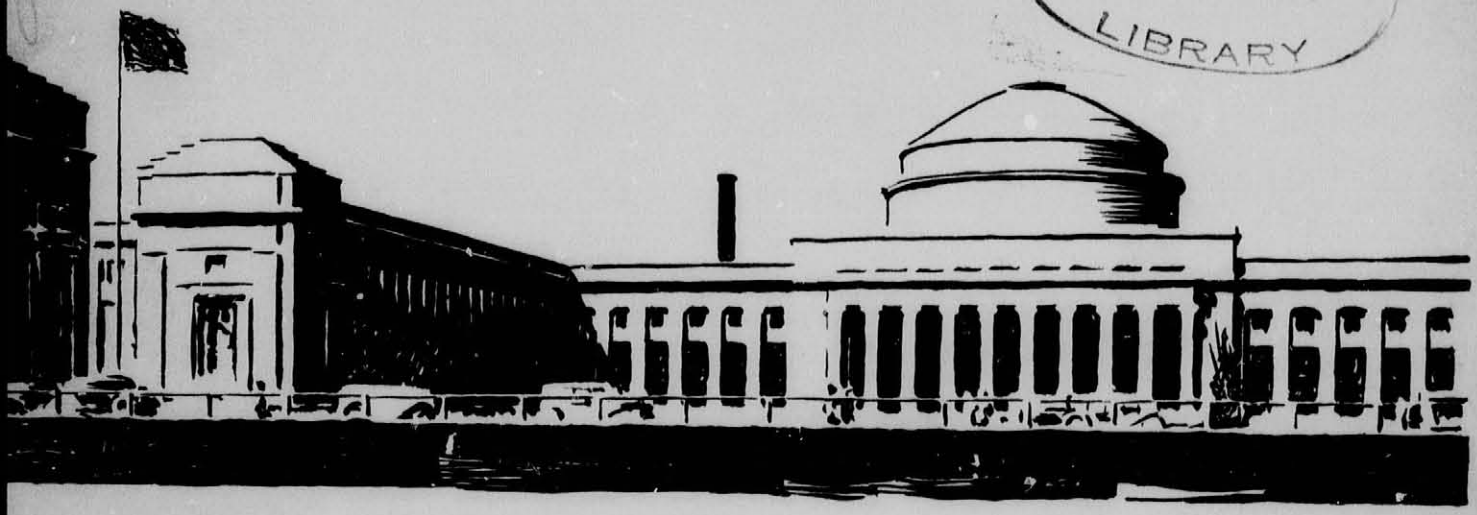
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CATALOGUE ISSUE

JUNE 1940

VOLUME 75 NUMBER 4

PUBLISHED BY THE INSTITUTE

CAMBRIDGE, MASSACHUSETTS

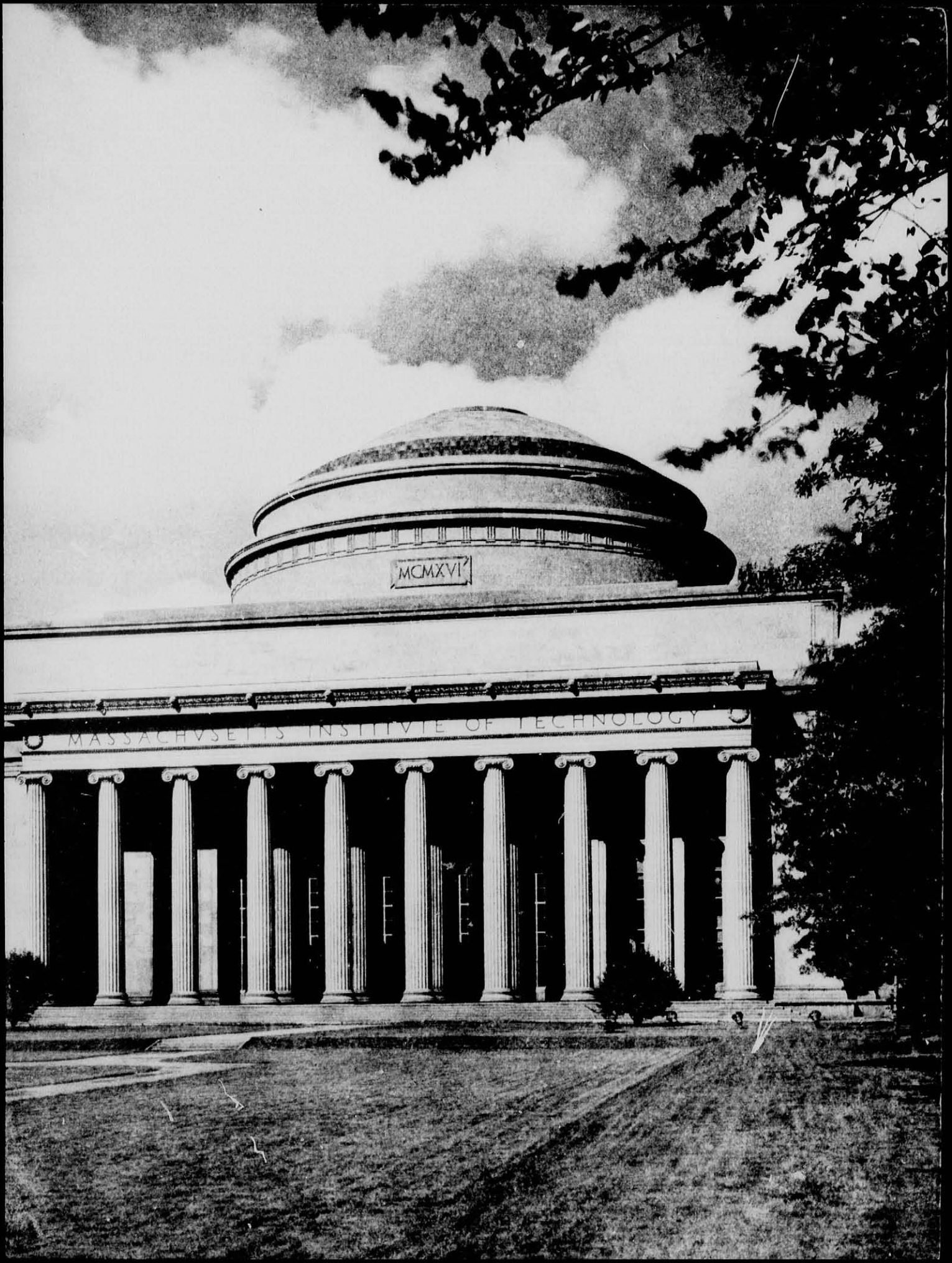
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The Institute reserves the right to make changes in the regulations and courses announced in this bulletin

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CAMBRIDGE, MASS., U. S. A.


