)	1	(Elective)	3	—	9	Franklin
M692‡	Charact. Value Prob.	M691	G(A)	2	(Elective)	3	—	9	Franklin
M73	Review of Mathematics	——	4	—	XIII-A	20	—	0	Douglass
M731	Mechanics	M22	3(B)	1	XVIII (1)	3	—	6	Crout
M732	Mechanics	M731	3(B)	2	XVIII (1)	3	—	6	Crout
M76‡	Th. of Probability	M21	G(A)	2	(Elective)	3	—	9	Struik
M77	Vector Analysis	*M22*	3(B)	1	XVIII (1)	3	—	6	Phillips
			3	2	VI (2), VIII				
M791	Th. & App. Elasticity	M22	G(A)	1	(Elective)	3	—	9	Reissner
M792	Th. & App. Elasticity	M791	G(A)	2	(Elective)	3	—	9	Reissner
M831	Analysis	M22	3(B)	1	XVIII	3	—	6	Franklin
M832	Analysis	M831	3(B)	2	XVIII	3	—	6	Franklin
M90	Math. Reading	——	G(A)	1 or 2	(Elective)		★		Phillips

MILITARY SCIENCE — MS1–MS99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
MS11	Military Science	——	1	1	All courses	0	3	0	Larner
MS12	Military Science	——	1	2	All courses	0	3	0	Bridges
MS21	Military Science	——	2	1	All courses	3	—	0	Larner
MS22	Military Science	——	2	2	All courses	3	—	0	——

★Time specially arranged. ‡ Not offered 1946–47.





APPENDIX A

STUDENT AID AND PRIZES

RESOURCES for financial aid to students include: The Technology Loan Fund and other loan funds, available for undergraduate and graduate students; Freshman Competitive and other scholarships open to students entering from secondary schools; undergraduate scholarship aid to upper classmen; fellowships and graduate scholarships, Teaching Fellowships, and full- and part-time Assistantships to aid students pursuing work leading to the Master's or Doctor's degree; and prizes.

The extent of these resources is indicated by the facts that, since its establishment in 1930, over 2,500 men have borrowed more than $1,880,000 from the Technology Loan Fund; and approximately $90,000 and $102,000 are annually available for undergraduate and graduate scholarship aid, respectively.

TECHNOLOGY LOAN FUND

It is the general policy to make a loan only to men who have completed at least one year of residence at the Institute with a good academic record. In *exceptional* cases, applications will be considered after one term of residence and in *very special and unusual* cases from entering students who have met, with high standing, all entrance requirements.

The maximum amount loaned to an individual in a single year may not exceed the tuition fee, with the additional stipulation that the maximum total loans granted to an applicant may not exceed $1,800 during his undergraduate period, or $2,400 during his undergraduate and graduate periods.

To receive favorable consideration an applicant must:

1. Be endorsed as to character and personality by: (*a*) an alumnus of the Institute from the community in which he has resided, or by some other citizen of standing in that community; (*b*) the Principal or Head Master of the high school or preparatory school, or the President or Dean of the college or university he has previously attended, (*c*) his Registration Officer or the Head of his Course.
2. Have passed, with a standing satisfactory to the Board, the physical examination required annually of all Institute students.
3. Submit a statement of his financial needs and such other information as the Board may deem necessary, on the application form supplied by the Board, such application to have the approval of his parent or guardian.
4. Be prepared to furnish such life insurance as collateral as may be required by the Board.

A recipient of a loan will be required to sign promissory notes in $50 units up to the amount of his loan, each note carrying interest at two per cent annum from the date of its issue to a date not exceeding two years after he leaves the Institute, and at five per cent per annum thereafter. Interest is to be paid semi-annually. Each note shall have a definite maturity, such maturities to be spaced at intervals of six months, beginning on or before the December thirty-first following the recipient's expected date of graduation, but payments may be anticipated.

Upon signing notes, the student will be supplied with copies thereof. After leaving the Institute he will be required to advise the Board annually, or at more frequent intervals, as to his whereabouts, the character of the work in which he is engaged, the remuneration he is receiving and his plans for the repayment of his obligations to this Fund.

OTHER LOAN FUNDS

NATHAN R. GEORGE LOAN FUND (1943). Bequest of $29,000 from Professor Nathan R. George of the Department of Mathematics, the "income to be loaned to undergraduates of M. I. T. who are either citizens or who intend to become citizens" and who are members of the third or fourth year classes.

JOHN A. GRIMMONS (1930). In memory of John A. Grimmons of the Class of 1921 through a deed of trust executed by the late C. Lillian Moore, the Institute received a sum of money to be "used in making loans to undergraduates who are preparing to make Electrical Engineering their life work; such loans to be known as given from the John A. Grimmons Perpetual Loan Scholarship; such loans are not to exceed six hundred (600) dollars to any one student in any one year and are to be made on condition that the loans shall bear interest at five per cent, and shall be repaid within ten years, and that repaid loans shall be treated as income to revert into the Perpetual Loan Fund and to be reloaned from time to time; such loans are to be protected by life insurance. . . . Loans are to be awarded to male, white, native born citizens of the United States, who are loyal to the State and Nation, are of sound physical body and show steadiness of purpose and zeal in educational acquirements."

LAMSON-VIRGIN LOAN FUND (1946). Bequest of $5,000 from Elizabeth H. Lamson, the income to be used in aiding a worthy student of excellent character who "must have shown not only respect for his parents but also proper consideration for the rights of others." Students thus aided shall repay if and when they find themselves able to do so.

FRESHMAN SCHOLARSHIPS

These are confined to students who make application to the Office of the Dean of Students before April 1 in advance of matriculation as of September, 1947.

Approximately 200 Freshman Competitive awards covering part tuition for the first year are made annually to students entering from secondary schools. Selection is based, to a large degree, upon the candidate's entrance record, College Boards, Regents, and preparatory or high school records; in other words, upon the evidence that he has the academic aptitude and training to enable him to pursue Institute studies with profit to himself and, in due time, to graduate creditably. However, and this is *considered of utmost importance*, the candidate is expected to give evidence through recommendations from former teachers, prominent citizens of his local community, and Institute graduates that he possesses excellent qualities of character and personal bearing, as well as willingness and ability to coöperate with the demands of an engineering, scientific, or architectural curriculum.

Except where distance from Cambridge precludes, a personal interview between an officer of the Institute and the applicant is required and, to facilitate these arrangements, early application is desired. Interviews with some nearby representative of the Institute will be arranged for candidates who live at a distance from Cambridge.

Besides the Freshman Competitive awards, other freshman scholarships are open to qualified applicants under terms set forth below. Most of these grants depend in part upon a candidate having some special qualification in addition to presenting evidence that he has high scholastic ability, i.e., that he be from a particular locality, a graduate of a particular school, etc. The figures in parentheses are the dates of establishment.

ALUMNI REGIONAL (1926). As a means of coöperating with Alumni in various Technology centers in attracting to the Institute students of exceptional ability and promise from all parts of the United States, several Regional Scholarships, carrying an award of full tuition for the freshman year, are offered in Chicago, Denver, Detroit, District of Columbia, Kansas City, Los Angeles, New York, New Jersey, Northern Ohio, Philadelphia, Pittsburgh, Portland, Ore., San Francisco, St. Louis, Seattle, Schenectady, Southern Ohio, and Westchester County, New York. These are open to American citizens of good character and health whose standing in their preparatory school studies has been high and who have satisfied with high standing all entrance requirements.

ARMY AND NAVY (1930). Sons of regular Army, Navy, Marine Corps and Coast Guard Officers, who are admitted as undergraduate students to the Institute, will pay half the regular tuition upon the recommendation of the Faculty Committee on Undergraduate Scholarships, the total number not to exceed ten each year. Preference will be given to qualified applicants admitted to the first-year class. Applications should be addressed to the Office of the Dean of Students and should be accompanied by documentary evidence that the applicant's father is a commissioned officer in the regular Army, Navy, Marine Corps or Coast Guard. It is the policy of the Committee not to recommend a man for one of these awards unless he has satisfied with high standing all entrance requirements of the Institute. Holders of these scholarships, if recommended by the Committee, may continue at the half-tuition rate during their second and succeeding undergraduate years.

BRIDGEPORT (1932). Established by the Institute through a bequest from Horace T. Smith of the Class of 1898, to be known as the Horace T. Smith Scholarship Fund. A scholarship, carrying a stipend of full tuition for the freshman year, is annually offered to a graduate of the High Schools of Bridgeport, Connecticut. Application should be made to the Office of the Dean of Students.

CAMBRIDGE (1916). A limited number of scholarships is granted to students entering the first year class at the Institute, who are graduates of schools in Cambridge and children of legal residents of that city. These Cambridge Scholarships, which carry a stipend of full tuition, are confined to students who make application furnishing evidence of need. An award may be continued in the second, third, and fourth years upon annual reapplication, providing the holder maintains a satisfactory scholastic record and continues to furnish evidence of need. Original application for a Cambridge Scholarship should be made through the Headmaster, or Principal, of the applicant's school, and such application must be filed with the Headmaster, or Principal. Awards will be by competition, based upon special examinations given by the Institute, with the stipulation that no successful candidate will be entitled to benefit from an award unless he or she satisfies, prior to admission, all entrance requirements of the Institute.

CLASS OF 1895 SCHOLARSHIP MEMORIAL FUND (1945). Gift of $25,000 from Gerard Swope of the Class of 1895 "the income annually to be used to provide scholarships for suitably qualified descendents of members of the Class of 1895. If in any year the total income is not required for this purpose, the balance shall be added to the Technology Loan Fund."

CLASS OF '96 FUND (1923). Received from the Class of 1896 to found a scholarship to be awarded subject to the approval of the Secretaries of the Class. Preference in making awards will be given to descendants of members of the Class of 1896, including freshmen, and grants from this fund are to be considered as loans to be repaid by the recipients when and if able.

CLASS OF '09 FUND (1937). Established as the "Class of 1909 Scholarship Fund," the net income to "be used to assist such deserving students as may be selected from time to time . . . , preference being given to direct descendants of members of the Class of 1909."

CLASS OF 1917 SCHOLARSHIP FUND (1942). Established on the twenty-fifth anniversary of the Class, the "income and principal . . . to be used to assist such deserving students as may be selected from time to time, preference being given to direct descendants of members of the Class of 1917. Beneficiaries are expected to issue notes agreeing to repay the face value, without interest, of amounts received."

CLASS OF '22 FUND (1942). Established at the twentieth reunion of the Class of 1922, the "income and principal . . . to be used to assist students entering the Institute as freshmen from secondary schools, with preference being given to sons (or daughters) of members of the Class." Beneficiaries "are expected to issue notes agreeing to repay the face value, without interest, of amounts received."

CLASS OF 1938 SCHOLARSHIP FUND (1938). Gifts from the Class of 1938, "the income for scholarships."

WILLIAM A. CONANT (1943). Bequest of $150,000 "for the purpose of establishing a permanent fund to be known as the W. A. Conant Scholarship Fund, the income therefrom to be used for the education of native born American Protestant boys of New England of American Protestant parents, who are graduates of some high or preparatory school, public or private in New England, preference to be given to the graduates of the public schools of Brookline, Massachusetts, but without limitation thereto, and whose parents are financially unable to send them to the Institute and whose own means are insufficient to allow them to attend the Institute."

One scholarship, carrying an annual stipend of $800 per year for each of the four undergraduate years, is annually offered to an entering freshman. Application should be made to the Office of the Dean of Students.

EAST BRIDGEWATER (1932). Established by the Institute through a bequest from Horace T. Smith of the Class of 1898, to be known as the Horace T. Smith Scholarship Fund. A scholarship, carrying a stipend of full tuition for the freshman year, is annually offered to a graduate of the High School of East Bridgewater, Massachusetts, recommended by the Principal, to whom application must be made.

FALL RIVER AND SWANSEA (1932). Established by the Institute through a bequest of Elizabeth R. Stevens, known as the Albert G. Boyden Fund. A limited number of scholarships for the freshman year, carrying stipends of part tuition, are annually offered to qualified applicants residing in Fall River or Swansea, Massachusetts. Applications must be filed at the Office of the Dean of Students. Selection will be based on qualifying examinations given by the Institute, and with the stipulation that no individual will be eligible to receive an award until he has fulfilled all entrance requirements of the Institute.

CHARLES HAYDEN MEMORIAL (1939). Established through a grant from the Charles Hayden Foundation, the Institute offers a number of scholarship awards in memory of the late Charles Hayden, a graduate of the English High School Class of 1886 and of the M. I. T. Class of 1890: "To aid deserving 'Boston and New York boys' — high school graduates whose parents are unable to finance the entire cost of their education — to enroll as members of the first-year class at Technology." Full particulars concerning these awards may be obtained from the Office of the Dean of Students.

AMELIA S. KNIESNER SCHOLARSHIP FUND (1944). Gift of William T. Kniesner of the Class of 1916 and his sisters, the income "to provide scholarship aid to meritorious or needy students, either entering freshmen or undergraduate students of the Institute, preference to be given to graduates of the high school or high schools of Danbury, Connecticut."

LLORA CULVER KRUEGER FUND (1936). Established from the residuary estate of the late Emma Robinson Culver "for needy and worthy Massachusetts Institute of Technology students who come from Schenectady or its immediate vicinity, preferably those recommended by the local Regional Scholarship Committee."

GEORGE H. MAY (1914). Gift of $5,000 from George H. May of the Class of 1892 to provide a scholarship "to assist graduates of the Newton High Schools who are students at M. I. T. and who have been recommended as eligible by the Superintendent and Head Master of the Newton High Schools." Beneficiaries under this fund are expected to issue notes agreeing to repay the face value, without interest, of amounts received.

MILTON HIGH SCHOOL FUND (1885). Founded by the Institute in recognition of contributions from residents of Milton. This scholarship is conferred upon such former pupils of the Milton High School in good standing at the Institute as the Master of that school and the School Committee of the town may select.

WILLIS WARD REEVES JR. FUND (1945). Established by Mr. and Mrs. Willis Ward Reeves of Hazard, Kentucky, "as a memorial to their son, Willis Ward Reeves, Jr. of the Class of 1946, late Lieutenant, U. S. Army Air Forces, killed in action over France during World War II . . . the income to be used for scholarship aid to deserving undergraduate students, with preference to those from Kentucky."

G. H. MILLER SMITH FUND (1945). Established by Mr. and Mrs. George Blackwell Smith of Lookout Mountain, Tennessee,

"as a memorial to their son, G. H. Miller Smith of the Class of 1943, late Lieutenant, U. S. Army, killed in action in France during World War II. . . . the income to be used for scholarship aid to deserving undergraduate students, with preference to those from Tennessee."

TECHNOLOGY CLUB OF CHICAGO SCHOLARSHIP FUND (1944). Gift of $6,000 from Harold B. Harvey of the Class of 1905 "to establish scholarships to be known as the Technology Club of Chicago Scholarship Fund," the awards to be made by a committee composed of the Honorary Secretaries of the Chicago area and the Dean of Students, and restricted "to boys who reside in the area of the club membership."

VERMONT (1924). Gift of $25,000 from Redfield Proctor of the Class of 1902 to found a scholarship "in memory of Vermonters who, having received their education at the Institute, served as engineers in the Armies of the Allies in the World War." The income is awarded annually "to worthy students . . . preference to any bona fide residents of Vermont doing undergraduate work at the Institute of Technology, and also Vermont students doing graduate work, or students who are graduates of or transfers from Middlebury College or Norwich University . . . who shall meet regular scholastic and other requirements."