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MASSACHVSETTS INSTITVTE OF TECHNOLOGY


MASSACHVSETTS INSTITVTE OF TECHNOLOGY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY BULLETIN

CATALOGUE ISSUE
1940

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

VOLUME 75 NUMBER 4



PUBLISHED BY THE INSTITUTE
CAMBRIDGE

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CALENDAR

FOR ACADEMIC YEAR 1940–1941

1940

Institute Year 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

1941

Last Exercises, First Term	Jan. 25
Examination Period	Jan. 27 through Feb. 8
Second Term Begins	Feb. 10
Washington's Birthday (*Holiday*)	Feb. 22
Spring Recess	April 2 through April 5
Last Exercises, Second Term	May 28
Second Term Examinations Begin	May 29
Memorial Day (*Holiday*)	May 30
Alumni Day	June 9
Commencement Day	June 10
Summer Session 1941 Begins	June 16

(*Except for a few subjects which begin on June 9*)

FOR ACADEMIC YEAR 1941–1942

1941

Institute Year Begins	Sept. 29
Columbus Day (*Holiday*)	Oct. 12
Armistice Day (*Holiday*)	Nov. 11
Thanksgiving Day (*Holiday*)	Nov. 27
Christmas Vacation	Dec. 24 through Jan. 3

1942

Last Exercises, First Term	Jan. 24
Examination Period	Jan. 26 through Feb. 7
Second Term Begins	Feb. 9
Washington's Birthday (*Holiday*)	Feb. 22
Spring Recess	April 18 through April 22
Last Exercises, Second Term	May 27
Second Term Examinations Begin	May 28
Memorial Day (*Holiday*)	May 30
Alumni Day	June 8
Commencement Day	June 9
Summer Session 1942 Begins	June 15

(*Except for a few subjects which begin on June 8*)

1940

JULY							AUGUST							SEPTEMBER						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
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7	8	9	10	11	12	13	4	5	6	7	8	9	10	8	9	10	11	12	13	14
14	15	16	17	18	19	20	11	12	13	14	15	16	17	15	16	17	18	19	20	21
21	22	23	24	25	26	27	18	19	20	21	22	23	24	22	23	24	25	26	27	28
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1941

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							31													

OCTOBER							NOVEMBER							DECEMBER						
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19	20	21	22	23	24	25	16	17	18	19	20	21	22	21	22	23	24	25	26	27
26	27	28	29	30	31		23	24	25	26	27	28	29	28	29	30	31			
							30													

1942

JANUARY							FEBRUARY							MARCH						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
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25	26	27	28	29	30	31								29	30	31				

APRIL							MAY							JUNE						
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5	6	7	8	9	10	11	3	4	5	6	7	8	9	7	8	9	10	11	12	13
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19	20	21	22	23	24	25	17	18	19	20	21	22	23	21	22	23	24	25	26	27
26	27	28	29	30			24	25	26	27	28	29	30	28	29	30				
							31													

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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 and 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 vitality to the Institute throughout its history, 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 and in applied physics 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, and in collaboration with a sister institution it established the first systematic training in public health.

From the rented rooms in which it started with 15 students, the Institute has grown until today it has a student body of 3,100, including 700 graduate students, a staff of over 600, a plant and endowment representing an investment of over $50,000,000, and a living alumni body of 33,000. The original school of industrial science has grown into the four schools of today, the School of Science, the School of Engineering, the School of Architecture, and the Graduate School, which together offer over 900 subjects of instruction.

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 practising 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.

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.

IN recent years there has been a marked trend at the Institute toward greater flexibility in the curriculum, and more individual treatment of students. This results from a developing policy on the part of the Faculty of making it possible for each member of the student body to follow the line of his special interests, with ample opportunity to work closely with members of the Staff, but with no lessening of the emphasis which the Institute has long placed on the fundamental sciences as a basis for advanced science or engineering.

For many years M. I. T. has been notable for the large amount of study of the humanities which is included in its regular curricula. There has also been a wholesome regard for those extra-curricular activities which tend to broaden a man's outlook, and these have had the cordial support of Faculty and Administration.

The number of Courses and options has been increased, until there are over forty regular Courses of Study, arranged to meet the needs of students of diverse interests. Moreover, the authority to make substitutions, which resides in the department heads and the petitions committee, renders it possible to alter any one of these to suit special cases. In addition there is the possibility, in the Courses in General Engineering and General Science, of arranging special schedules for those who are pursuing unusual objectives.

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 increased opportunity to map out his own path with the aid and counsel of the Staff.

Karl T. Compton

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THE CORPORATION 1940–1941

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[1] Address correspondence to Massachusetts Institute of Technology.

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Willis R. Whitney		

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HORACE SAYFORD FORD

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SAMUEL CATE PRESCOTT, Sc.D.
Dean of Science

WALTER ROY MACCORNACK, S.B.
Dean of Architecture

ROBERT GRANVILLE CALDWELL, PH.D., D.LITT.
Dean of Humanities

HARRY MANLEY GOODWIN, PH.D.
Honorary Dean of the Graduate School

JOHN WYMOND MILLER BUNKER, PH.D.
Dean of the Graduate School

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Dean of Students

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Associate Dean of Students

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Executive Assistant to the President

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Director, Division of Industrial Coöperation
Placement Officer

FRANKLIN LEROY FOSTER, Sc.D.
Assistant to Director,
Division of Industrial Coöperation

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Professor Emeritus; former Director of Admissions

BRAINERD ALDEN THRESHER, S.B., A.M.
Director of Admissions

ROBERT MERRIMAN KIMBALL, S.B.
Assistant Director of Admissions

JOSEPH CHRISMAN MACKINNON, S.B.
Registrar

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Assistant to the Registrar

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Librarian

BERTHA PRESTON TRULL, A.B.
Assistant Librarian

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Medical Director

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Director of News Service

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Director, Albert Farwell Bemis Foundation

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Curator, Dard Hunter Paper Museum

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Director of the Lowell Institute School

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Director, Register of Former Students

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Director, Alumni Fund

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General Secretary, T. C. A.

PENNELL NUTTING ABORN, A.B.
Secretary, Student Employment Bureau, T. C. A.

FLORENCE WARD STILES, S.B.
Adviser to Women Students

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Bursar

WOLCOTT ANDERS HOKANSON
Assistant Bursar

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Manager of Division of Laboratory Supplies

ALBERT VALENTINE SMITH
Superintendent of Buildings and Power

JAMES WILLIAM FRASER MACDONALD
Assistant Superintendent of Buildings and Power

CARL MAGNUS FRITHIOF PETERSON, S.M.
Assistant Superintendent of Buildings and Power

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Chairman of Dormitory Board

AVERY ALLEN ASHDOWN, PH.D.
Master of the Graduate House

WILLIAM NASH DAVIS, B.S.
Manager of the Graduate House

WALTER CROMWELL WOOD
Master of the Senior House

FREDERICK GILBERT HARTWELL
Manager of Dormitories and Walker Memorial

ALBERT WILLIAM BRIDGES
Manager of Dining Service

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Dean of Science
Dean of Architecture
Dean of Humanities
Dean of the Graduate School
Dean of Students
Director of the Division of Industrial Coöperation
Chairman of the Faculty
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President of the Alumni Association

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JEROME CLARKE HUNSAKER, Sc.D.

Architecture
WALTER ROY MACCORNACK, S.B.

Biology and Public Health
SAMUEL CATE PRESCOTT, Sc.D.