UNDERGRADUATE SCHOLARSHIP AID FOR UPPER CLASSMEN

In addition to the Freshmen Scholarships, the Institute holds funds from the income of which awards are made to students in the upper undergraduate years. It is the policy of the Faculty Committee on Undergraduate Scholarships to assist as many well qualified students as possible by assigning, in general, amounts less than full tuition. Awards are made only to students who have completed at least a year of satisfactory work at the Institute.

In making selections, the ability of the student, as indicated by the scholastic record, is the primary consideration. However, account is also taken of the applicant's evidences of need for financial assistance, of his good character, and of his general worthiness and professional promise. Applications should, except as noted below, be made on blanks to be obtained at Room 7–131.

The scholarships or funds described are arranged in the alphabetical order of their names, the figures in parentheses being the dates of establishment:

LOUIE G. APPLEBEE (1942). Bequest "to be expended in assisting deserving students."

ELISHA ATKINS (1894). Founded by Mrs. Mary E. Atkins of Boston with a gift of $5,000.

THOMAS WENDALL BAILEY (1914). Bequest of Thomas Wendall Bailey, the income to assist "needy students in the Department of Architecture."

CHARLES TIDD BAKER (1922). Bequest of $20,000 from Charles Tidd Baker, one half of the net income "applied each year to the assistance of poor and worthy students."

BILLINGS STUDENT (1900). Bequest of $50,000 from Robert C. Billings "to found the Billings Student Fund. Any student receiving benefit from this fund is expected to abstain from the use of alcohol or tobacco in any of their varied forms."

LEVI BOLES (1915). Bequest of $10,000 from Frank W. Boles in memory of his father, Levi Boles, the "net income thereof to be applied annually to the assistance of needy and deserving students."

JONATHAN BOURNE (1915). Bequest of $10,000 from Hannah B. Abbe to constitute a fund "known as the Jonathan Bourne Scholarship Fund, the income only to be used in aid of deserving students."

ALBERT G. BOYDEN (1931). Bequest of $40,000 from Elizabeth R. Stevens as a permanent fund, to be known as the Albert G. Boyden Fund, "income only to be awarded as scholarships to assist worthy and needy students, preference to be given to young men or women residents of the town of Swansea or the city of Fall River."

HARRIET L. BROWN FUND (1932). Bequest of Harriet L. Brown "to be held in trust as a scholarship . . . the income to be given to such needy and deserving young women desiring to become students at M. I. T., as would otherwise be unable to attend; and in case of two or more applicants of equal merit, preference shall be given to a native of either Massachusetts or New Hampshire."

MABEL BLAKE CASE (1920). Bequest of $25,000 from Caroline S. Freeman to be "known as Mabel Blake Case Fund, income to be used to aid deserving students (preferably women) who are in need of assistance."

NINO TESHER CATLIN (1926). Gift from Maria T. Catlin to establish a fund in memory of her son, Nino T. Catlin of the Class of 1918, the income "to be awarded to needy and deserving students."

LUCIUS CLAPP (1905). Gift from Lucius Clapp to form a fund "to aid worthy students who may not be able to complete their studies without help."

FRED L. AND FLORENCE L. COBURN (1932). Bequest of $5,000 from Fred L. Coburn, the income of which "shall be expended by said Trustees in giving aid and assistance to students of M. I. T. . . . preference being given by said Trustees to students residing in Somerville, Massachusetts."

COFFIN MEMORIAL (1929). This gift from the executors of the estate of Charles A. Coffin — a bequest — carried out the wishes of Mr. Coffin. The fund is to be used for loans or other aid to students as determined by the Executive Committee.

ALBERT CONRO SCHOLARSHIP FUND (1943). Bequest of Mary T. Conro, sister of Emma O. Conro, of the Class of 1884, in memory of their uncle, "for the purpose of establishing and maintaining a scholarship in . . . mining engineering . . . to be known as the Albert Conro Scholarship."

CONSOLIDATED VULTEE AIRCRAFT CORPORATION SCHOLARSHIPS (1944). Two scholarships carrying stipends of full tuition for the senior year, established by this Corporation and "open to highly recommended engineering students in Civil Engineering, Electrical Engineering, Mechanical Engineering, or Aeronautical Engineering, and pursuing courses related to aeronautical engineering, who will have completed their junior year."

THE GEORGE R. COOKE FUND (1939). Established by gift of $3,000, "the income to be awarded to a student, preferably in the Course in Civil Engineering, or in some related field of study giving preparation for Public Service and Government. Prior to matriculation, the recipient, who need not necessarily be a candidate for a degree, must have acquired practical experience and earned his living by working in some field, preferably for one year or more. Candidates are to be judged upon their evidences of character, sincerity of purpose and need for assistance."

LUCRETIA CROCKER (1916). By the will of Matilda H. Crocker, the Institute was made the residuary legatee of her estate "for the establishment of one or more scholarships for women in memory of my sister, Lucretia Crocker . . . the income to aid one or more young women in need of pecuniary assistance in obtaining instruction at said Institute."

ISAAC W. DANFORTH (1903). Bequest of $5,000 from James H. Danforth for scholarship purposes as a memorial to his brother, Isaac Warren Danforth.

ANN WHITE DICKINSON (1898). Bequest of $40,000 from Ann White Dickinson "to establish free scholarships in M. I. T. . . . such persons enjoying benefit . . . shall be worthy young men of American origin."

DORMITORY (1903). Raised by miscellaneous subscriptions and formerly known as Students' Aid Fund.

THOMAS MESSINGER DROWN (1928). Bequest of $50,000 from Mary Frances Drown, "to be used to establish scholarships for deserving undergraduate students, to be known as the Thomas Messinger Drown Scholarships."

FRANCES AND WILLIAM EMERSON FUND (1930). Awards not exceeding $600 to students in the School of Architecture. Applications should be made directly to the Dean of the School of Architecture.

FARNSWORTH (1889). Founded by Mrs. Mary E. Atkins of Boston with a gift of $5,000.

CHARLES LEWIS FLINT (1889). Bequest of $5,000 from Charles L. Flint, for the "support of some worthy student preference to be given to some graduate of the English High School, Boston."

SARAH S. FORBES (1913). Originally a fund of $2,800 given in trust in 1868 by Sarah S. Forbes to William Barton Rogers and Henry S. Russell, trustees, and transferred in 1913 to the Institute, "for the maintenance and education of a scholar in M. I. T."

PHILIP JACOB FRIEDLANDER (1945). Gift of Israe Friedlander "in appreciation of the opportunity my son, Philip Jacob Friedlander, had of spending a little more than a year at M. I. T. before enlisting in the United States Naval Reserve . . , the income to be used with the income from other such fund. for the purpose of helping qualified students at M. I. T. regardless of race, creed, or color, or geographical origin, who may be in need of financial assistance . . ."

NORMAN H. GEORGE (1919). Bequest of Norman H. George "to be used for the assistance of needy and worthy students in obtaining an education in M. I. T."

ARTHUR B. GILMORE (1941). Bequest of $10,000 from Arthur B. Gilmore ". . . for the purpose of assisting needy students who shall be members of the Beta Theta Pi Fraternity . . . said net income to be divided among not more than two students in any one year."

BARNETT D. GORDON FUND (1942). Gift of $5,000 from Barnett D. Gordon of the Class of 1916, "the income as scholarships for deserving students at M. I. T."

LUCIA G. HALL (1945). Bequest of Louise K. Gunn to "be known as 'The Lucia G. Hall Scholarships' . . . the income only therefrom to be used for the aid of worthy students."

HALL-MERCER SCHOLARSHIP FUND (1940). Bequest of Alexander G. Mercer ". . . income only . . . for the benefit of such poor students as have passed through some of the Public Schools with the best reputation for character and ability."

JAMES H. HASTE (1930). Bequest of James H. Haste of the Class of 1896, "for the aid of deserving students . . . of insufficient means, said fund, together with any other sums which said institution may receive under this will, to be known as the James H. Haste Fund."

GEORGE HOLLINGSWORTH (1916). Bequest of $5,000 from Rose Hollingsworth to found the George Hollingsworth Scholarship.

T. STERRY HUNT (1894). Bequest of $3,000 from T. Sterry Hunt, for seven years Professor of Geology at Technology, to found a scholarship in his name. Restricted to students of Chemistry and preference is given to those in the higher years.

WILLIAM F. HUNTINGTON (1892). From Susan E. Covell, the Institute received a gift of $5,000 to constitute a fund in memory of William F. Huntington of the Class of 1875, the "income to apply to payments of tuition of needy and deserving students . . . preference to be given to students in Civil Engineering."

DAVID L. JEWELL (1928). Bequest of $25,000 from Colonel David L. Jewell "to be known as the David L. Jewell Fund, the income therefrom to be used to pay the tuition charges of five young men who may be selected by the President or Board of Trustees of the Institute as worthy of assistance, and who, were it not for such assistance, might be unable to pursue their studies at such Institute."

JOY (1886). Established by the gift of Nabby Joy and created pursuant to a decree of the Supreme Judicial Court of Massachusetts for the benefit of "one or more women studying Natural Science at M. I. T."

WILLIAM LITCHFIELD (1910). Bequest of $5,000 from William Litchfield to establish "a single scholarship . . . known as William Litchfield Scholarship, income to be awarded and paid annually to such student in said Institute as may, upon a competitive examination, be determined by the President of said Institute to be entitled thereto for excellence in scholarship and conduct."

ELISHA T. LORING (1890). Bequest of $5,000 from Elisha Thacker Loring, for "the assistance of needy and deserving pupils."

LOWELL INSTITUTE (1923). Gift from the alumni of the Lowell Institute School to found a Fund, the income of which is annually awarded to assist some graduate of that School who desires to enter upon undergraduate studies at M. I. T. Applications must be filed at the Office of the Dean of Students.

RUPERT ANDERSON MARDEN (1933). Established by an anonymous gift "toward a memorial to be known as the Rupert Anderson Marden Scholarship Fund, income available annually to aid a worthy student at M. I. T. — Protestant and of American origin — preference to a student taking the Cooperative Course in Electrical Engineering."

ROBERT W. MILNE FUND (1943). Bequest of $70,000 as "an endowment fund under the title of 'The Robert W. Milne Fund' the income thereof to be used and applied for the assistance of worthy and needy students in obtaining an education in said Institute."

JAMES H. MIRRLEES (1886). Gift of $2,500 from James Buchanan Mirrlees of Glasgow, Scotland, to constitute a scholarship in memory of his son, James Henry Mirrlees, who died in 1886 while attending the Institute. The income is awarded to the "student in the third or fourth year of the Mechanical Engineering Course most deserving pecuniary assistance."

FRED W. MORRILL SCHOLARSHIP FUND (1941). Bequest of Hattie B. Morrill the "income from which is to be used for the purpose of providing financial assistance to some student or students at the discretion of the Trustees of said Institute. . . ."

NICHOLS (1895). Bequest of $5,000 from Mrs. Betsy F. W. Nichols to constitute The Nichols Scholarship in memory of her son William Ripley Nichols of the Class of 1869, for sixteen years Professor of General Chemistry at the Institute. Preference is given to students in the Course in Chemistry.

CHARLES C. NICHOLS (1904). Bequest of $5,000 from Charles C. Nichols to constitute a scholarship.

JOHN FELT OSGOOD (1909). Bequest of $5,000 from Eliza B. Osgood "to establish and maintain a scholarship in Electricity in memory of my husband, John Felt Osgood."

GEORGE L. PARMELEE (1921). Bequest from George L. Parmalee of "one third of my property and estate, interest thereof to be used for tuition of worthy students, either special or regular, according to the direction of the Faculty."

RICHARD PERKINS (1887). Bequest of $100,000 from Richard Perkins, the income from half of which is available for the "support of free scholarships in said Institute."

FLORENCE E. PRINCE FUND (1943). Bequest of Florence E. Prince "for the aid of worthy students who may need assistance in the matter of maintenance and living expenses while pursuing their studies."

SONS AND DAUGHTERS OF NEW ENGLAND PURITAN COLONY (1931). Gift of $600 from the Sons and Daughters of New England Puritan Colony. Holders of this scholarship must be of New England ancestry.

THOMAS ADELBERT READ (1934). Bequest of $10,000 from Julia A. Read "to establish the Thomas Adelbert Read Scholarship, in memory of my late brother of that name; the income of said fund to be awarded to some worthy and needy student of that institution, preferably to a resident of Fall River. . . ."

CHARLES A. RICHARD'S FUND (1939). Bequest of approximately $30,000 "to be known as the Charles A. Richard's Fund . . . the income only for assistance of poor Protestant students in the Institute."

JOHN ROACH (1937). Bequest of $2,400 from Emeline Roach to constitute a fund "to be known as the John Roach Scholarship Fund, the income to be used to provide an annual scholarship to a needy and deserving student pursuing the Course in Naval Architecture and Marine Engineering."

WILLIAM BARTON ROGERS (1904). Established by the Institute in commemoration of the early association of President William Barton Rogers with the College of William and

Mary. Stipend $400 per year; granted to a student nominated by the faculty of the College of William and Mary.

WILLIAM P. RYAN MEMORIAL (1935). Established by friends of the late Professor William P. Ryan of the Class of 1918, the income to be used for scholarship aid (graduate or undergraduate) in Chemical Engineering, the award to be made by the Scholarship Committee on recommendation of the Head of the Department of Chemical Engineering.

JOHN P. SCHENKL (1922.) Bequest of $20,000 from Johanna Pauline Schenkl "to be held in trust to establish one or more scholarships in the Department of Mechanical Engineering" in memory of her father, John P. Schenkl.

THOMAS SHERWIN (1871). Founded with a gift of $5,000 from the English High School Association in memory of Thomas Sherwin. Holders must be graduates of the English High School of Boston and must be pursuing a regular course at the Institute.

HORACE T. SMITH (1931). Bequest from Horace T. Smith of the Class of 1898, to provide scholarships to worthy students, preference to be given to graduates of the East Bridgewater (Massachusetts) and Bridgeport (Connecticut) High Schools.

ANNA SPOONER FUND (1939). Bequest of approximately $7,500 "the income therefrom . . . to be used . . . in assisting meritorious students."

STEVENSON TAYLOR (1928). Established by the American Bureau of Shipping in memory of Stevenson Taylor, its late President. Tenable for two years; carries an annual stipend of $500; awarded in alternate years to a deserving third year student (who must be an American citizen) in the Course in Marine Transportation of the Department of Naval Architecture and Marine Engineering. Applications should be made directly to the Head of the Department of Naval Architecture and Marine Engineering.

SAMUEL E. TINKHAM (1924). Established by the Boston Society of Civil Engineers to aid a worthy student in Civil Engineering.

F. B. TOUGH (1924). Established "for the purpose of extending financial assistance to worthy students." Preference is given to students in Mining or Oil Production. Applications should be made directly to the Head of the Department of Geology.

SUSAN UPHAM (1892). Gift of $1,000 from Susan Upham, "to assist students deserving financial aid."

SAMSON R. URBINO (1927). Bequest of $1,000 from Samson R. Urbino, "to be used to aid students who need assistance, Germans preferred."

VERMONT (1924). Gift of $25,000 from Redfield Proctor of the Class of 1902 to found a scholarship "in memory of Vermonters who, having received their education at the Institute, served as engineers in the Armies of the Allies in the World War." The income is awarded annually "to worthy students . . . preference to any bona fide residents of Vermont doing undergraduate work at the Institute of Technology, and also Vermont students doing graduate work, or students who are graduates of or transfer from Middlebury College or Norwich University . . . who shall meet regular scholastic and other requirements."

ANN WHITE VOSE (1896). Bequest from Ann White Vose of $25,000 "plus one half of the remainder of my estate . . . to establish free scholarships in M. I. T. . . . such persons enjoying benefit . . . shall be worthy young men of American origin."

ARTHUR M. WAITT (1925). Bequest of $10,000 from Arthur M. Waitt, for "assisting needy and deserving students in the second-, third-, and fourth-year classes of the Mechanical Engineering Course of said Institute."

GRANT WALKER FUND (1943). Bequest of $50,000 "the income to be used for scholarships for deserving students in said Institute."

JAMES WATT (1942). Bequest of Jennie A. Douglas, to establish "a scholarship in Mechanical Engineering to be known as the James Watt Scholarship."

HERMAN E. WEIHMILLER FUND (1942). Gift of H. E. Weihmiller of the Class of 1925 in memory of his late father "for aiding students or prospective students of M. I. T., who are deserving of financial aid in furtherance of, or as assistance towards an aeronautical career at M. I. T. . . . without restriction as to sex, creed, color or nationality."

LOUIS WEISSBEIN (1915). Bequest of $4,000 from Louis Weissbein "to found a scholarship to be awarded each year to a promising student, preference to be given a Jewish boy in making the award."

FRANCES ERVING WESTON (1912). Bequest of Frances Erving Weston, "to aid a native-born American Protestant girl of Massachusetts."

SAMUEL MARTIN WESTON (1912). Bequest of Frances Erving Weston, to found a scholarship in memory of her husband, Samuel Martin Weston, "to aid a native-born American Protestant boy, preference to be given one from Roxbury."

AMASA J. WHITING (1927). Bequest of $2,000 from Mary W. C. Whiting "to constitute a fund to be known as Amasa J. Whiting Fund . . . the income . . . to pay or help to pay tuition of deserving students whose means are limited. . . . Preference shall be given to students coming from the town of Hingham, Massachusetts."

ELIZABETH BABCOCK WILLMANN (1935). Bequest from Elizabeth Babcock Willmann, "to help in paying the tuition of girl students taking the Chemistry Course."

MORRILL WYMAN (1915). Bequest of Morrill Wyman, the income of which is "applied in aid of deserving and promising students, but without exclusion in regard to rank, upon the understanding that if in after life the person receiving aid shall find it possible, he shall reimburse the said fund for moneys so applied, but there shall be no legal obligation to make such reimbursement."

GRADUATE SCHOLARSHIPS AND FELLOWSHIPS

A FELLOWSHIP, is an award of a cash stipend, with or without a credit against tuition fees, based on academic performance and promise of professional competence to aid the recipient in his pursuit of advanced study and research. This award recognizes the recipient as having demonstrated the promise of unusual attainments in science or engineering.

A SCHOLARSHIP is an award of a financial credit toward tuition fees, made to a graduate student of academic promise, to aid and encourage his graduate study toward an advanced degree.

Fellowships and Scholarships are awarded by the Committee on the Graduate School only to graduate students who are not also staff members. Tuition credits to whole-time or part-time staff appointees are arranged by the departments recommending staff appointments from funds other than those designated for graduate students.

GRADUATE STUDENT FELLOWSHIPS are available to certain graduate students proceeding toward advanced degrees: ADVANCED RESEARCH FELLOWSHIPS are available to certain holders of advanced degrees who are not enrolled as graduate students (*e.g.*, Post-doctoral Fellowships). The recipient of a Fellowship is designated as a Fellow for the period of time specified in his award. He pays full tuition, has full student status, and no services are required of him in respect to his Fellowship.

APPLICATIONS

Applications for Fellowships or Scholarships must be filed upon the form "Application for Scholarship Aid" obtainable from the Admissions Office and should be returned to the Secretary of the Graduate School at that same office.

Applications will be referred to appropriate department officers and will be acted upon by the Committee on the Graduate School at stated times.

For each regular academic year beginning with a Fall term, Applications for Scholarship Aid must be in hand on the previous March 1. Notices of award will be mailed on April 1, and awards not accepted by April 15 will be cancelled.

During the transition stage from accelerated to normal academic schedules, applications will be received also on June 1, for subsequent action if funds are available.

Applications from students applying for admission to the Graduate School must be accompanied by full credentials required with the admission application. Only applicants with highest credentials may expect favorable consideration from the Scholarship Committee previous to at least one term of residence as a graduate student and any award to a new student will usually not exceed tuition.

Each award will be terminated following a term record of less than 3.5 unless mitigating circumstances in explanation of low grades are accepted by the Committee on the Graduate School.

The recipient of scholarship aid is expected to complete the period of study for which an award is made, and discontinuance of his work before the end of such period imposes upon him the obligation to refund to the Bursar all portions of the award which have been used, unless a waiver is granted by the Committee on the Graduate School.

Correspondence concerning scholarships should be addressed to the Chairman of the appropriate Departmental Committee on Graduate Students (see page 69).

ASSISTANTSHIPS AND TEACHING FELLOWSHIPS

Assistantships and Teaching Fellowships are sub-faculty staff appointments made upon recommendations of heads of departments to whom applications shall be addressed either with, or subsequent to, application for admission to the Graduate School.

A "full-time" staff appointee, if also a graduate student, may register for approximately 18 units per term of scheduled subjects (exclusive of thesis based on contract or other assigned research) toward an advanced degree; a "half-time" similar appointee may register for approximately 30 units per term; Veterans who are academically qualified are eligible for one-third time Assistantships which permit registration for 38 units per term as a graduate student.

Graduate students, whether or not they are also on the staff, may apply for financial assistance to the Technology Loan Fund Board.

GRADUATE FELLOWSHIPS

The capitalized name in each case is that of the donor of funds which support the Fellowship.

ALLIED CHEMICAL AND DYE CORPORATION. One in Chemistry and one in Chemical Engineering. Each stipend $1,200 plus tuition for the academic year 1946–47.

WILLIAM SUMNER BOLLES. In any department. Stipend $300 plus tuition for the academic year 1946–47.

BRUCE'S JUICES, INC. In Food Technology, for a veteran of World War II enrolled for a doctorate. Stipend not to exceed $2,000 for 12 months' study.

F. W. CHANDLER. In City Planning. Stipend $350. (Holders of tuition scholarships are eligible.)

CLARK THREAD COMPANY. In Textile Technology. Stipend $1,200 plus tuition per academic year. Three awards are available for 1946–47.

CONSOLIDATED VULTEE AIRCRAFT CORPORATION. In Aeronautical Engineering. Stipend $750 plus tuition per academic year. Three awards are available for 1946–47.

E. I. DU PONT DE NEMOURS AND COMPANY. Stipend $1,200 if unmarried, $1,800 if married, in each case plus tuition, for the year 1946–47. One in Chemistry; one in Chemical Engineering; one in Physics; one in Mechanical Engineering.

E. I. DU PONT DE NEMOURS AND COMPANY. Advanced Research (Postdoctoral) in Chemistry. Stipend $3,000 for 12 months in 1946–47.

RICHARD C. DU PONT MEMORIAL. In Meteorology. Stipend not to exceed $1,200 per academic year.

INDUSTRIAL ECONOMICS. For students proceeding toward a doctorate in Industrial Economics. Stipend $600 to $1,200 per academic year. Several awards are available for 1946–47.

INDUSTRIAL FELLOWSHIPS IN ELECTRONICS (sponsored by a group of Industrial Organizations).
In Physics or Electrical Engineering in the Electronics Laboratory.
A. Predoctoral. Stipends $1,200–$1,500 plus tuition per academic year.
B. Advanced Research. For post-advanced degree research. Stipend $2,000–$3,000 per year.

HARRY WENTWORTH GARDNER. For advanced work in Architecture at M. I. T. or elsewhere.

GOODYEAR TIRE AND RUBBER COMPANY. In Aeronautical Engineering. Stipend $900 plus tuition per academic year.

GULF OIL CORPORATION. In Physics. Preference to children of Gulf employees. Stipend $1 100 per academic year.

CHARLES HAYDEN MEMORIAL. To enable a citizen of the United States, who has demonstrated professional promise during his undergraduate career at the Institute, to pursue a year of advanced study leading to its Master's degree, with consideration of character, need and participation in undergraduate extra-curricular activities as well as academic record of the applicant.

CLARENCE J. HICKS MEMORIAL. In Industrial Relations, for a graduate of not more than five years since his Bachelor's degree. Stipend $650 for 1946–47.

S. C. JOHNSON AND SON, INC. In Colloid Chemistry. Stipend not to exceed $1,500 per 12 months in 1946–47.

KIMBERLY-CLARK CORP. In Chemical Engineering. Subject of interest to pulp and paper industry. Stipend $1.200 plus tuition per academic year 1946–47.

ARTHUR D. LITTLE. Predoctoral, one in Chemistry, one in Chemical Engineering. Each stipend $1,800 per academic year 1946–47.

ARTHUR D. LITTLE. Postdoctoral, in any department. Stipend $3,000 for 12 months in 1946–47.

APPLIED MATHEMATICS. Predoctoral students in Applied Mathematics. Stipend $700 plus tuition per academic year. Several awards are available for 1946–47.

McINTOSH APPLE FUND. In Food Technology. Stipend not to exceed $2,000 per 12 months.

MOORE. In Chemistry. Open to a graduate of the Institute for study in residence or elsewhere, preference to the field of Organic Chemistry. Stipend $1,100 for 12 months 1946–47.

NATIONAL RESEARCH CORPORATION. In field of high vacuum. American graduate student whose research relates to study or development of processes in pressure range 10^{-7}–1.0 mm. Hg. Stipend not to exceed $1,000 per term.

OWENS ILLINOIS GLASS COMPANY. In department of Geology. Stipend $2,000 per academic year 1946–47.

REPUBLIC STEEL CORPORATION. In any field approved by the department of Metallurgy as ancillary to the production or uses of steel. Stipend $1,200 to $2,400 plus tuition per academic year. Five awards available for 1946–47.

ELLEN H. RICHARDS MEMORIAL. In the department of Chemistry, in sanitary or allied branches of chemistry. Preference given to a woman. Stipend $800 per academic year.

SPERRY GYROSCOPE COMPANY. In Aeronautical instrumentation or air transport. Stipend $1,000 per academic year.

STANDARD BRANDS. In Food Technology, Chemical Engineering or Biology. Stipend $2,200 per academic year.

STANDARD OIL COMPANY OF CALIFORNIA. In Chemical Engineering. Stipend $1,000 plus tuition per academic year.

STANDARD OIL COMPANY OF INDIANA. In Chemical Engineering. Stipend $1,200 plus tuition per academic year.

GERARD SWOPE. Predoctoral students of exceptional ability and promise who graduated in an Honors Group or its equivalent from this or any other college in Science or Engineering. Among equally qualified candidates, preference to be given to (*a*) residents of St. Louis, Mo., (*b*) residents of Highland Park or New Brunswick, N. J., (*c*) employees of General Electric Company or their children. Stipend $1,000 per academic year. Three awards available in 1946–47.

TEXTILE. Textile research in Division of Textile Technology, for graduates of Lowell Textile School. Stipend $750 per academic year 1946–47.

UNITED FRUIT COMPANY. In Nutritional Biochemistry. Predoctoral. Stipend $1,200 per academic year 1946–47.

S. K. WELLMAN. In Powder Metallurgy. Stipend not to exceed $1,200 plus tuition per 12 months in 1946–47.

GRADUATE SCHOLARSHIPS

Awards usually limited to $500 per academic year, but in no case to exceed $600 per year.

Open to any graduate student in any department.

AUSTIN FUND	$13,500
SALTONSTALL FUND	$350
SAVAGE FUND	$450
SWETT FUND	$350
WHITNEY FUND	$18,000

Open to women, only, in any department.

COLLAMORE FUND	$450
ROGERS FUND	$800

Open to graduate students in fields or departments as specified

Architecture

FRANCES AND WILLIAM EMERSON FUND. To aid stuents in the School of Architecture for advanced study in the graduate school upon recommendation of the Dean of Architecture.

WILLARD B. PERKINS. For advanced work in Architecture at M. I. T. or elsewhere. Stipend $450.

Chemistry or Chemical Engineering

DALTON FUND. American male graduate of M. I. T.: Textile Chemistry preferred. $250.

THORP FUND. Industrial Chemistry, approved by department of Chemical Engineering. $350.

VERGES FUND. Research related to sugar industry. $350.

Food Technology

QUAKER OATS FUND. $550.

Metallurgy

REVERE COPPER AND BRASS FUND. $600.

GRADUATE SCHOLARSHIPS WITH REGIONAL RESTRICTIONS

CAUCA UNIVERSITY. Full tuition to one qualified graduate of Cauca University, Colombia, per year.

EXCHANGE SCHOLARSHIPS. Arrangements for exchange of graduate students with or without stipend in addition to waiver of tuition are in operation with IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON; also through SWISS-AMERICAN and SCANDINAVIAN-AMERICAN FOUNDATIONS; also with certain South American institutions through the Department of State.

NATIONAL SCHOOL OF ENGINEERS. Full tuition to one qualified graduate of the National School of Engineers of Lima, Peru, per year.

THEODORE B. PARKER MEMORIAL. Open to graduates of colleges of the Tennessee Valley States.

VERMONT SCHOLARSHIP. Open to a native of Vermont or a graduate from Middlebury College or Norwich University. Undergraduate applications have preference from this fund.

PRIZES

AMERICAN SOCIETY OF TOOL ENGINEERS (1945). Gift of the Boston Chapter of the Society. A monetary prize of $100 offered annually for the best graduation thesis on a subject related to the professional field of tool engineering.

ROBERT A. BOIT (1921). Bequest of $5,000 from Robert A. Boit, to provide annual prizes "to stimulate the interest in the best use of the English language." Awards are made to first- and second-year men on the basis of essays written on topics announced by the Department of English and History.

CABOT MEDALS (1901). Gift of Samuel Cabot of the Class of 1870, awarded to five members of each first-year class who have shown the greatest physical improvement during the year.

JAMES MEANS MEMORIAL (1925). A medal and monetary prize of $100 offered annually for the best thesis on an aeronautical subject. Joint thesis may be entered and, if successful, duplicate medals will be awarded and the prize divided. Open only to candidates for the Bachelor's degree. (Not offered during the war.)

WILLIAM BARTON ROGERS AWARDS (1937). Monetary prizes to members of the Senior Class who, in the opinion of the Faculty Committee on Undergraduate Scholarships, have demonstrated "outstanding qualities, weight to be given to non-academic or extra-curricular as well as academic accomplishment, and consideration of financial need to be disregarded."

STRATTON (1930). Established by the late President Samuel W. Stratton. Prizes of $50, $30, and $20 awarded for the best presentation of scientific papers by undergraduates, the final competition being held at a public meeting.

The following annual prizes are offered to students in the Departments indicated:

Aeronautical Engineering

HENRY WEBB SALISBURY MEMORIAL AWARD (1941). Established by the family and friends of Henry Webb Salisbury '33 to provide the award of useful reference books, preferably annually, to a student who has done outstanding work in the Department of Aeronautical Engineering.

Architecture and Planning

ALPHA RHO CHI MEDAL (1932). To the graduating senior of the School of Architecture who has shown an ability for leadership, performed willing service for his school and department, and given promise of real professional merit through his attitude and personality.

CHAMBERLIN (1913). Gift of Boston Society of Architects. Prize of $25 to a student in the graduate class in Architecture. Awarded in alternate years.

F. W. CHANDLER (1914). Gift of Boston Society of Architects in memory of Professor Chandler. Five prizes of $5 each awarded for sketch problems in the fourth, fifth, and graduate years.

CLASS OF 1904 (1925). Gift of the Class of 1904. Three prizes of $5 each awarded to students in the third-year class in Architecture for sketch problems.

WILLIAM EMERSON (1940). Gift of the Alumni and Staff. Five prizes of $10 each awarded in the first, second, third, fourth and fifth years of Course IV and one prize of $10 awarded in either Course IV-B or IV-C.