Building Engineering and Construction
WALTER CHARLES VOSS, S.M.

Business and Engineering Administration
ERWIN HASKELL SCHELL, S.B.

Chemical Engineering
WALTER GORDON WHITMAN, S.M.

Chemistry
FREDERICK GEORGE KEYES, PH.D., Sc.D.

City Planning
FREDERICK JOHNSTONE ADAMS, B.ARCH.

Civil and Sanitary Engineering
CHARLES BLANEY BREED, S.B.

Economics and Social Science
RALPH EVANS FREEMAN, M.A., B.LITT.

Electrical Engineering
HAROLD LOCKE HAZEN, Sc.D.

English and History
HOWARD RUSSELL BARTLETT, B.S., A.M.

General Science, General Engineering
RALPH GORTON HUDSON, S.B.

Geology
WARREN JUDSON MEAD, PH.D.

Hygiene
GEORGE W MORSE, M.D., F.A.C.S.

Marine Transportation
LAWRENCE BOYLSTON CHAPMAN, S.B.

Mathematics
HENRY BAYARD PHILLIPS, PH.D.

Mechanical Engineering
JEROME CLARKE HUNSAKER, Sc.D.

Metallurgy
ROBERT SEATON WILLIAMS, PH.D.

Military Science
CLARENCE T. MARSH, B.S., COLONEL, U.S.A.

Modern Languages
ERNEST FELIX LANGLEY, PH.D.

Naval Architecture and Marine Engineering
HENRY HIRAM WHEATON KEITH, S.B.

Naval Construction
HENRY EASTON ROSSELL, S.M.

Physics
JOHN CLARKE SLATER, PH.D.

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Dean of Engineering
Dean of Science
Dean of Architecture
Dean of Humanities
Dean of the Graduate School
Dean of Students
Chairman of Summer Session Committee
Chairman of Committee on Undergraduate Courses
Director of Division of Industrial Coöperation
Chairman of Faculty
Secretary of Faculty
Registrar
Heads of Departments and Professional Courses

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GEORGE W. SWETT, S.B., *Secretary of the Faculty*
JOSEPH C. MACKINNON, S.B., *Assistant Secretary of the Faculty*

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SAMUEL C. PRESCOTT, *Dean of Science*
WALTER R. MACCORNACK, *Dean of Architecture*
ROBERT G. CALDWELL, *Dean of Humanities*
JOHN W. M. BUNKER, *Dean of the Graduate School*
HAROLD E. LOBDELL, *Dean of Students*
BRAINERD ALDEN THRESHER, *Director of Admissions*
JOSEPH C. MACKINNON, *Registrar*
WILLIAM N. SEAVER, *Librarian*
THOMAS P. PITRÉ, *Associate Dean of Students*





Above. *Walker Memorial, the student union, center of undergraduate activities. It contains dining halls, a library, activity offices, a club room for students who commute, and other social facilities*

Below. *The new addition, now under construction, to the Sloan Laboratory for Aircraft and Automotive Engines*



INSTRUCTING STAFF, 1940-1941

(Arranged by Departments and Courses)

AERONAUTICAL ENGINEERING

(Including Meteorology and the Daniel Guggenheim Aeronautical Laboratory)

Professors

JEROME CLARKE HUNSAKER, Sc.D.
Professor in charge of the Department

RICHARD HARBERT SMITH, PH.D.
Professor of Aeronautical Engineering

CHARLES STARK DRAPER, Sc.D.
Professor of Aeronautical Engineering

OTTO CARL KOPPEN, S.B.
Professor of Aeronautical Engineering

JOSEPH SHIPLEY NEWELL, S.B.
Professor of Aeronautical Structural Engineering

SHATSWELL OBER, S.B.
Associate Professor of Aeronautical Engineering

EDWARD STORY TAYLOR, S.B.
Associate Professor of Automotive Engineering

HEINRICH PETERS, D.ENG. (*Absent*)
Associate Professor of Aeronautical Engineering

JOHN RAYMOND MARKHAM
Associate Professor of Aeronautical Engineering

MANFRED RAUSCHER, Sc.D.
Assistant Professor of Aeronautical Engineering

AUGUSTUS RUDOLPH ROGOWSKI, S.M.
Assistant Professor of Aeronautical Engineering

JOHN DEZENDORF TRIMMER, PH.D.
Assistant Professor of Aeronautical Engineering

Lecturers

FRANK WALKER CALDWELL, S.B.
Aircraft Propellers

EDGAR STALEY GORRELL, S.M.
Air Transportation

ARNOLD MARTIN KUETHE, PH.D.
Aerodynamics

IGOR I. SIKORSKY, M.S.
Flying Boats

THEODORE HENRY TROLLER, DR.ING.
Fluid Machinery

EDWARD PEARSON WARNER, D.Sc.
Air Law and Economics

THEODORE PAUL WRIGHT, D.Sc.
Airplane Design

RICHARD VON MISES, D.TECH., PH.D.
Fluid Mechanics

Instructor

HOMER RAY OLDFIELD, JR., S.M.

Research Associate

JOSEPH BICKNELL, S.M.

Research Assistants

EDWARD PATTERSON BENTLEY, S.B.

HENRY HAROLD HOADLEY, B.S.

LESTER LEES, S.B.

HOLDEN WHITE WITHINGTON, S.B.

Assistants

WENSLEY BARKER, JR., S.B.

JOHN RANDALL DIVER

JAMES WALLACE MCBRIDE, B.Sc.

WILLIAM THOMAS SHULER, S.M.

METEOROLOGY

Professors

SVERRE PETTERSSEN, PH.D.
Professor of Meteorology; in charge

CARL-GUSTAV ARVID ROSSBY, Sc.D. (*Absent*)
Professor of Meteorology

HURD CURTIS WILLETT, PH.D.
Associate Professor of Meteorology

JÖRGEN HOLMBOE, M.Sc.
Assistant Professor of Meteorology

HENRY GARRETT HOUGHTON, JR., S.M.
Assistant Professor of Meteorology

Instructor

DELBAR POULEUR KEILY, S.B.

Research Associates

JEROME NAMIAS

ALAN COGSWELL BEMIS, A.B., S.M.

Research Assistants

ROGER AYLMER ALLEN, M.S.

ROBERT KENNETH BLANCHARD, B.S.

RAYMOND HENRY KRAFT, B.S.

KENNETH EDWARD SMITH, B.S.

MARGARET WHITCOMB, S.B.