FREEHAND DRAWING (1920). Prizes of a book to each of the students whose work is judged to be the best in composition and in life class drawing.

LIBRARY (1931). Awarded to the second-year student receiving the highest award on a designated project.

ROTCH (1895). Gift of Arthur Rotch. Two prizes of $200 awarded at the end of the fifth year to the regular and the special student having the best general records. The special student must have spent at least two years in residence to be eligible.

SCHOOL OF ARCHITECTURE MEDALS (1922). A bronze medal of the School awarded at the end of the academic year to the winner of each prize, and also to students in the fifth and graduate years with the highest number of "medal" values.

STUDENT MEDAL OF THE AMERICAN INSTITUTE OF ARCHITECTS (1914). Awarded on the recommendation of the School to the member of the fifth-year class whose record for the Course is the best.

SUMMER SKETCHING (1921). For the best set of outdoor summer sketches in pencil or pen and ink or measured drawings, and for the best set of outdoor summer sketches in water colors or wash; prizes of a book to each.

BOSTON SOCIETY OF ARCHITECTS (1923). Gift of the Society. Prizes totalling $50 for week-end conjunctive problems with Harvard and the Boston Architectural Club.

WILLIAM R. WARE (1923). In memory of the founder of the School, prizes totalling $50 for week-end conjunctive problems with Harvard and the Boston Architectural Club.

H. LANGFORD WARREN (1923). In memory of Professor Warren, prizes totalling $50 for week-end conjunctive problems with Harvard and the Boston Architectural Club.

Chemical Engineering

HUNNEMAN (1927). Established by William Cooper Hunneman in memory of his son, Roger DeFriez Hunneman A.B. Harvard 1917, S.M. M. I. T. 1923. Award of $50 to the most meritorious senior who has shown outstanding originality in his work in the regular Course in Chemical Engineering.

Metallurgy

AMERICAN SMELTING AND REFINING COMPANY (1946). Gift of the Company to establish prize awards of $500 each for the academic year 1946–47 to five undergraduates whose studies at M. I. T. were interrupted by entering upon military or naval duty during World War II, and who have returned to M. I. T. as ex-servicemen to complete degree requirements in the Course in Metallurgy. Recipients are to be selected by the Head of the Course in Metallurgy, subject to approval by the Faculty Committee on Undergraduate Scholarships, from among candidates who are "physically sound and in their twenties," and preference in the selection is to be accorded to third year students whose academic programs emphasize pyro-metallurgy.

Naval Architecture and Marine Engineering

AMERICAN BUREAU OF SHIPPING (1924). Award of $100 by the Bureau to the American citizen in the graduating class who attains the highest average in scholarship for the last two years in the Course.

APPENDIX B

DIRECTORY OF HONORARY SECRETARIES

THE Honorary Secretaries listed below are alumni "Ambassadors of Technology" in communities throughout the United States and in selected foreign centers. Prospective applicants for admission to the First-Year Class, living more than 100 miles from Cambridge, are referred to the nearest Honorary Secretary for a conference as a part of the required entrance procedure.

The Honorary Secretary is not expected to be a source of detailed information on entrance requirements, credits and the like, nor does he make, on behalf of the Institute, commitments regarding admission or the award of scholarships. All such matters should be taken up directly with the proper officers of the Institute. The function of the Honorary Secretary is to advise the student regarding his educational program and objectives, and to assist the Admissions Office in the selection of the limited number of applicants accepted each year in the entering class.

Students wishing to enter with advanced standing, or as members of the graduate school, are likewise encouraged to confer with the nearest Honorary Secretary, but are not required to do so.

ALABAMA:
Birmingham. Douglas F. Elliott, '24, Alabama Power Co., 600 N. 18th St.

ARIZONA:
Phoenix. Charles F. Willis, '06, *The Mining Journal*, 520 Title and Trust Bldg.

CALIFORNIA:
Los Angeles. Forest G. Harmon, '23, Kilsby & Harmon, 3311 E. Slauson.
Kenneth C. Kingsley, '23, Norris Stamping and Mfg. Co., 5215 S. Boyle Ave.
San Francisco. Allen W. Horton, Jr., '36, Standard Oil Co. of California, Standard Oil Bldg.
George D. Whittle, '08, Bridge Engineer, Public Roads Admin., 720 Phelan Bldg., 760 Market St.

COLORADO:
Denver. Alfred E. Perlman, '23, Chief Engineer, Denver & Rio Grande Western R. R., Rio Grande Bldg., 1531 Stout St.

CONNECTICUT:
Bridgeport. Zay B. Curtis, Jr., '35, 421 Meadowbrook Rd., Fairfield.
Gilbert C. Mott, '37, 181 Whitney Ave.
Edward L. Wemple, '34, 939 Barnum Ave.
Hartford. Thomas D. Green, '26, 38 Montclair Dr., W. Hartford.
Thomas B. Rhines, '32, Hamilton Standard Propellers, East Hartford.
New Haven. Albert S. Redway, '23, The Geometric Tool Co., Blake and Valley Sts.
Waterbury. Harold G. Manning, '12, The Post College Bldg. 24 Central Ave.

DELAWARE:
Wilmington. Willis F. Harrington, '05, E. I. du Pont de Nemours & Co., du Pont Bldg.

DISTRICT OF COLUMBIA:
Washington.
Albert F. Bird, '30, Navy Dept. Bureau of Ships.
Lt.-Col. Harry H. Fisk, '22, Selective Service Hdqts., 21st and C Sts., N.W.
J. Y. Houghton, '26, 906 American Bldg., 1317 F St., N.W.
William K. MacMahon, '22, Rosslyn Gas Co., 3240 Wilson Blvd., Arlington, Va.
Edward D. Merrill, '09, Capital Transit Co., 36th and M Sts., N.W.
George D. Mock, '28, Washington Gas Light Co., 1100 29th St., N.W.
Robert K. Thulman, '22, Federal Housing Administration, 1001 Vermont Ave., N.W.

FLORIDA:
Jacksonville. George W. Simons, Jr., '15, Hildebrandt Bldg.
Miami. B. Howard Brown, '30, 70 S. W. 27th Rd.
Tampa. Franklin O. Adams, '07, 305 Morgan St.

GEORGIA:
Atlanta. William E. Huger, '22, Courts & Co., 11 Marietta St., N.W.

ILLINOIS:
Chicago. L. H. G. Bouscaren, '04, Stone & Webster, 33 S. Clark St.
Edmund G. Farrand, '21, United Conveyor Corp., 1200 Old Colony Bldg.
Lonsdale Green, '87, 5639 Kenwood Ave.
P. E. Lavedan, '20, Pres., The Liquid Carbonic Corp.
R. M. Nelson, '30, 332 S. Michigan Blvd.
J. Sherry O'Brien, '17, Harvey Metal Corp., 74th St. and Ashland Ave.
Ralph Sargent, '18, Sargent & Lundy, 140 S. Dearborn St.
William C. Steinwedell, '25, Stewart-Warner Corp., 1828 Diversey Parkway.
Evanston. Robert W. Van Kirk, '18, 2502 Park Pl.
Rockford. Arthur B. Brand, '26, Cummings, Brand & McPherson Advertising, 716 Gas-Electric Bldg.
Winnetka. L. H. G. Bouscaren, '04, 646 Prospect Ave.

INDIANA:
Fort Wayne. Frederick P. Feustel, '33, City Light and Water Utilities, 308 E. Berry St.
Indianapolis. Howard S. Morse, '03, Indianapolis Water Co., 113 Monument Circle.

IOWA:
Des Moines. Harold C. Neumann, '17, Arthur H. Neumann & Bros., Inc., Hubbell Bldg.
Dubuque. Richard V. McKay, '06, Key City Gas Co., 669 Main St.

KENTUCKY:
Louisville. Elmer A. Skonberg, '29, The Mengel Co.

LOUISIANA:
New Orleans. Theo. O. Hotard, '12, Commissioner of Public Property, City of New Orleans.

MAINE:
Augusta. Willard B. Purinton, '22, Purinton Brothers Co., 333 Water St.
Bangor. Frank A. Knight, '38, Eastern Corp.
Portland. Stanley W. Hyde, '17, Prin., N. Yarmouth Academy, Yarmouth.

MARYLAND:
Baltimore. J. Carl Fisher, '17, Consolidated Gas-Electric Light & Power Co., Lexington Bldg.
George W. Spaulding, '21, 1605 Lexington Bldg.

MASSACHUSETTS:
Springfield. Ralph E. Curtis, '18, Curtis Universal Joint Co., Inc., 4 Birnie Ave.

MICHIGAN:
Detroit. Charles T. Ellis, '17, 1377 Harvard Rd., Grosse Pointe Park.
Allyne C. Litchfield, '17, U. S. Rubber Products, Inc., 6600 E. Jefferson Ave.
Adam K. Stricker, Jr., '29, General Motors Corp., General Motors Bldg., 3044 W. Grand Blvd.

MINNESOTA:
Duluth. William C. Lounsbury, '03, Minnesota Power and Light Co.
Minneapolis. Willis R. Salisbury, '12, Salisbury & Satterlee Co.
St. Paul. Winter Dean, '21, Nicols, Dean & Gregg.

MISSISSIPPI:
Jackson. Donald B. Gilman, '32, Miss. Products, Inc.

MISSOURI:
Kansas City. James C. Irwin, Jr., '18, U. S. Cold Storage Corp., 500 E. Third St.
St. Louis. Delos G. Haynes, '09, 818 Olive St.
Wesley Loomis, III, '33, Miss. Valley Trust Bldg., 506 Olive St.
Philip E. Morrill, '14, Bemis Bro. Bag Co., 408 Pine St.

MONTANA:
Butte. William A. Kemper, '04, 118 W. Broadway.
Great Falls. Earl S. Bardwell, '06, 2503 Third Ave., N.

NEBRASKA:
Omaha. John M. Hanley, '30, Supt. of Production, Northern Natural Gas Co., Room 228, Aquila Court.

NEW HAMPSHIRE:
Concord. Leigh Spaulding Hall, '14, Hall Brothers Co., 31, S. Main St.

NEW JERSEY:
Atlantic City. Harold I. Eaton, '09, Eastern Engineering Co. 4 N. North Carolina Ave.
Bloomfield. Carole A. Clarke, '21, 215 Linden Ave., Glen Ridge.
Camden. W. N. Currier, '31, 232 Elm Ave., Haddonfield.
Dover. Howard B. Allen, '18, New Jersey Power and Light Co., 9 W. Blackwell St.
East Orange. George Des Marais, '20, 140 Glenwood Ave.
Elizabeth. Donald D. Way, '19, 226 Wychwood Rd., Westfield.
Glen Ridge. Stewart C. Coey, '06, 39 Wildwood Ter.
Hackensack. Harold H. Brackett, '12, 515 Summit Ave., Oradell.
Irvington. William J. Grady, '22, 26 N. Crescent, Maplewood.
Jersey City. Edwin S. Lockwood, '21, Public Service Electric and Gas Co., 325 Palisade Ave.
Kearny. Dr. Robert V. Townend, '14, 101 Seeley Ave., Arlington.
Manasquan. Munroe C. Hawes, '21, 111 Union Ave.
Maplewood. Gordon G. Holbrook, '10, 9 Beach St.
Millburn. A. Raymond Brooks, '17, Wayside, Brantwood, Short Hills.
Montclair. Livingston P. Ferris, '11, 11 Bellevue Ave., Upper Montclair.
Morristown. Everett W. Vilett, '22, 91 Whitney Rd., Short Hills.
Newark. Henry C. Colson, Jr., '09, Carnrick Co., 20 Mt. Pleasant Ave.
Orange. Frank Maguire, '17, 201 Vose Ave., S. Orange.
Passaic. Frank L. Bradley, '20, Forstmann Woolen Co.
Paterson. Edmund J. Thimme, '23, Valley View Ter., Packanack Lake.
Plainfield. Geoffrey M. Rollason, '13, Aluminum Co. of America, Garwood.
Ridgewood. Herman A. Affel, '14, 827 Morningside Rd.
Rutherford. Newton S. Foster, '28, 15 E. Pierrepont Ave.
South Orange. Alfred I. Phillips, Jr., '10, 211 Lenox Ave.
Summit. Winfield I. McNeill, '17, 14 Hillcrest Ave.
Trenton. Thomas H. Gill, '22, 9 Stuart Ave., Hillwood Lakes.
Westfield. Lyman L. Tremaine, '23, 422 Baker Ave.

NEW YORK:
Albany. Burt R. Rickards, '99, State Department of Health.
Binghamton. William McDowell, '30, International Machine Corp., Endicott, N. Y.
Buffalo. Whitworth Ferguson, '22, Ferguson Electric Construction Co., 333 Ellicott St.
Marvine Gorham, '93, 420 Jackson Bldg.
Hudson. Robert A. Schmucker, '15, 545 Union St.
Newburgh. Thomas C. Desmond, '09, 94 Broadway.
New York City. William J. Barrett, '16, Metropolitan Life Insurance Co.
C. George Dandrow, '22, Johns-Manville Co., 22 E. 40th St.
Laurence B. Davis, '22, Socony-Vacuum Oil Co., Inc., 26 Broadway.
Saxton W. Fletcher, '18, J. O. Ross Eng. Corp., 350 Madison Ave.
Alfred T. Glassett, '20, W. J. Barney Corp., 101 Park Ave.
G. Peter Grant, Jr. '35, Grant Photo Products, 401 Fourth Ave.
Laurence C. Hart, '13, Johns-Manville Co., 22 E. 40th St.
Donald A. Henderson, '25, 20th Century-Fox Film Corp., 444 W. 56th St.
Irving D. Jakobson, '21, Jakobson Shipyard, Inc., West End Ave., Oyster Bay, L. I.
Charles C. Ladd, '30, Blair, Curtis & Hayward, 60 E. 42d St.
William H. Latham, '26, Director of Maintenance and Operation, Arsenal Bldg., 5th Ave. and 64th St.
George J. Leness, '26, Merrill Lynch, Pierce, Fenner, and Beane, 70 Pine St.
Duncan R. Linsley, '22, First Boston Corp., 100 Broadway.
P. H. Littlefield, '24, Canada Dry Gingerale, Inc., 100 E. 42d St.
James A. Lyles, '27, Vice-President, First Boston Corp., 100 Broadway.
William H. Mueser, '22, Moran, Proctor, Freeman, and Mueser, 420 Lexington Ave.
John J. Murphy, '23, Linde Air Products Co., 30 E. 42d St.
Raymond C. Rundlett, '22, Curtis Publishing Co., 60 E. 42d St.
Robert P. Shaw, '23, N. Y. Museum of Science and Industry, R. C. A. Bldg., 30 Rockefeller Plaza.
Poughkeepsie. George T. Welch, '21, Comptroller, Vassar College.
Rochester. John F. Ancona, '03, 311 Hiram Sibley Bldg., 316 Alexander St.
Dwight VandeVate, '22, 112 Shoreham Dr.
Rome. Richard A. Wilkins, '18, Revere Copper and Brass, Inc.
Schenectady. Charles J. Koch, '23, 1185 Ardsley Rd.
Ralph C. Robinson, '01, 1138 Oxford Pl.
Syracuse. Frederick W. Barker, '12, Syracuse Savings Bank, 102 N. Salina St.
Edwin A. Gruppe, '22, Central N. Y. Power Corp., 300 Erie Blvd., West.
Utica. Carl H. Anderson, '27, 280 Genesee St.

NORTH CAROLINA:
Charlotte. Beaumert Whitton, '33, Southeastern Construction Co., 218 W. Second St.

OHIO:
Akron. Parry Keller, '15, Goodyear Tire and Rubber Co.
Cincinnati. John D. Cochrane, '23, Formica Insulation Co. 4620 Spring Grove Ave.
Cleveland. Howard P. Ferguson, '27, Standard Oil Co., Midland Bldg.
William C. Sessions, '26, Bosworth & Sessions, 1337 Guardian Bldg.
Henry G. Steinbrenner, '27, Kinsman Transit Co., 706 Rockefeller Bldg.
Columbus. Clarence E. Richards, '18, American Education Press, Inc., 400 S. Front St.
Dayton. Michael J. Gibbons, '06, 116 Thruston Blvd.
Toledo. Herbert A. Barnby, '23, Owens-Illinois Glass Co.
Youngstown. James L. Wick, '06, Falcon Bronze Co., 218 S. Phelps St.

OKLAHOMA:
Oklahoma City. Charles B. Stuart, '34, The Fidelity National Bank.
Tulsa. William J. Sherry, '21, 804 Kennedy Bldg.

OREGON:
Portland. Ernest B. MacNaughton, '02, First National Bank.
A. Glenn Stanton, '21, 208 S. W. Stark St.

PENNSYLVANIA:
Bethlehem. Charles H. Herty, Jr., '21, Bethlehem Steel Co.
Erie. Richard P. Price, '25, Vice-Pres., Hammerhill Paper Co.
Harrisburg. Percy E. Tillson, '06, Bell Telephone Co. of Pennsylvania, 210 Pine St.
Lancaster. Charles K. Miller, '23, Armstrong Cork Co.
Philadelphia. Philip M. Alden, '22, Philadelphia Electric Co., 1000 Chestnut St.
H. W. Anderson, '15, Fidelity Machine Co., 3908 Frankford Ave.

Greville Haslam, '15, Episcopal Academy, Overbrook.
Henry W. Jones, '26, Atlantic Refining Co., 260 S. Broad St.
George T. Logan, '29, Philadelphia Electric Co., 1000 Chestnut St.
Charles W. Stose, '22, Atlantic Refining Co., 3144 Passyunk Ave.
Pittsburgh. Charles M. Boardman, '25, Duquesne Light Co., 435 Sixth Ave.
Thomas Spooner, '09, Manager, Central Eng. Labs. and Stds. Dept., Westinghouse Elec. and Mfg. Co., E. Pittsburgh.
Reading. Allyn C. Taylor, '06, Consumers Gas Co., 441 Penn St.
Scranton. William L. Dennen, '17, 805 Ash St., Clark's Summit.
Robert K. Moore, Jr., '34, 1703 Madison Ave.

SOUTH CAROLINA:
Charleston. James F. Crist, '24, South Carolina Power Co.

TENNESSEE:
Chattanooga. Richard S. Bicknell, '10, 1516 Sunset Rd., N. Chattanooga.
Knoxville. Van Court M. Hare, '23, 605 Union Bldg.
Memphis. C. W. Loomis, '16, Bemis Bro. Bag Co., P. O. Box 2566, De Soto Station.
Harry Webb, '09, Monteagle S. S. Assembly, Monteagle.
Nashville. Donald W. Southgate, '11, Nashville Trust Bldg.

TEXAS. *Dallas.* Frank F. Bell, '10, Uvalde Construction Co., 2400 Uvalde St.
Jonathan A. Noyes, '12, Sullivan Machinery Co., 1914 Commerce St.
El Paso. Charles I. Auer, '01, 902 Park Rd.
Fort Worth. Count B. Capps, '20, W. B. Fishburn Cleaners Inc., 1212 Main St.
San Antonio. Terrell Bartlett, '06, The Terrell Bartlett Engineers, 2700 Transit Tower.

UTAH:
Salt Lake City. George M. Gadsby, '09, Utah Power and Light Co., Kearns Bldg.

VERMONT:
Rutland. Birney C. Batcheller, '86, Wallingford.

VIRGINIA:
Lynchburg. Edward R. Harris, '25, The Mead Corp.
Norfolk. Chas. W. Johnston, '05, 214 Broad St., Portsmouth.
Richmond. Donald N. Frazier, '11, American Mutual Liability Insurance Co., 1223 Mutual Bldg.

WASHINGTON:
Seattle. H. W. McCurdy, '22, Puget Sound Bridge and Dredging Co., 2929 16th Ave., S.W.
Spokane. Edward E. Scofield, '19, Washington Water Power Co.

WEST VIRGINIA.
Charleston. William S. Brackett, '23, Carbide and Carbon Chemicals Corp., S. Charleston.

WISCONSIN:
Milwaukee. Philip N. Cristal, '17, Northwestern Mutual Life Insurance Co.

U. S. TERRITORIES AND DEPENDENCIES

CANAL ZONE:
Balboa Heights. Meade Bolton, '16, Box 23.

HAWAII:
Honolulu. William C. Furer, '06, 1909 Aleo Pl.

FOREIGN COUNTRIES

ARGENTINA:
Buenos Aires. Jose Carlos Bertino, '23, Central Naval, Florida 801.
Herman F. Krantz, '28, Otis Elevator Co., Avenida Leandro N. Alem 1616.

AUSTRALIA:
Melbourne. Col. Lionel H. Lemaire, '13, Chief Inspector Army, L.H.Q., Victoria Barracks, Melbourne S. C. 1.

BRAZIL:
Rio de Janeiro. Alexandre H. Leal, '35, Cia Carris, Luz e Forca Avenida Marechal Floriano 168.

CANADA:
Montreal, Que. Augustin Frigon, '11, Manager, Canadian Broadcasting Corp., 1440 St. Catherine St. W.
A. D. Ross, '22, A. D. Ross and Co., Room 413, 680 Sherbrooke St. West.
St. John, N. B. H. Usher Miller, '09, P. O. Box 796.
Toronto, Ont. Hal L. Bemis, '35, Campbell Soup Co., Ltd., Third and Birmingham Sts., New Toronto.
Winnipeg, Man. Richard C. Huggard, '30, Huggard & Monecrieff, Ltd., 1 Somerset Bldg.

COLOMBIA:
Bogota. John O. Bower, '22, Texas Petroleum Co., Apartado Aereo 3622 (airmail), Apartado Postal (regular mail) 877.

ENGLAND:
London. David A. Shepard, '26, 36 Queen Anne's Gate, Westminster, London S.W. 1.

INDIA:
Calcutta. William F. Rivers, '26, c/o Standard-Vacuum Oil. Co., P.O. Box 146.

MEXICO:
Mexico City. George D. Camp, '16, Apartado 1005, Ejido 7 Office 507.

NORWAY:
Oslo. Harold R. Bjerke, '23, Osterhausgate 18.

SOUTH AFRICA:
Johannesburg. Glenn L. Bateman, '25, Box 1671.

SWITZERLAND:
Zurich. Werner Schoop, '22, Flexflam A. G., Schmidhof, Lowenstrasse 2.

APPENDIX C

STUDENT HOUSING

FOR MARRIED STUDENTS

THE Institute's plans for aiding married students in finding housing include two projects organized in the autumn of 1945:

A Housing Bureau with an expert staff to assist in finding suitable quarters in the Greater Boston area.

"Westgate": a housing development of 100 dwelling units on the campus in which occupancy will for the present be confined to honorably discharged married veterans of World War II who are actually in residence as full-time students at M. I. T.

THE HOUSING BUREAU — ROOM 4-132

This special office is maintained to render assistance to married students and staff in finding outside accommodations, furnished or unfurnished, including temporary quarters when necessary. Married applicants, if in residence or accepted for admission to the Institute, are encouraged to visit the Housing Bureau in person since outside lodgings or dwelling units cannot be contracted for *except by the individual and the landlord immediately concerned.* Men with children are especially urged to postpone bringing their families to Cambridge or Boston until they have definitely arranged for suitable accommodations.

"WESTGATE" — THE TECHNOLOGY HOUSING DEVELOPMENT

On the ten-acre plot, situated on Institute land in Cambridge west of Massachusetts Avenue (at Fowler Street, between Memorial Drive, which skirts the Charles River Basin and Vassar Street), the Institute has completed the construction of 100 small homes. This temporary residential project, known as "Westgate," which has been planned as the result of an acute housing shortage in the Boston-Cambridge area, includes 50 houses containing one bedroom and 50 houses containing two bedrooms.

The houses, arranged in single and twin units, are similar to small apartments with the privacy of a house and with the additional advantage that each house has its own plot of land. The smaller houses consist of a bedroom, combination living and dining room with a kitchen unit, closed off by doors, and ample closet space. The larger type house has in addition a second bedroom and a separate kitchen. These houses, which are unfurnished except for stove, refrigerator, and kitchen cabinet, are insulated and are heated by gas.

Parking space is sufficient for cars of both tenants and guests. Off-highway arrangement provides safe play space for children, although it is not expected that the houses will be occupied by families having children of school age.

Leases will be drawn on the basis of monthly rentals of $45 and $55 for the one-bedroom and two-bedroom houses, respectively, including all utilities except telephone and gas. The cost of gas for heating, cooking, and hot water is *not included* in the monthly rental figures given above, and it is estimated that the cost of gas to tenants will average $7 to $10 per month over the calendar year.

Occupancy in "Westgate" will for the present be confined to honorably discharged married veterans of World War II who are actually in residence as full-time students at M. I. T. Applications should be filed with the Housing Bureau for consideration by a committee of Faculty members charged with the allotment of *available houses.*

THE GRADUATE HOUSE

THE Graduate House, having a maximum capacity of 455 residents, is reserved exclusively for men graduate students. It is located at Memorial Drive and Massachusetts Avenue, Cambridge, directly across the avenue from the main educational group. The House originally occupied the oldest of the dormitories known as the Faculty Group, which now has become the Senior House. It was established in 1933 in the belief that "those contacts which aid in developing qualities of leadership and coöperation would be encouraged by bringing graduate students into one group." In further justifying this new development in student life at the Institute, it was pointed out that "the most natural training comes from free social intercourse between men of different interests but of equivalent intellectual outlook."

On the first floor of the west wing of the House are the public rooms and the dining rooms. An attractive lounge is located at the left of a short flight of stairs leading from the lobby. The Crafts Living Room and Library, named for James M. Crafts, President of the Institute at the turn of the century, are at the end of the west corridor leading towards the Charles River. The Macomber Room also opens from this same corridor. It is used chiefly in connection with the Fabyan Dining Room. The Campus Room, suitable for dinners and dances, and the Buttery, designed for informal gatherings, are located in the basement of the west wing. The corresponding east wing basement contains the hand ball court, the ping-pong room, the photographic dark room and a large modern shower room.

A member of the Faculty, who is familiar with the general aims and problems of graduate students, is resident house master. With the advice and assistance of a student house committee, he has supervision of the Graduate House.

A number of general social activities are sponsored by the Graduate House. Informal gatherings are held on Tuesday and Thursday evenings in the Buttery. Sunday afternoon teas are held during the academic year and an Alumni Day tea in June. A series of Graduate House dinners is held on Wednesday evenings from the end of October until the week of April the nineteenth, and a distinguished guest is invited on each of these occasions to make a brief address. Various groups in the House sponsor small dances in the Campus Room for which it is admirably suited. Participation in these different functions is urged for all residents of the Graduate House.

In keeping with the widespread interest in athletics among graduate students there are organized in the House five teams in football, in basket ball, in bowling, and in soft ball. To take advantage more fully of the facilities afforded by the Institute for sailing, a shore school is held in the Buttery during the early part of the second term. Opportunities are available for contests in the game rooms within the House and for tennis and squash on courts maintained by the Institute.

A House Tax, included in the rental, is turned over to the Graduate House Committee for library, athletic and social activities, and for the maintenance of the Dark Room, the Buttery, and the Music Room.

EQUIPMENT

Each resident is provided with a bed, an inner spring mattress, blankets, towels, bed linen, a pillow, desk, side chair, easy-chair, bookcase, desk lamp, wastebasket, and ash tray. All rooms are furnished with rugs and window draperies, and are on the interconnecting house telephone system. Most of the double and triple suites are provided with tables. The rooms are thus fully equipped for immediate occupancy and it is requested that additions by students be only upon agreement with the manager of the Graduate House.

SERVICE

In addition to the use of the space and the equipment, the rental covers the service of porters who make up the beds each day, except week-ends and holidays, and take care of the cleaning. Also included are heat, light, electric lamps, continuous hot and cold water, soap, and the laundering of towels and all bed linen. The house service is directly in charge of the manager.

APPLICATIONS FOR ROOMS

Applications for the Graduate House should be made to W. N. Davis, manager of the Graduate House, 305 Memorial Drive, Cambridge 39, Massachusetts.

Each student must file an application card, and if applying for double or triple suites, suggestions of possible roommates may be indicated on the application, but lacking any suggestions, opportunity will be provided for meeting prospective roommates.

An application fee of $5.00 is required. This amount is credited toward room rent. It will be returned if no room be assigned.

ALLOTMENT OF ROOMS

The assignment of rooms by the Dormitury Board will be in order of application, but the Board reserves the right to reject any applicant for sufficient reason. Priority in the assignment of rooms is granted to Graduate Students already living in the House whose applications are filed on or before the date posted on the bulletin board. Notices of assignments will be forwarded to these applicants as soon as possible, and acceptances must be returned to the manager as requested, otherwise, the rooms may be reassigned.

OCCUPANCY

Rooms rented for the term as indicated by the Institute calendar may be occupied from the Wednesday before the opening of the term until the Tuesday after the close of the term — about 17 weeks. Graduate students, who by virtue of their staff appointment are required to be in residence two weeks before the opening of any term, will be given every consideration in assigning accommodations upon written request to the manager.

RENTALS, PAYMENTS, AND REFUNDS

The rental of the single rooms and suites varies according to space, exposure, and lavatory installation. These prices are clearly indicated on the floor plans.

Payments for each term will be due regularly without notice — before the beginning of each term. *No bills will be sent.*

The Dormitory Board extends the following privileges, subject to change without notice, in the cancellation of applications.

Applications may be canceled without charge before the Wednesday prior to Registration Day upon written notice to the Manager.

Students who desire to move from the Graduate House after Registration Day and who do not contemplate leaving the Institute will be refunded a proportionate part of their payments, less $10, on condition that another student can be secured immediately to take over the remaining portion of the rental.

Rentals are automatically canceled upon transfer to a coöperative course and a proportionate refund allowed. The student is not allowed, however, to sublet or transfer his room, or his share in a room, without the consent of the Dormitory Board.

FURTHER INFORMATION

KEYS. Key cards for individual room keys and post office box keys may be obtained at the Graduate House Office. A deposit of $1 for the two is required, but this is refunded upon surrender of the keys.

The Graduate House Office is located in the lobby of the House. A clerk is in attendance from 8 a.m. to 12 p.m. All necessary information may be obtained there. A night porter and a watchman are on duty from midnight until eight o'clock in the morning. The office of the manager of the Graduate House is at the head of a short flight of stairs leading from the lobby.

THE CRAFTS LIVING ROOM is a large, comfortably furnished living room designed for the use of residents and their guests at any time from eight o'clock in the morning until midnight. The Lounge is available for similar purposes. Since the Graduate House is the residence of men students, ladies are not permitted in other than the public rooms except on special occasions.

CRAFTS LIBRARY. There is a collection of two thousand volumes dealing with the history of science, engineering, architecture, economics, philosophy and the biographies of eminent scientists, engineers, architects, and philosophers. The most useful handbooks for engineering and science together with dictionaries and encyclopaedia are provided. The library carries subscriptions to twelve leading magazines.