INSTRUCTING STAFF

ARCHITECTURE

(Including City Planning and Housing)

Professors

WALTER ROY MACCORNACK, S.B.
Dean of Architecture; Professor of Architecture; in charge of the Department

WILLIAM EMERSON, D.A.
Professor of Architecture, Emeritus

WILLIAM HENRY LAWRENCE, S.B.
Professor of Architectural Engineering, Emeritus

HARRY WENTWORTH GARDNER, S.B.
Professor of Architectural Design

WILLIAM FELTON BROWN
Professor of Freehand Drawing, Emeritus

HENRY LATIMER SEAVER, A.M. *Professor of History*

LAWRENCE BERNHART ANDERSON, M.ARCH.
Associate Professor of Architectural Design

HERBERT LYNES BECKWITH, M.ARCH.
Associate Professor of Architectural Design

JOHN LYON REID, M.A., M.ARCH. (*Absent*)
Associate Professor of Architecture

EDWARD MELVILLE BRIDGE, S.B.
Assistant Professor of Architectural Practice

ERNEST NAPOLEON GELOTTE, S.B.
Assistant Professor of Construction

Lecturers

SAMUEL CHAMBERLAIN
Expressions of Graphic Art

THEODOR CARL MÜLLER, S.B.
Design in Manufactured Products

ELIOT THWING PUTNAM, A.B., *Architectural History*

Instructors

JOHAN SELMER-LARSEN

ROBERT CHARLES DEAN, M.ARCH.

JAMES FORD CLAPP

NIELS HJALMAR LARSEN

Assistants

FLORENCE WARD STILES, S.B., *Librarian; Adviser to Women Students*

MARGARET MALL VIGNOLES, A.B., S.B., *Assistant Librarian*

WILLIAM HOSKINS BROWN, B. ARCH.

CITY PLANNING AND HOUSING

FREDERICK JOHNSTONE ADAMS, B.ARCH.
Associate Professor of City Planning; in charge of the Course

FLAVEL SHURTLEFF, A.B., LL.B.
Associate Professor of Legislation and Administration

JUSTIN RICHARDSON HARTZOG, B.S., M.L.D., *Assistant Professor of City Planning*

Lecturers

RALPF EBERLIN, B.S., C.E.
Site Planning and Construction

FREDERICK P. CLARK, B.ARCH.
City and Regional Planning

SIR RAYMOND UNWIN, LL.D., D.TECH., *City Planning and Housing*

Research Associate

GORDON STEPHENSON, B.ARCH., M.C.P.

Research Assistants

BURNHAM KELLY, A.B., LL.B.

DONALD FRANCIS MONELL, S.B.

BIOLOGY AND PUBLIC HEALTH

Professors

SAMUEL CATE PRESCOTT, SC.D.
Dean of Science; Professor of Industrial Biology; in charge of the Department

ROBERT PAYNE BIGELOW, PH.D.
Professor of Zoölogy and Parasitology, Emeritus

CLAIR ELSMERE TURNER, A.M., DR.P.H., SC.D.
Professor of Biology and Public Health

JOHN WYMOND MILLER BUNKER, PH.D.
Dean of the Graduate School; Professor of Biochemistry and Physiology; in charge of Course VII-A

MURRAY PHILIP HORWOOD, PH.D.
Professor of Bacteriology and Municipal Sanitation

JOSEPH WARREN HORTON, SC.D.
Associate Professor of Biological Engineering

BERNARD EMERSON PROCTOR, PH.D.
Associate Professor of Food Technology

JOHN WEBSTER WILLIAMS, B.S., M.D.
Associate Professor of Public Health Laboratory Methods

CHARLES HENRY BLAKE, PH.D.
Associate Professor of Zoölogy

JOHN ROBERT LOOFBOUROW, PH.D.
Associate Professor of Biophysics

MARSHALL WALKER JENNISON, PH.D.
Assistant Professor of Bacteriology and Sanitary Biology

ROBERT SAMUEL HARRIS, PH.D.
Assistant Professor of Biochemistry of Nutrition

BERNARD SIDNEY GOULD, PH.D.
Assistant Professor of Biochemistry

CECIL GORDON DUNN, PH.D.
Assistant Professor of Industrial Biology

IRWIN WHITING SIZER, PH.D.
Assistant Professor of Physiology

Lecturers

William Frederick Clapp
Marine Economics
Joel Irving Connolly, S.M.
Public Health Engineering
Edmund Newton Harvey, Ph.D.
Electro-Physiology
Charles Francis Horan
Industrial Hygiene
George Truman Palmer, Dr.P.H.
Public Health Administration
Edwin Hemphill Place, M.D.
Communicable Disease Control
Burt Ransom Rickards, S.B.
Public Health Education
Frances Stern, M.A.
Nutrition
Ralph Edwin Tarbett, S.B.
Public Health Engineering
James Alner Tobey, Dr.P.H., LL.D.
Sanitary Law
Robert Spurr Weston, S.B., A.M.
Public Health Engineering
Charles Francis Wilinsky, M.D.
Public Health Administration

Research Associates

Robert Leonard Emerson, A.B., M.D.
Caryl Parker Haskins, Ph.D.
Lloyd Malcolm Mosher, S.B.
Roy Maxfield Whelden, Ph.D.
Gilbert William King, Ph.D.
Ernest Earl Lockhart, S.M.

Research Assistants

Charles Edward Buchwald, M.S.
Richard Durgin Campbell, S.B.
Pauline Clay Christie, A.B., C.P.H.
David Graham Greenlie, S.B.
John Cochran Sluder, S.B.

Teaching Fellows

Richard Henderson, S.B.
Warren Hillbourne Southworth, B.S., M.A.

BUILDING ENGINEERING AND CONSTRUCTION

Professors

Walter Charles Voss, S.M.
Professor of Building Construction; in charge of the Department
Dean Peabody, Jr., S.M.
Associate Professor of Structural Design
Howard Raymond Staley, S.M.
Assistant Professor of Building Construction

Instructor

Albert George Dietz, A.B., S.M.

Research Assistant

Howard Emerson Phillips, B.S.

BUSINESS AND ENGINEERING ADMINISTRATION

Professors

Erwin Haskell Schell, S.B.
Professor of Business Management; in charge of the Department
Charles Huntington Porter, A.B., S.B.
Professor of Accounting
Karl Dickson Fernstrom, S.B.
Professor of Business Management
Wyman Parkhurst Fiske, M.B.A., LL.B., Litt.D.
Professor of Accounting; Director of Sponsored Fellowship Program
Albert Adams Schaefer, A.B., LL.B.
Professor of Law and Government
Ross McDuffee Cunningham, M.B.A., D.C.S.
Assistant Professor of Marketing
Ronald Herbert Robnett, B.S., M.B.A.
Assistant Professor of Accounting
Archibald Williams, S.B.
Assistant Professor of Production Management
Gerald Bruce Tallman, M.B.A., Ph.D.
Assistant Professor of Marketing

Lecturer

Harold Bugbee, S.B. *Advertising*

Assistants

Olive Barnard
Edwin Arthur Boyan, S.B.
Richard Henry Engleman, B.S.
Erling Olof Johan Helland, B.C.E., B.B.A.
Elwood Lawson McGee, B.C.E., B.B.A.
Richard Muther, S.B.
Alfred Iréneé Stuart, B.S., M.B.A.