MAIL AND EXPRESS. Packages and mail matter for students living in the Graduate House should be addressed as follows: *The Graduate House, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.* Individual post office lock boxes are provided and are located in the lobby. Express and freight are handled through the office. Trunks and boxes to be sent out, should be packed and labeled and left in the basement near the elevator. The Graduate House shipping clerk will see that they are picked up by the appropriate shipping agency and forwarded at cost.

TELEPHONE SERVICE. Persons calling the Graduate House from outside should ring Kirkland 2680. Through a system of intramural telephone service the Office is enabled easily to call any occupant between the hours of 8 a.m. and midnight. Telephone pay stations for out-going calls are located on the first floor at the foot of the central staircases.

LAUNDRY AND VALET SERVICE. The Graduate House Office operates a laundry and valet agency, and residents are enabled to secure such service through the Office at reduced prices.

STORAGE. Ample facilities for storage of trunks are provided in the basement of the halls without charge. It is requested that trunks not be kept in the rooms.

AUTOMOBILE REGULATIONS AND PARKING. A motor vehicle or trailer owned by a non-resident, or registered in a country or State other than Massachusetts, may be operated in Massachusetts on its out-of-state registration for the same period that, as determined by the Registrar, the State or country of registration grants similar privileges of operation to residents of the Commonwealth. Motor vehicles of non-residents operated under these privileges must, however, be covered by a policy of liability insurance to limits of not less than $5,000–$10,000 (1) If the vehicle is operated in this Commonwealth more than thirty days in the aggregate in any one year; or (2) In any case where the owner acquires a regular place of abode or business or employment within the Commonwealth for a period of more than thirty days A non-resident permit is not required, but a non-resident must have the policy, or a certificate from the insurance company, on his person or in the vehicle in an easily accessible place. Failure to do so is made prima-facie evidence that insurance required by law has not been maintained.

Outdoor parking of properly registered automobiles is permitted on the Institute grounds and on the Graduate House parking lot at the risk of the owner.

DINING SERVICE. On the first floor of the west wing of the House there are four attractive dining rooms. The main dining room has a capacity of 180. Here breakfast and lunch are served in cafeteria style and at night dinner is served at the tables. In the west dining room, with 89 chairs, table service is available for lunch and dinner. The Fabyan Dining Room, capacity 14, is used for small private luncheons or dinners. The Campus Room, in the basement, will seat 300 persons for a banquet and it is designed for subdivision into three smaller rooms. It is available for the midday or the evening, on application to the manager.

All food is prepared in a well coördinated, modern kitchen and bake shop located in the building.

No board by the day or week is furnished and no resident of the House is required to use the dining service. Because of the attractiveness of the rooms, their convenient location, and the high quality of the food provided, the patronage is good.

The Dormitory Board, to which reference has been made, is appointed by the President of the Institute. It is charged with responsibility for the general regulations, sanitation, service, maintenance of the building and the allotment of rooms.

For further information address the Manager of the Graduate House, Massachusetts Institute of Technology, Cambridge, Massachusetts.

SENIOR AND UNDERGRADUATE HOUSES

Effective September 25, 1946 (Subject to change)

The permanent houses of the undergraduate dormitories and other campus buildings which have been remodelled to provide inexpensive living accommodations for six hundred additional students are available for occupancy upon application in accordance with the following memorandum which gives a summary of prewar dormitory policy, amended to conform to present circumstances. The following information is effective as of September 25, 1946, and subject to change.

The permanent student housing facilities provided at the Massachusetts Institute of Technology have been carefully planned and organized to afford an economical, comfortable place in which to live, an environment conducive to study and an opportunity to participate in those social and extra-curricular activities which properly supplement scholastic work.

Additional accommodations, designed for temporary emergency housing, have many desirable features such as adequate heating, lighting, toilet facilities, single beds, mattresses, individual study desks, lockers, and so forth, but are of the "barracks" type in both sleeping and study accommodations. These accommodations may be termed adequate and as satisfactory as is possible under present conditions.

GOVERNMENT

The senior and undergraduate houses and the emergency housing unit are administered as a part of the general plan of student self-government at the Massachusetts Institute of Technology, with the coöperation of the Dormitory Board, appointed by the President and acting in an advisory capacity. The student dormitory committee organizes and supervises all activities, athletic and social, and coöperates with all recognized undergraduate activities at the Institute.

The success of student self-government depends upon the willingness of every resident to coöperate and contribute, and therefore upon the responsibility the group as a whole is willing to assume. Those who are unable or unwilling to live under student government and support its principles in the strictest sense, whether on or off the Institute grounds, are undesirable tenants and are so recognized by the Dormitory Committee and the Dormitory Board. The privilege of residence in the dormitories will therefore be denied to those who do not accept this responsibility.

THE SENIOR HOUSE

Ware, Atkinson, Runkle, Holman, Nichols, and Crafts

The Senior House, located on Memorial Drive, east of Walker Memorial and near the President's House, has been completely reconditioned. Accommodations are available for two hundred and twenty-seven registered male students.

Most of the first floor rooms in all the halls except Crafts and Ware are designed for single occupancy. On the upper floors most of the quarters are suites, comprising a living room, a dressing room, and a sleeping room arranged for two students. Because of the demand for additional accommodations a few of the larger suites have been re-equipped to accommodate three men. All rooms are equipped for immediate occupancy.

THE UNDERGRADUATE HOUSES

Munroe, Hayden, Wood, Goodale, Bemis, Walcott
For Undergraduate Students

The six halls are situated on the main campus near Walker Memorial. They have accommodations for four hundred and eighty-three men. Most of the rooms are designed for single occupancy — some inter-connecting — with a limited number of double and triple suites. Due to the housing shortage, many of the interconnecting rooms have been equipped as a combination suite, a study and bedroom accommodating three men. There are lavatory installations in all these rooms, supplemented by adequate toilets and showers on each floor of every hall.

EQUIPMENT AND SERVICE

(*Permanent Undergraduate Houses Only*)

All the rooms in the permanent dormitory units at the Massachusetts Institute of Technology are *fully equipped for occupancy*, and additions by students are not permitted. All single rooms are equipped with a special bed or couch, all hair innerspring mattress with cover, pillow, bedspread, blankets, chiffonier, desk and chair, study chair, bookcase, rug, draperies, desk lamp, waste basket, light bulbs, extra electrical outlets, and interconnecting telephone. Double and triple suites are furnished in a manner similar to the single rooms, but in addition have study tables. As a temporary measure some of the larger double rooms are equipped for three men. Bed linen and towels are furnished and replaced regularly by porters who make up and clean the rooms each day except week-ends and holidays.

In addition to space, the rental includes heat, light, continuous hot and cold water, intercommunicating telephone service, porter service, soap, towel and linen supply and laundry service for bed linen and towels. The dormitory buildings are of first-class construction and are fireproof. Steam heat is available throughout the year, day and night. The house service is directly in charge of the manager and is maintained by experienced porters. A representative of the Institute is on the premises day and night.

The above applies to permanent buildings only. (See special paragraph "Barracks Housing" below.)

RENTAL AND OCCUPANCY

The rental for accommodations in the permanent undergraduate and senior houses is either $105 or $140 each person each academic term, approximately $6 or $8 a week, payable in advance. The majority of the rooms in Munroe, Hayden, Wood, Goodale, Bemis and Walcott are similar; in many cases, however, because of the demand for accommodations, two interconnecting rooms have been equipped as a bedroom and study for three men. There are differences in location, exposure, size of rooms, and so forth, in the Senior House, but the facilities, equipment, and service are standard throughout the dormitory system.

The period of occupancy for any academic term is from the Wednesday preceding Registration Day (Monday) through the Tuesday following the last day of the scheduled examination period. (See official M. I. T. calendar.)

SENIOR HOUSE RENTALS

All accommodations in Ware, Atkinson, Runkle, Holman, Nichols and Crafts are at the rate of $140 each occupant each term, except the following, which are $105 each occupant each term.

3-Man Suites

Atkinson	203	205	Runkle	203–04–06		Holman	203	204
	303	305		303–04–06			303	304
	403	405		403–04–06			403	404
			Nichols	203	204			
				303	304			
				403	404			

Single Rooms

Atkinson	204A	204B	Runkle	206A	601
	304A	304B		306A	602
	404A	404B		406A	603
				501	604
				502	604A
				505	605
					605A

PERMANENT UNDERGRADUATE DORMITORY RENTALS

All accommodations in Munroe, Hayden, Wood, Goodale, Bemis, Walcott are at the rate of $140 each occupant each term, except the following, which are $105 each occupant each term.

Goodale — 3-Man Suites

108–09	111–12	113–14	101–02	103–04	106–07
208–09	211–12	213–14	201–02	203–04	206–07
308–09	311–12	313–14	301–02	303–04	306–07
408–09	411–12	413–14	401–02	403–04	406–07
508–09	511–12	513–14	501–02	503–04	506–07

Walcott — 3-Man Suites

101–02	104–05			110–11	113–14
201–02	204–05	206–07	208–09	210–11	213–14
301–02	304–05	306–07	308–09	310–11	313–14
401–02	404–05	406–07	408–09	410–11	413–14
501–02	504–05	506–07	508–09	510–11	513–14

Bemis — Double Rooms

112	212	312	412	512

APPLICATIONS AND RESERVATIONS

Applications for rooms must be accompanied by a deposit of $5, check made payable to D. L. Rhind, Bursar, forwarded to Mr. Henry K. Dow, Manager of the Undergraduate Dormitories, Massachusetts Institute of Technology, 3 Ames Street, Cam-

bridge 39, Massachusetts. Applications will be accepted only from those who have been notified of their admission by the Director of Admissions and will be filed in order by date as received. Preference in the assignment of rooms will be in order from this list.

Notification of an assignment will be forwarded to successful applicants and a definite reservation made about thirty days prior to the opening of the term. The reservation and the $5 application fee entitle the applicant to occupy a room in the dormitories from the Wednesday preceding the date established for the opening of the term to 4 p.m. on Registration Day. The applicant must, however, appear in person at the Dormitory Office on Registration Day and extend the reservation by payment of the balance of the rent ($100 or $135), which entitles him to occupancy until the Tuesday following the last day of the scheduled examination period for that term; otherwise, the reservation is automatically cancelled and the room made available to an applicant from the waiting list. The dormitory rental due on Registration Day should not be sent in advance nor included with other payments which are made directly to the Bursar.

Reservations may, however, be cancelled up to the Wednesday preceding Registration Day upon written notice to the Manager of the dormitories, and the application fee of $5 refunded in full.

The names of unsuccessful applicants remain on a waiting list and assignments are made as rooms become available. Due to the privilege in the cancellation of dormitory reservations extended to those who affiliate with recognized fraternities, a number of rooms become available for occupancy at the beginning of the term. Applicants on the waiting list should, therefore, report in person to the Dormitory Office (rear of Walker Memorial) on arrival, to apply for immediate assignment to rooms released by cancellation, to be assigned to temporary quarters in the dormitories pending the release of accommodations on Registration Day or thereafter, or to withdraw their names from the waiting list if accommodations have been secured elsewhere. Applicants who withdraw their names from the waiting list by 4 p.m. on Registration Day will be refunded the application fee of $5. The refund of $5 will be made directly to the applicant regardless of the source of he application fee.

ALLOTMENT OF ROOMS

The assignment of rooms by the Dormitory Board will be in order of application but the Board reserves the right to reject any applicant for sufficient reason. Priority in the assignment of rooms, except those especially reserved for entering first-year students, is granted to students in residence. Application forms for the next regular term will be distributed to residents about thirty days prior to the end of a term and must be returned to the Manager of the dormitories accompanied by a reservation fee of $5, check payable to D. L. Rhind, Bursar. Assignments will be made to these applicants immediately and a definite reservation made. The number of single rooms reserved for first-year students will vary from term to term depending upon circumstances

FRATERNITY AFFILIATION

The "recognized list" of fraternities at the Massachusetts Institute of Technology includes twenty or more chapters whose houses are situated on private property in Cambridge, Boston, and Brookline. Residence in the dormitories or fraternities offers advantages over local apartment and rooming houses in that the former provide a more intimate contact with Technology life and activities. Approximately ninety per cent of the new fraternity men are pledged prior to the end of the first week of the academic year, and in order that they may assume residence at the fraternity house of their choice immediately and thereby release accommodations to those on the waiting list who prefer residence in the dormitories, privileges in the cancellation of dormitory reservations are extended to those who make a decision on or before Registration Day. Parents who anticipate fraternity affiliation for their sons should, if possible, grant them permission to act on their own initiative. The satisfactory housing of a large group of entering students under present conditions can be accomplished only through the coöperation of parents, students, and fraternity and dormitory representatives in making early and prompt decisions so that temporary housing is reduced to a minimum. Students are therefore requested to withdraw applications for dormitory residence promptly if they are certain that such accommodations will not be required.

REFUNDS

Reservations are automatically cancelled upon withdrawa. of a student from the Institute or transfer to a coöperative course, and a proportionate refund allowed.

Residents of the dormitories who desire to move to recognized fraternity houses after Registration Day and prior to the following Monday, and whose transfer is requested by authorized representatives of the fraternity, will be refunded the rental fee less a charge for occupancy at the weekly rate, less $10. If, however, another student is available on the waiting list to assume occupancy immediately, the charge of $10 will not be made.

Students, except transfers to fraternities, who desire to move from the dormitories prior to the Monday following Registration Day and who do not contemplate leaving the Institute, will be refunded the rental fee less a charge for occupancy at the weekly rate, less $10.

Students who desire to move from the dormitories after the Monday following Registration Day, and who do not contemplate leaving the Institute will be refunded the rental fee less a charge for occupancy at the weekly rate, less $25.

The student is not allowed, under any circumstances, to sublet or transfer his room or his share in a room, without the consent of the Dormitory Board.

REGULATIONS AND GENERAL INFORMATION

Key Deposits and Refund. A deposit of $1 is required for room and mail-box keys, subject to refund in full when returned.

Laundry and Valet Service. Laundry service is on a cash basis. Laundry bags, slips and tags are available at the office desk. Notification of return of laundry will be through the mail boxes. Laundry service one week, valet service four days. Prices reasonable.

Telephone and Western Union Service. Long-distance and local calls received through the dormitory switchboard will be relayed through telephones located on each floor. Intercommunicating and Institute service is available through the room telephones. Western Union messages may be sent from the office. *Telephone number is Kirkland 5300.*

Porter Service. Available Monday through Saturday only. Sunday and holiday porter service is limited under present conditions to cases of emergency only. Residents are required to care for their rooms on Sundays.

Visitors. The dormitories are for men only, and persons of the opposite sex are not permitted in the rooms or buildings, except the dormitory office, and the Burton Room, Munroe Hall. The use of liquor and the preparation of meals or cooking of any kind on the premises are prohibited. Violations of these regulations will result in the cancellation of room assignments.

Dining Service. Dining facilities are in the Walker Memorial, headquarters of student activities, adjacent to the dormitories, on a cafeteria basis. No board by the day or week is furnished, and no student is required to use this service. Because of the low cost and the excellent facilities, however, about 3000 meals a day are served. The dining service operates seven days a week. A sandwich and soda bar in Walker Memorial is available seven days a week until 10 p.m., and there are other suitable dining facilities in the vicinity.

Storage. Space is available in the basement for trunks and baggage at the owner's risk. The Institute assumes no liability, and articles must be removed when occupancy is cancelled. No boxes or trunks will be permitted in the rooms.

Mail and Express. Packages and mail should be addressed to Massachusetts Institute of Technology Dormitories, 3 Ames Street, Cambridge 39, Mass.

INQUIRIES

Address correspondence to Mr. Henry K. Dow, Manager of the Dormitories, Massachusetts Institute of Technology

Dormitories, 3 Ames Street, Cambridge 39, Massachusetts. Telephone: Kirkland 5300, or Kirkland 6900 Extension 437.

BARRACKS HOUSING
Building 22

The Massachusetts Institute of Technology has remodelled and equipped a large, three-story war laboratory building directly in the rear of the main educational group as a temporary inexpensive housing unit, designed to accommodate 600 registered male students. The building is well heated and lighted, and has an excellent sprinkler system and several completely enclosed fire exits. The use of this building as a temporary housing unit has been approved by the proper authorities.

Accommodations are of necessity of the "barracks" type in both sleeping and study. The study rooms are, however, partitioned in sections to accommodate two students, and individual desks and desk chairs are provided. The sleeping areas vary in size and accommodate from 6 to 16 men, and are equipped with single beds, mattresses, lockers, and chairs. There will be one large shower room on the first floor and adequate toilet facilities throughout the building.

An area of 800 cubic feet is allotted to each resident in the sleeping areas. There is adequate ventilation, and assignments insofar as possible will be to rooms on the second and third floors.

This temporary barracks unit will be in charge of a manager who will be assisted by experienced porters who will clean the rooms. Facilities for the handling of mail, laundry, and shipping are available.

Because of the scarcity of materials and equipment, each resident assigned to the unit will be required to provide his own sheets, blankets, pillow, pillow-cases, soap and towels, and to make up his bed and otherwise care for the space to which he is assigned. Each student should also provide two padlocks for the clothes lockers which will be provided. Laundry service for bed linen and towels will be available but at the expense of the resident. If at any time in the future the items listed above can be purchased in sufficient quantity for the operation of this unit, under the usual Dormitory procedure, the equipment will be provided and the bed linen and towels laundered without an additional charge.

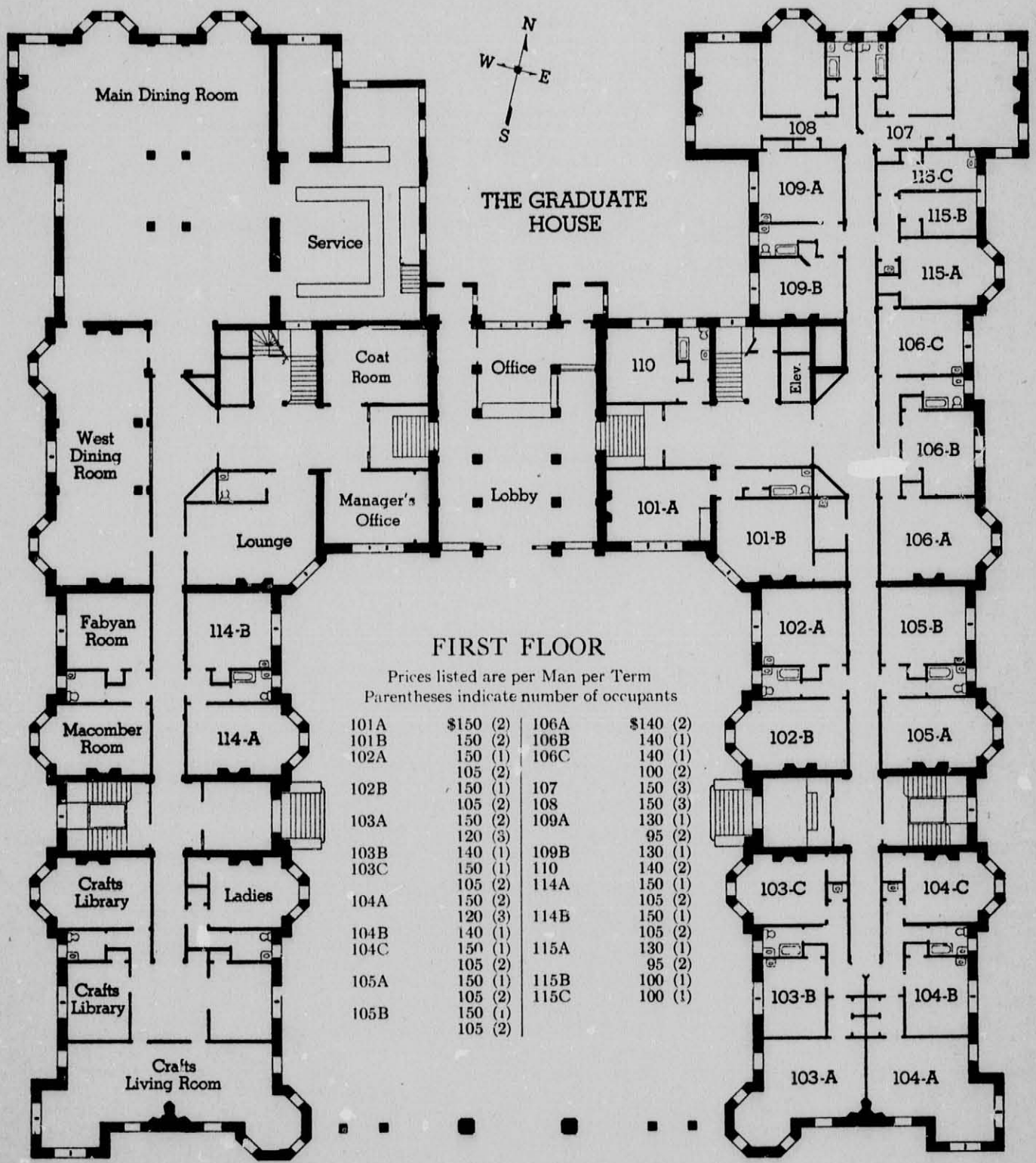
The rental for these accommodations has been established at $60 each occupant, each term (approximately $3.50 each week) $5 of which should accompany the application, the balance of $55 payable in advance on Registration Day. That portion of the section on student housing (Senior and Undergraduate Houses) dealing with government, application and reservation, allotment of rooms, fraternity affiliations, occupancy and regulations is applicable to this housing unit, except that residents may transfer to fraternities, other M. I. T. housing units, or other available outside accommodations without penalty, at any time with a proportionate refund.

In the establishment of this housing unit it has been the aim of the Dormitory Board to provide adequate temporary housing, with such essential conveniences as are necessary, at a rental which is consistent with the allowances under the G. I. Bill of Rights.

Students assigned to this unit are advised to ship personal effects, and so forth, in a trunk or locked box which may be used for storage for belongings and are encouraged to provide such banners and other decorative material as will lend a more collegiate atmosphere to a barracks dormitory. This unit will be operated under a system of student government and the coöperation of all residents in recognizing the rights and privileges of others is required.

Correspondence and express after September 1, 1946, should be addressed to Manager, Barracks Dormitory, Building 22, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

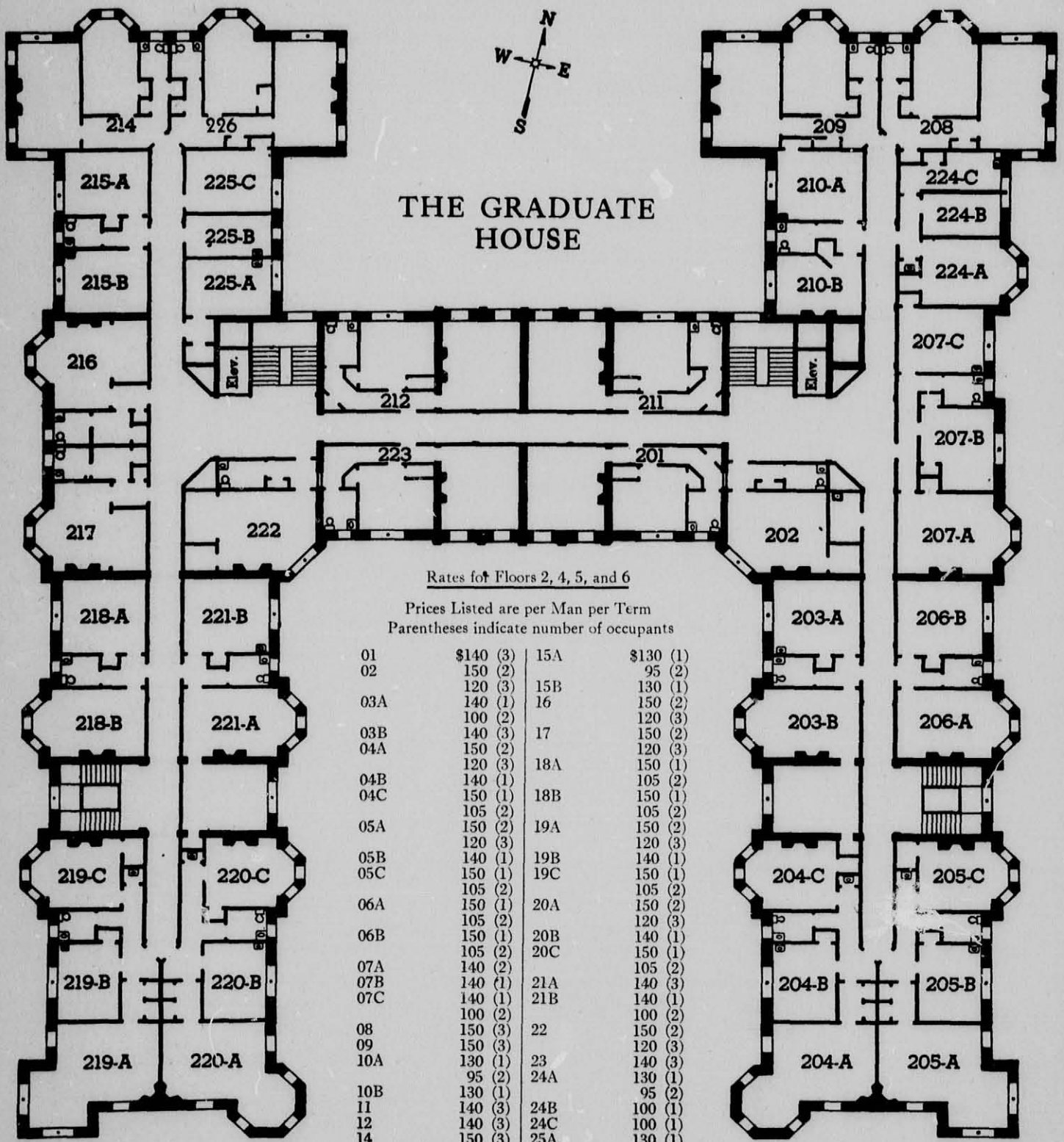
Correspondence mailed prior to September 1 should be addressed to the Manager of the Dormitories, 3 Ames Street, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.



FIRST FLOOR

Prices listed are per Man per Term
Parentheses indicate number of occupants

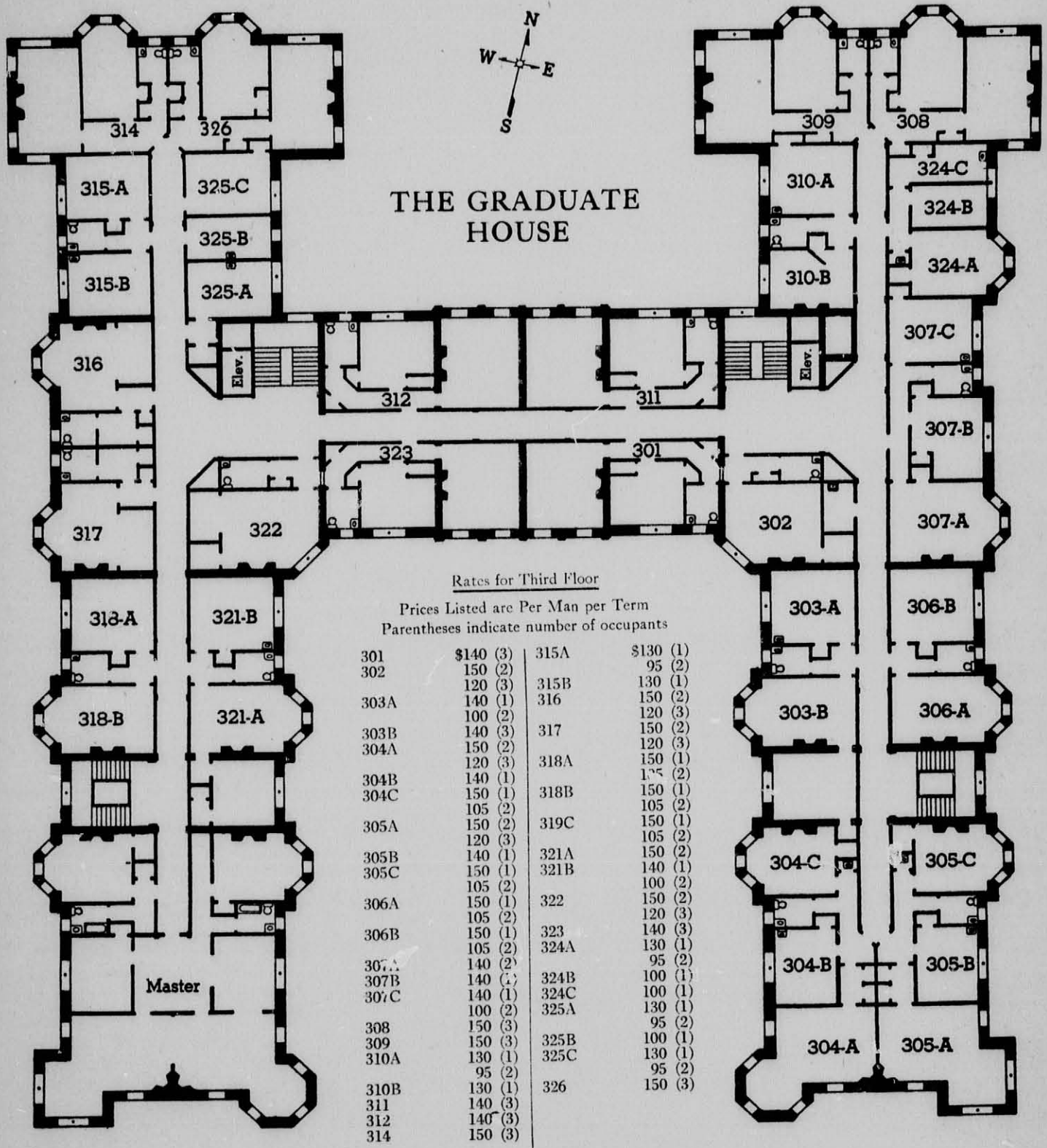
101A	$150	(2)	106A	$140	(2)
101B	150	(2)	106B	140	(1)
102A	150	(1)	106C	140	(1)
	105	(2)		100	(2)
102B	150	(1)	107	150	(3)
	105	(2)	108	150	(3)
103A	150	(2)	109A	130	(1)
	120	(3)		95	(2)
103B	140	(1)	109B	130	(1)
103C	150	(1)	110	140	(2)
	105	(2)	114A	150	(1)
104A	150	(2)		105	(2)
	120	(3)	114B	150	(1)
104B	140	(1)		105	(2)
104C	150	(1)	115A	130	(1)
	105	(2)		95	(2)
105A	150	(1)	115B	100	(1)
	105	(2)	115C	100	(1)
105B	150	(1)			
	105	(2)			