INSTRUCTING STAFF

CHEMICAL ENGINEERING

(Including the School of Chemical Engineering Practice)

Professors

WALTER GORDON WHITMAN, S.M.
Professor of Chemical Engineering; in charge of the Department; Director of the School of Chemical Engineering Practice

WARREN KENDALL LEWIS, PH.D., D.SC.
Professor of Chemical Engineering

WILLIAM HENRY MCADAMS, S.M.
Professor of Chemical Engineering

CLARK SHOVE ROBINSON, S.M.
Associate Professor of Chemical Engineering

HAROLD CHRISTIAN WEBER, D.SC.
Associate Professor of Chemical Engineering

HOYT CLARKE HOTTEL, B.A., S.M.
Associate Professor of Fuel Engineering; Director, Fuels Research Laboratory

THOMAS KILGORE SHERWOOD, SC.D.
Associate Professor of Chemical Engineering

ERNST ALFRED HAUSER, PH.D.
Associate Professor of Chemical Engineering

EDWIN RICHARD GILLILAND, SC.D.
Associate Professor of Chemical Engineering

CHARLES ELI REED, SC.D.
Assistant Professor of Chemical Engineering

GEORGE ALFRED AKIN, B.S.
Assistant Professor of Chemical Engineering; Director, Buffalo Station, School of Chemical Engineering Practice

ROY POWELL WHITNEY, S.M.
Assistant Professor of Chemical Engineering; Director, Bangor Station, School of Chemical Engineering Practice

HERMAN PAUL MEISSNER, D.SC.
Assistant Professor of Chemical Engineering

Instructors

SCOTT WELLS WALKER, S.M.
JOHN HIRAM LUTZ, B.SC.
CHARLES ANDERSON STOKES, B.S.
GLENN CARBER WILLIAMS, M.S.

Research Associate

BYRON BAKER WOERTZ, SC.D.*

Research Assistants

FRED LEROY CHASE, JR., A.B.
ROBERT BALDWIN EGBERT, B.CH.E.
LOWELL LEE FELLINGER, B.S.
AUSTIN WELLINGTON FISHER, JR., B.S.
ISRAEL RALPH LANDAU, B.S.
HENRY CITO MEINERS, B.S.
CHARLES ERNEST WINTERS, S.M.

Assistants

JOHN WILLIAM BRUMBAUGH, B.S.
JOSEPH FRANCIS COFFEY, S.B.
CARL MAJOR COOPER, B.S.
CHARLES HENRY DAVENPORT, M.A.SC.
RICHARD KNIGHT DIX, S.B.
MARJORIE ETTA ERNST, A.B.
LEWIS DODSON ETHERINGTON, B.S.
FREDERICK WERNER HAMMESFAHR, S.B.
FREDYUM HENRICKSON, JR., S.B.
ROBERT LOUIS HUFFMAN, B.CH.E.
ROBERT WILSON KING, S.B.
WILLIAM ARTHUR KLEMM, S.B.
MATTHEW BRYCE LEGGETT, S.M.
LELAND ROY LYONS, B.S.
GUY THORNTON MCBRIDE, JR., S.B.
FREDERICK CHARLES MOESEL, S.M.
ARTHUR WAYNE PLUMMER, B.S.
EDWARD MACARTHUR REDDING, S.B.
LEONARD WHITE RUSSUM, B.A., B.S.
HARRY MCGOODWIN ZIMMERMAN, S.B.

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Director

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Assistant Director

PARLIN

JOSEPH ARTHUR BERGANTZ, M.S.
Director

DAVID JAMES TORRANS, S.B.
Assistant Director

BUFFALO

GEORGE ALFRED AKIN, B.S.
Director

JOHN FRANKLIN CHAPIN, S.B
Assistant Director

*Solar Energy Conversion Research.

CHEMISTRY

(Including the Research Laboratories of Physical, Organic, and Inorganic Chemistry)

Professors

FREDERICK GEORGE KEYES, PH.D., SC.D.
Professor of Physical Chemistry; in charge of the Department; Director of the Research Laboratory of Physical Chemistry

JAMES FLACK NORRIS, PH.D., SC.D.
Professor of Organic Chemistry

MILES STANDISH SHERRILL, PH.D.
Professor of Physical Chemistry

EARL BOWMAN MILLARD, PH.D.
Professor of Physical Chemistry

ARTHUR ALPHONZO BLANCHARD, PH.D.
Professor of Inorganic Chemistry

LOUIS JOHN GILLESPIE, PH.D.
Professor of Physical Chemistry

WALTER CECIL SCHUMB, PH.D.
Professor of Inorganic Chemistry; Director of the Research Laboratory of Inorganic Chemistry

LEICESTER FORSYTH HAMILTON, S.B.
Professor of Analytical Chemistry; in charge of Undergraduate Instruction

GEORGE SCATCHARD, PH.D.
Professor of Physical Chemistry

JAMES ALEXANDER BEATTIE, PH.D.
Professor of Physical Chemistry

TENNEY LOMBARD DAVIS, PH.D.
Professor of Organic Chemistry

AVERY ADRIAN MORTON, PH.D.
Professor of Organic Chemistry; Director of the Research Laboratory of Organic Chemistry

WILLIS RODNEY WHITNEY, PH.D., SC.D., CH.D.
Non-Resident Professor of Chemical Research

ALPHEUS GRANT WOODMAN, S.B.
Associate Professor of Analytical Chemistry, Emeritus

WILLIAM THOMAS HALL, S.B.
Associate Professor of Analytical Chemistry, Emeritus

ERNEST HAMLIN HUNTRESS, PH.D.
Associate Professor of Organic Chemistry

LOUIS HARRIS, PH.D.
Associate Professor of Physical Chemistry

CLIFFORD BURROUGH PURVES, PH.D.
Associate Professor of Organic Chemistry

AVERY ALLEN ASHDOWN, PH.D.
Associate Professor of Organic Chemistry

STEPHEN GERSHOM SIMPSON, PH.D.
Associate Professor of Analytical Chemistry

RALPH CHILLINGWORTH YOUNG, PH.D.
Associate Professor of Inorganic Chemistry

GERHARD DIETRICHSON, PH.D.
Assistant Professor of Chemistry

ARTHUR RANDALL DAVIS, PH.D.
Assistant Professor of Chemistry

ROBERT CASAD HOCKETT, PH.D.
Assistant Professor of Chemistry

NICHOLAS ATHANASIUS MILAS, PH.D.
Assistant Professor of Chemistry

CHARLES MONTGOMERY WAREHAM, S.B.
Assistant Professor of Chemistry

SAMUEL CORNETTE COLLINS, PH.D.
Assistant Professor of Chemistry

EDMUND LEE GAMBLE, PH.D.
Assistant Professor of Chemistry

GEORGE GLOVER MARVIN, PH.D.
Assistant Professor of Chemistry

ISADORE AMDUR, PH.D.
Assistant Professor of Chemistry

LAWRENCE JOSEPH HEIDT, PH.D.
Assistant Professor of Chemistry

Instructors

THOMAS PALM PITRÉ, B.A.
JOHN LAWRENCE ONCLEY, PH.D.
ALBERTO FREDERIC THOMPSON, JR., PH.D.
THOMAS ROBINSON PIRIE GIBB, JR., S.B.
JOHN WILLARD STOUT, JR., PH.D.
CLARK CONKLING STEPHENSON, PH.D.
WALTER HUGO STOCKMAYER, Ph.D.
WILLIAM MORTON LEADERS, Ph.D.
FRANK KING PITTMAN, B.E., M.S.

Research Associates

BAALIS EDWIN BLAISDELL, PH.D.
MARGARET KINGMAN SEIKEL, PH.D.
CHAUNCEY STARR, PH.D.
EUGEN RABINOWITCH, PH.D.*
CLARENCE ALBERT JOHNSON, PH.D.
RICHARD OLIVER EDGERTON, Ph.D.**

Teaching Fellows

HAROLD ELWOOD ADAMS, M.S.
KENNETH THOMAS BARKEY, M.S.
JOHN WILLIAM BLATTENBERGER, S.B.
ROBERT GEORGE BRECKENRIDGE, M.A.
OLAF ABEL BREDESON, M.A.
ROBERT MOORE BRIDGFORTH, JR., B.S.
ALEXANDER BROWN, M.S.
DAVID GRAY EDWARDS, B.S.
CHARLES FREY GLICK, M.S.
DONALD FRANCIS HOLLOWAY, S.B.
EDWARD RYNEX KANE, B.S.
JAY VICTOR RICHARD KAUFMAN, B.S.
JULIUS KOVITZ, S.B.
JOHN LEONARD OHLSON, S.B.
ROBERT THORWALD OLSEN, M.S.
GEORGE HAROLD PATTERSON, B.S.
LLOYD HOLDEN PERRY, B.A., M.S.
SCHRADE FRED RADTKE, S.B.
HENRY RAPOPORT, S.B.
LESLIE MERRILL REDMAN, A.B.
CONRAD SCHUERCH, JR., S.B.
JAMES HERBERT SCHULMAN, S.B.
ALFRED STOCKFLETH, M.S.
NELSON WHITMAN, B.A.
LAWRENCE BRENTON WOOLAVER, S.B.

* Solar Energy Conversion Research.
** Vitamin Synthesis Research.

CIVIL AND SANITARY ENGINEERING

Professors

CHARLES BLANEY BREED, S.B.
Professor of Railway and Highway Transportation; in charge of the Department; Chairman of the Faculty
CALVIN FRANCIS ALLEN, ENG.D.
Professor of Railroad Engineering, Emeritus
CHARLES MILTON SPOFFORD, S.B.
Hayward Professor of Civil Engineering, Emeritus
ARTHUR GRAHAM ROBBINS, S.B.
Professor of Topographical Engineering, Emeritus
HAROLD KILBRITH BARROWS, S.B.
Professor of Hydraulic Engineering, Emeritus; Honorary Lecturer
GEORGE EDMOND RUSSELL, S.B.
Professor of Hydraulics
JOHN BRAZER BABCOCK, 3D, S.B.
Professor of Railway Engineering
JOHN WARDWELL HOWARD, S.B.
Associate Professor of Topographical Engineering
WALTER MAXWELL FIFE, S.M.
Associate Professor of Civil Engineering
THOMAS RINGGOLD CAMP, S.M.
Associate Professor of Sanitary Engineering
ROY WASHINGTON CARLSON, SC.D.
Associate Professor of Civil Engineering
KENNETH CASS REYNOLDS, SC.D.
Associate Professor of Hydraulics
JOHN BENSON WILBUR, SC.D.
Associate Professor of Civil Engineering
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JOHN DONALD MITSCH, S.B.
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DONALD WOOD TAYLOR, B.S.
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CHARLES HEAD NORRIS, S.M.
PHILIP CHARLES STEIN, SC.D.

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WILLIAM ENKEBOLL, B.S.
FRANK FOSTER HINES, S.B.
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ECONOMICS AND SOCIAL SCIENCE

Professors

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DAVIS RICH DEWEY, PH.D., LL.D.
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FLOYD ELMER ARMSTRONG, A.M.
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Professor of Economics
F. ALEXANDER MAGOUN, S.M.
Associate Professor of Human Relations
BRAINERD ALDEN THRESHER, S.B., A.M.
Associate Professor of Economics; Director of Admissions
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DOUGLASS VINCENT BROWN, PH.D.
Associate Professor of Industrial Relations
CONRAD MAYNADIER ARENSBERG, PH.D.
Assistant Professor of Social Anthropology
DOUGLAS MURRAY MCGREGOR, PH.D.
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HAROLD ADOLPH FREEMAN, S.B.
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CHARLES ANDREW MYERS, PH.D.
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FRANCIS STEPHEN DOODY, A.B.
JONATHAN NESBITT MITCHELL, A.B., M.B.A.
LOUIS CASS YOUNG, S.M.

ELECTRICAL ENGINEERING

Professors

HAROLD LOCKE HAZEN, Sc.D.
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DUGALD CALEB JACKSON, C.E., D.Sc., D.Eng.
Professor of Electric Power Production and Distribution, Emeritus

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Professor of Electrical Machinery

WILLIAM HENRY TIMBIE, A.B.
Professor of Electrical Engineering and Industrial Practice

HERBERT BRISTOL DWIGHT, D.Sc.
Professor of Electrical Machinery

WALDO VINTON LYON, S.B.
Professor of Electrical Machinery

RALPH GORTON HUDSON, S.B.
Professor of Electrical Engineering; in charge of Course IX

RALPH DECKER BENNETT, PH.D.
Professor of Electrical Measurements

EDWARD LINDLEY BOWLES, S.M.
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CARLTON EVERETT TUCKER, S.B.
Professor of Electrical Engineering

CLIFFORD EARL LANSIL, S.B.
Associate Professor of Electrical Engineering

RICHARD DUDLEY FAY, A.B., S.B.
Associate Professor of Electrical Communications

LOUIS FRANK WOODRUFF, S.M.
Associate Professor of Electric Power Transmission

KARL LELAND WILDES, S.M.
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JAYSON CLAIR BALSBAUGH, S.M.
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ERNST ADOLPH GUILLEMIN, PH.D.
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MURRAY FRANK GARDNER, S.M.
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RICHARD HENRY FRAZIER, S.M.
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PARRY MOON, S.M.
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HAROLD EUGENE EDGERTON, Sc.D.
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SAMUEL HAWKS CALDWELL, Sc.D.
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ARTHUR ROBERT VON HIPPEL, PH.D.
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TRUMAN STRETCHER GRAY, Sc.D.
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WILMER LANIER BARROW, Sc.D.
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JOHN GEORGE TRUMP, Sc.D.
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WILLIAM MOTT HALL, Sc.D.
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GORDON STANLEY BROWN, Sc.D.
Assistant Professor of Electrical Engineering

CHARLES KINGSLEY, JR., S.M.
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MALCOLM STRONG MCILROY, E.E.
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Instructors

ARAM BOYAJIAN, A.B., E.E. (*Non-Resident*)
LYMAN MINER DAWES, S.B.
JAMES EDWARD MULLIGAN, S.M.
CHARLES JUSTUS KOCH, S.M. (*Non-Resident*)
CARL NEITZERT, Sc.D.
ARTHUR EUGENE FITZGERALD, Sc.D.
JAMES ALBERT WOOD, JR., PH.D.
ALBERT CARRUTHERS HALL, S.M.
WILLIAM HENRY RADFORD, S.M.
LEWIS PHILIP REITZ, JR., S.B.