Rates for Floors 2, 4, 5, and 6

Prices Listed are per Man per Term
Parentheses indicate number of occupants

01	$140 (3)	15A	$130 (1)
02	150 (2)		95 (2)
	120 (3)	15B	130 (1)
03A	140 (1)	16	150 (2)
	100 (2)		120 (3)
03B	140 (3)	17	150 (2)
04A	150 (2)		120 (3)
	120 (3)	18A	150 (1)
04B	140 (1)		105 (2)
04C	150 (1)	18B	150 (1)
	105 (2)		105 (2)
05A	150 (2)	19A	150 (2)
	120 (3)		120 (3)
05B	140 (1)	19B	140 (1)
05C	150 (1)	19C	150 (1)
	105 (2)		105 (2)
06A	150 (1)	20A	150 (2)
	105 (2)		120 (3)
06B	150 (1)	20B	140 (1)
	105 (2)	20C	150 (1)
07A	140 (2)		105 (2)
07B	140 (1)	21A	140 (3)
07C	140 (1)	21B	140 (1)
	100 (2)		100 (2)
08	150 (3)	22	150 (2)
09	150 (3)		120 (3)
10A	130 (1)	23	140 (3)
	95 (2)	24A	130 (1)
10B	130 (1)		95 (2)
11	140 (3)	24B	100 (1)
12	140 (3)	24C	100 (1)
14	150 (3)	25A	130 (1)
			95 (2)
		25B	100 (1)
		25C	130 (1)
			95 (2)
		26	150 (3)



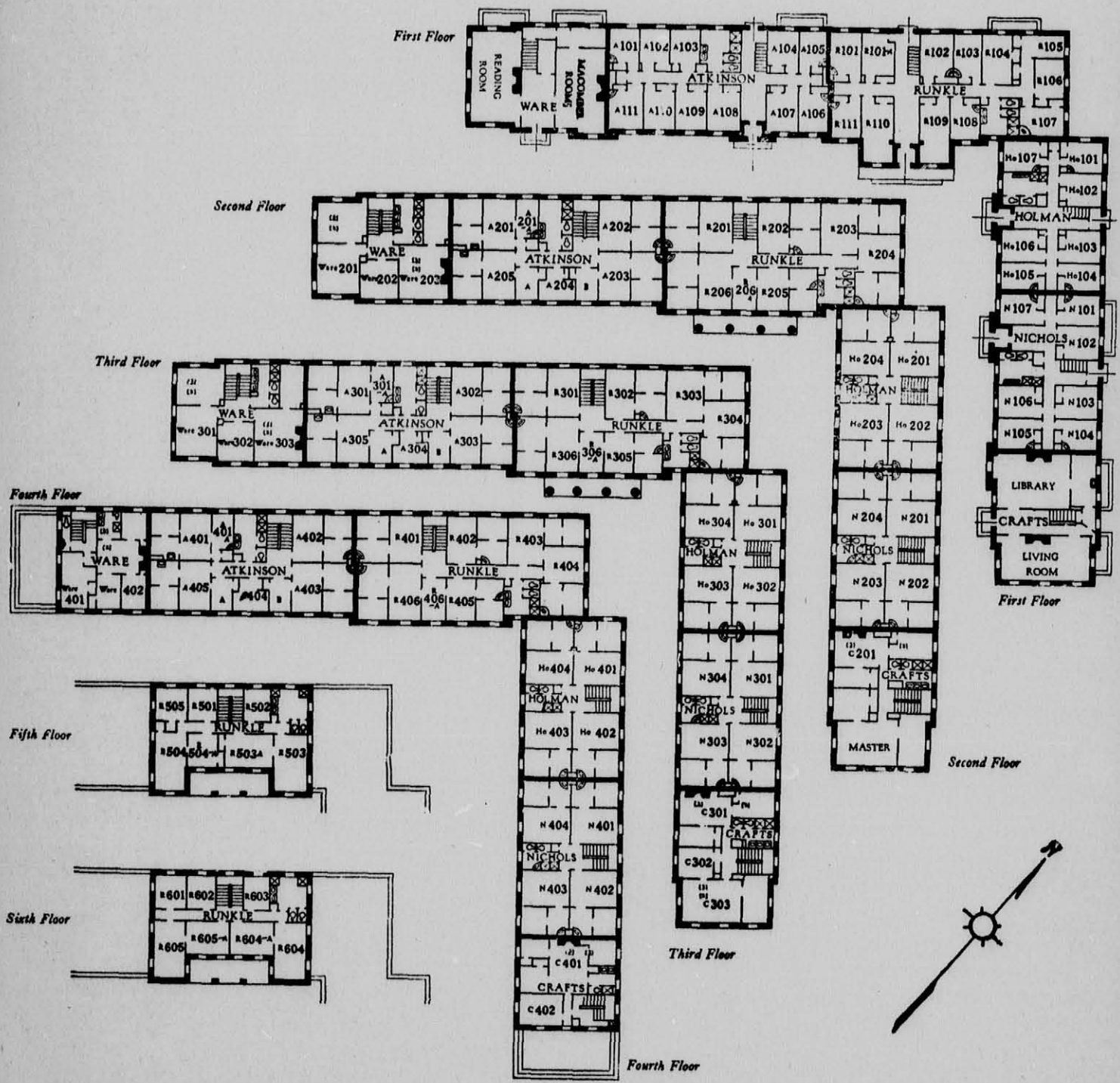
Rates for Third Floor

Prices Listed are Per Man per Term
Parentheses indicate number of occupants

301	$140 (3)	315A	$130 (1)
302	150 (2)		95 (2)
	120 (3)	315B	130 (1)
303A	140 (1)	316	150 (2)
	100 (2)		120 (3)
303B	140 (3)	317	150 (2)
304A	150 (2)		120 (3)
	120 (3)	318A	150 (1)
304B	140 (1)		105 (2)
304C	150 (1)	318B	150 (1)
	105 (2)		105 (2)
305A	150 (2)	319C	150 (1)
	120 (3)		105 (2)
305B	140 (1)	321A	150 (2)
305C	150 (1)	321B	140 (1)
	105 (2)		100 (2)
306A	150 (1)	322	150 (2)
	105 (2)		120 (3)
306B	150 (1)	323	140 (3)
	105 (2)	324A	130 (1)
307A	140 (2)		95 (2)
307B	140 (1)	324B	100 (1)
307C	140 (1)	324C	100 (1)
	100 (2)	325A	130 (1)
308	150 (3)		95 (2)
309	150 (3)	325B	100 (1)
310A	130 (1)	325C	130 (1)
	95 (2)		95 (2)
310B	130 (1)	326	150 (3)
311	140 (3)		
312	140 (3)		
314	150 (3)		

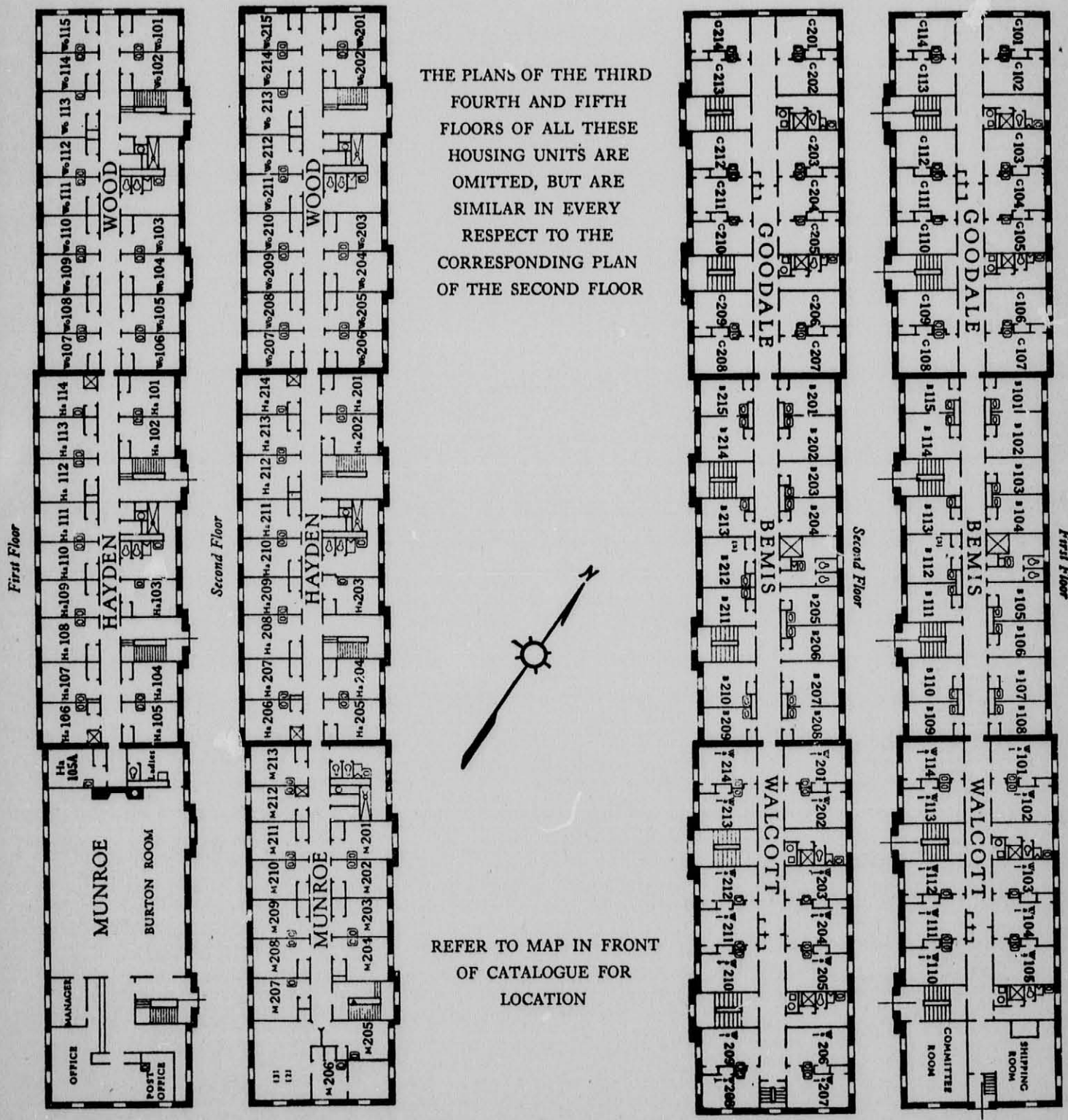
SENIOR HOUSE

WARE ATKINSON RUNKLE
HOLMAN NICHOLS CRAFTS



UNDERGRADUATE HOUSES

MUNROE HAYDEN WOOD GOODALE BEMIS WALCOTT



THE PLANS OF THE THIRD FOURTH AND FIFTH FLOORS OF ALL THESE HOUSING UNITS ARE OMITTED, BUT ARE SIMILAR IN EVERY RESPECT TO THE CORRESPONDING PLAN OF THE SECOND FLOOR

REFER TO MAP IN FRONT OF CATALOGUE FOR LOCATION

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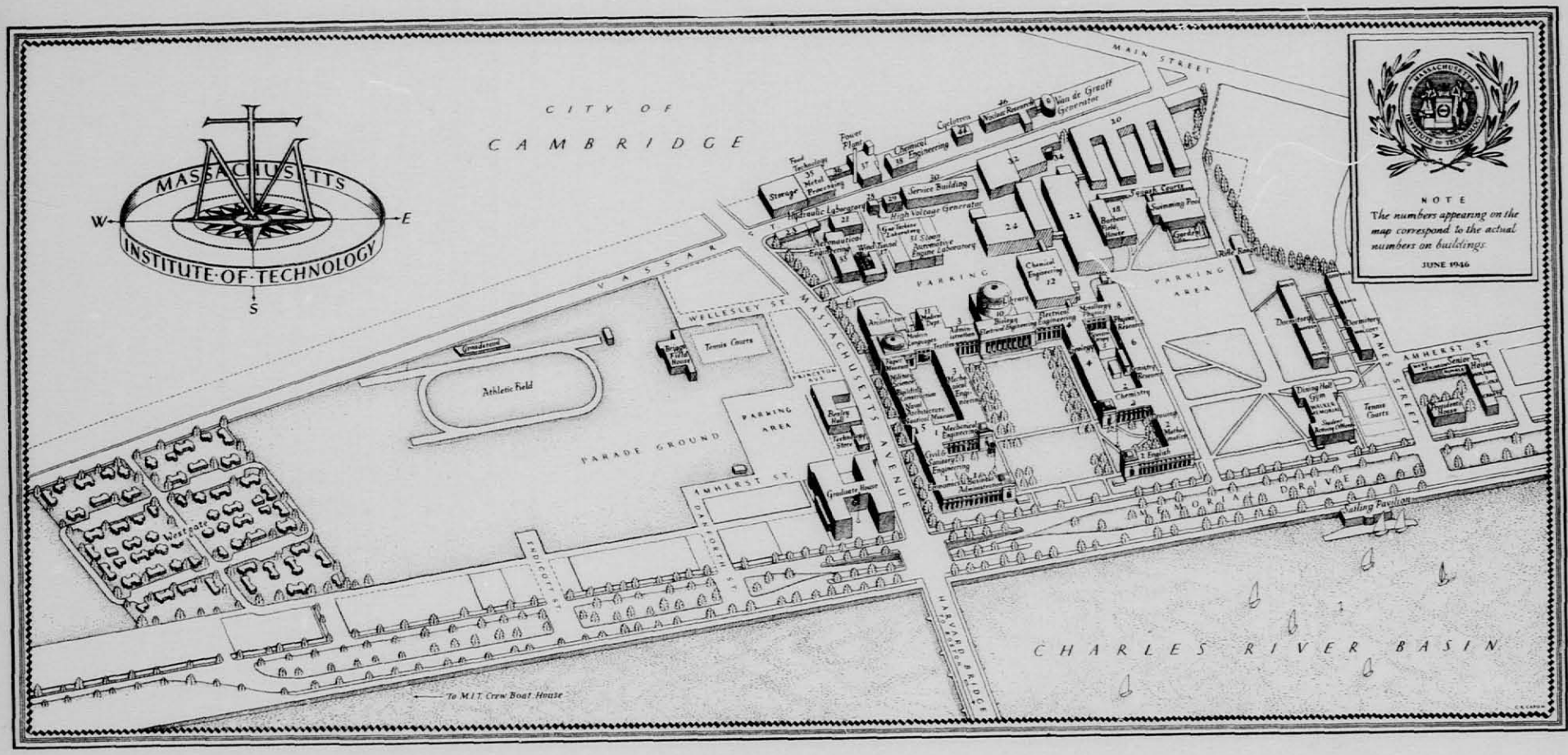
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MASSACHUSETTS
INSTITUTE OF TECHNOLOGY
W
E
S
CITY OF
CAMBRIDGE
MAIN STREET
VASSAR
WELLESLEY ST.
MASSACHUSETTS AVENUE
AMHERST ST.
PARADE GROUND
Athletic Field
Tennis Courts
PARKING AREA
Gymkhana
Bemis Field House
Rowing Hall
Graduate House
Technology Store
Chemical Engineering
Service Building
High Voltage Generator
Cyclotron
Van de Graaff Generator
Power Plant
Food Technology
Metal Processing
Hydraulic Laboratory
Aeronautical Engineering
Wind Tunnel
Gas Turbine Laboratory
Automotive Engineering Laboratory
Architecture
Library
Biology
Electrical Engineering
Physics Research
Chemistry
Mechanical Engineering
Naval Architecture
Marine Transportation
Modern Languages
Economics
Geology
Meteorology
Civil and Sanitary Engineering
Industrial Management
Aeronautical Engineering
Rogers Building
Dormitory
Dormitory Annex
Dining Hall
Gym
Swimming Pool
Squash Courts
Rifle Range
Sloane Physics Laboratory
Senior House
Graduate House
Sailing Pavilion
Memorial Drive
Charles River Basin
Harvard Bridge
Boston
To M.I.T. Crew Boat House
Westgate
NOTE
The numbers appearing on the map correspond to the actual numbers on buildings.
JUNE 1946