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ROBERT JOSEPH MAURER*

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ROBERT WILLIAM CLOUD, S.M.
JACKSON HANCOCK COOK, S.B.
PERRY ORSON CRAWFORD, JR., S.B.
JAMES WILLANS DAVISSON, A.B.
JAY WRIGHT FORRESTER, B.S.
HERBERT EARLE GRIER, S.B.
HERBERT HARRIS, JR., M.E.E.
DEMETRIUS GEORGE JELATIS, S.B.*
MATTHEW TOBRINER LEBENBAUM, B.A.
GORDON MELVIN LEE, M.S.
ROBERT PLUNKETT, S.B.
FRANCIS JOSEPH SAFFORD, S.M.
FRANK MATT VERZUH, S.B.
BARTON LEE WELLER, B.S.
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Assistants

DONALD PIERCE CAMPBELL, B.S.
GODFREY THOMAS COATE, S.M.
THOMAS FRANKLIN JONES, JR., S.M.
WILLIAM LUCAS ROOT, S.B.
BENJAMIN PARKS WATSON, B.S.
J. EDMOND WOLFE, S.M.

* Solar Energy Conversion Research.

INSTRUCTING STAFF

ENGLISH AND HISTORY

Professors

Howard Russell Bartlett, B.S., A.M.
Professor of English and History; in charge of the Department

Archer Tyler Robinson, A.M.
Professor of English; in charge of the Courses in History

Robert Emmons Rogers, Litt.D.
Professor of English

Penfield Roberts, A.M. (*Absent 1st Term*)
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Matthew Richard Copithorne, A.B.
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Theodore Smith, A.M.
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Instructors

Walter Francis Urbach, A.M.
Sterling Lanier, S.B.
James Charles Risk, A.B.

Peter Rutter, A.B.
Lynwood Silvester Bryant, A.M.

Ralph Samuel Bates, Ph.D.
Paul Maynard Chalmers, A.M.
John Bell Rae, Ph.D.

GEOLOGY

Professors

Warren Judson Mead, Ph.D.
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Hervey Woodburn Shimer, Ph.D., Sc.D.
Professor of Paleontology

Frederick Kuhne Morris, Ph.D.
Professor of Geology

Louis Byrne Slichter, Ph.D.
Professor of Geophysics

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Associate Professor of Economic Geology

Martin Julian Buerger, Ph.D.
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Harold Williams Fairbairn, Ph.D.
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Robert Rakes Shrock, Ph.D.
Assistant Professor of Geology

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Patrick Mason Hurley, B.A., B.A.Sc.

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Joseph William Mills, B.A.

Orville Frank Tuttle, M.S.
Leonard Wheelock Weaver, B.S.

HYGIENE

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Dean of Students

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Roger Thomas Doyle, M.D.
Assistant to Medical Director

John Winslow Chamberlain, S.B., M.D.
Assistant to Medical Director

John Webster Williams, B.S., M.D.
Associate Professor of Public Health Laboratory Methods; Pathologist

Henry Patrick McCarthy
Director of Physical Training

MATHEMATICS

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NORBERT WIENER, PH.D.
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MECHANICAL ENGINEERING

(Including Textile Technology)

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ALLYNE LITCHFIELD MERRILL, S.B.
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CHARLES FRANCIS PARK, S.B.
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CARL RICHARD SODERBERG, S.B.
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WILLIAM MACGREGOR MURRAY, SC.D.
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CHARLES ARTHUR BULFINCH
JOHN ANTHONY HRONES, S.M.
HENRY EDWARD KILEY, S.B.
LEOPOLD ROBERT MICHEL, M.S.
BLAKE MILLS, S.M.
RALPH JOHN BOWLEY
BRANDON GARNER RIGHTMIRE, B.M.E., M.A.
DEANE LENT, A.B.
RICHARD UPHAM BRYANT, S.B.
CLARENCE WILLIAM CHRISTIANSEN
CHRISTIAN ERNEST GROSSER, S.B.
ALBRECHT EDWARD REINHARDT, S.B.
LUCIEN ROMAIN VIANEY
EDWARD LANGDON BARTHOLOMEW, JR., S.B.
MATTHIJS GIDEON JAN BOISSEVAIN, S.B.
FREDERICK REUTER EVANS, M.E.
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WILFRID LEO WALSH

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JAMES COOPER LONGWELL, S.B.
RICHARD ELLIOTT MACPHAUL, S.B.
HARRY MAJORS, JR., M.S.
FRANK JOHN MEHRINGER
ERNEST PAUL NEUMANN, S.B.
CARL OLEN WOOD, B.S.
WILLIAM EDWARD WOOD

TEXTILE TECHNOLOGY

EDWARD ROBINSON SCHWARZ, S.B.
Professor of Textile Technology, in charge

Lecturers

VINCENT THOMAS GIARDINO, S.B.
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ERWIN OSWALD KRUEGEL, S.M.
Textile Technology

FRANK JAMES O'NEIL
Textile Research

WALTER MOODY SCOTT, PH.D.
Textile Research

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KENNETH RUSSELL FOX, B.T.E.
HERBERT LEADERMAN, B.A., S.M.

METALLURGY

(Including Mineral Dressing and Ceramics)

Professors

ROBERT SEATON WILLIAMS, PH.D.
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ROBERT HALLOWELL RICHARDS, LL.D.
Professor of Mining Engineering and Metallurgy, Emeritus

WILLIAM SPENCER HUTCHINSON, S.B.
Professor of Mining, Emeritus

GEORGE BOOKER WATERHOUSE, PH.D., D.Met.
Professor of Process Metallurgy

CHARLES E. LOCKE, S.B.
Professor of Mining Engineering and Ore Dressing

MAURICE DEKAY THOMPSON, PH.D.
Professor of Electrochemistry

JOHN CHIPMAN, PH.D.
Professor of Process Metallurgy

CARLE REED HAYWARD, S.B.
Professor of Process Metallurgy

ANTOINE MARC GAUDIN, B.S., E.M.
Richards Professor of Mineral Dressing

VICTOR OLIVER HOMERBERG, Sc.D.
Professor of Physical Metallurgy

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JOHN TORREY NORTON, Sc.D.
Associate Professor of the Physics of Metals

FRANCIS BITTER, PH.D.
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FREDERICK HARWOOD NORTON, S.B.
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JOHN WULFF, D.Sc.
Associate Professor of Physical Metallurgy

ORSON CUTLER SHEPARD, A.B.
Associate Professor of Metallurgy (Visiting)

MORRIS COHEN, Sc.D.
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CARL FREDERICK FLOE, Sc.D.
Assistant Professor of Physical Metallurgy

ALBERT RUDOLPH KAUFMANN, Sc.D.
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REINHARDT SCHUHMANN, JR., Sc.D.
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ANDREW LEIGH JOHNSON, M.Sc.

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MARIA TELKES, PH.D.*

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NICHOLAS JOHN GRANT, S.B.
DONALD LEWIS GUERNSEY, B.S.
JOHN HERBERT HOLLOMON, S.B.
WILLIAM JOHN KNAPP, S.B.
WILLIS GRANT LAWRENCE, B.S.
THEODORE BOGER WINKLER, B.S.

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MICHAEL BERLINER BEVER, D.Iur. M.B.A.
JOSEPH EMMETT CARPENTER, M.S.
FREDERIC HEWLETT CRAVEN, M.S.
STEWART GAILEY FLETCHER, B.S.
MITCHELL HEENEY KLINE, B.S.
MORRIS EMMONS NICHOLSON, S.B.
OTTO ZMESKAL, M.S.

MILITARY SCIENCE AND TACTICS

Professors

CLARENCE T. MARSH, B.S., Colonel, Coast Artillery Corps
Professor of Military Science and Tactics; in charge of the Department

ELROY SANDY JACKSON IRVINE, S.B., Lieutenant Colonel, Corps of Engineers
Associate Professor of Military Science and Tactics; in charge of Engineer Unit; Executive Officer

HAROLD ALBERT NISLEY, S.M., Major, Ordnance Department
Associate Professor of Military Science and Tactics; in charge of Ordnance Unit

HAROLD RUFUS JACKSON, B.S., Major, Coast Artillery Corps
Associate Professor of Military Science and Tactics; in charge of Coast Artillery Unit

ALBERT M. PIGG, B.S., Major, Signal Corps
Associate Professor of Military Science and Tactics; in charge of Signal Corps Unit

ARCHIBALD DONALD FISKEN, A.B., Major, Coast Artillery Corps
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LEONARD M. JOHNSON, A.B., Captain, Chemical Warfare Service
Assistant Professor of Military Science and Tactics; in charge of Chemical Warfare Unit

STANLEY TANNER WRAY, M.S., 1st Lieutenant, Corps of Engineers
Assistant Professor of Military Science and Tactics; with Engineer Unit

Instructors

MARK BRADEN ASHLEY, Technical Sergeant, D.E.M.L., Coast Artillery Corps

HAROLD FRANCIS MCDONNELL, LL.B. Staff Sergeant, D.E.M.L., Corps of Engineers
Assistant Armorer

ALEXANDER HOLMES, Staff Sergeant, D.E.M.L., Coast Artillery Corps
Armorer

SAMUEL LEROY FREY, Staff Sergeant, D.E.M.L., Chemical Warfare Service
Assistant Armorer

GEORGE CALVIN HUNT, Sergeant, D.E.M.L., Signal Corps

ERIC HILMER FRITHIOF SVENSSON, Warrant Officer, U.S.A., Ret.
In charge of Band

WARD BEECHER CARROLL, Sergeant, D.E.M.L., Coast Artillery Corps.
Assistant Armorer

ALFRED HAROLD HALL, Technical Sergeant, Ordnance Department

* Solar Energy Conversion Research.

MODERN LANGUAGES

Professors

ERNEST FELIX LANGLEY, PH.D.
Professor of French; in charge of the Department

HERMAN RUDOLPH KURRELMEYER, PH.D.
Professor of German

FRANCIS MORTON CURRIER, PH.D.
Assistant Professor of German

RICHARD FELIX KOCH, A.M.
Assistant Professor of Modern Languages

Instructor

FRIEDRICH WILHELM GROB, I.U.D. (Berne)

NAVAL ARCHITECTURE AND MARINE ENGINEERING

Professors

HENRY HIRAM WHEATON KEITH, S.B.
Professor of Naval Architecture; in charge of the Department

WILLIAM HOVGAARD, E.ENG.
Professor of Naval Design and Construction, Emeritus

JAMES ROBERTSON JACK
Professor of Naval Architecture and Marine Engineering, Emeritus; Honorary Curator of the Nautical Museum

GEORGE OWEN, S.B.
Professor of Naval Architecture

LAWRENCE BOYLSTON CHAPMAN, S.B.
Professor of Marine Transportation and Marine Engineering; in charge of Course XIII-C

HENRY EASTIN ROSSELL, GRAD. U.S.N.A., S.M. Commander (C.C.) U.S.N. *Retired*
Professor of Naval Construction; in charge of Course XIII-A

FRANK MENDELL LEWIS
Professor of Marine Engineering

CHARLES SHERIDAN JOYCE, CAPTAIN, U.S.N. *Retired*
Professor of Naval Engineering

EVERS BURTNER, S.B.
Associate Professor of Naval Architecture and Marine Engineering

Lecturer

RICHARD MCKEE RUSH, S.M.
LIEUTENANT COMMANDER (C.C.) U.S.N.

Instructors

MILTON KARR, S.B.

EDWARD DAWSON, S.M.

FRANK JEWETT MATHER, III, A.B., S.B.

WALTER WOOD ROBERTSON

PHYSICS

Professors

JOHN CLARKE SLATER, PH.D.
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HARRY MANLEY GOODWIN, PH.D.
Professor of Physics and Electrochemistry, Emeritus

WILLIAM JOHNSON DRISKO, S.B.
Professor of Physics, Emeritus

NEWELL CALDWELL PAGE, S.B.
Professor of Electricity

GEORGE RUSSELL HARRISON, PH.D.
Professor of Physics; Director of Applied Physics; Director of Research Laboratory of Experimental Physics

ARTHUR COBB HARDY, SC.D.
Professor of Optics and Photography

PHILIP MCCORD MORSE, PH.D.
Professor of Physics

MANUEL SANDOVAL VALLARTA, SC.D., PH.D.
Professor of Physics

BERTRAM EUGENE WARREN, SC.D.
Professor of Physics

ROBERT JEMISON VAN DE GRAAFF, PH.D.
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DONALD CHARLES STOCKBARGER, SC.D.
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FRANCIS WESTON SEARS, S.M.
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EDWARD STONESTREET LAMAR, PH.D.
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WALTER EDWARD ALBERTSON, PH.D.
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GEORGE GRAHAM HARVEY, PH.D.
Assistant Professor of Physics

CHESTER MURRAY VAN ATTA, PH.D.
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SEIBERT QUIMBY DUNTLEY, SC.D.

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ARTHUR FREDERIC KIP, PH.D.
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JOHN RUDOLPH PELLAM, S.B.
ALEXANDER ANSELMUS PETRAUSKAS, M.S.
ROSS DONALD FRANKLIN THOMPSON, B.S.
ZIGMOND WALTER WILCHINSKY, M.S.

Assistants

ROBERT MATTESON BLUNT
WILLIAM JOSIAH GLASSON, B.A., S.B.
JAMES PHILIP HOCKER, M.S.
JOHN EDWARD MEADE, S.B.

DIVISION OF HUMANITIES

ROBERT GRANVILLE CALDWELL, PH.D., D.Litt. — *Dean of Humanities; in charge of the Division*

The Division of Humanities includes the Departments of ENGLISH AND HISTORY, ECONOMICS AND SOCIAL SCIENCE, and MODERN LANGUAGES, and the SECTION OF GENERAL STUDIES.

General Study subjects are given by members of the staffs of various Departments.

Chairman of the Committee on the Technology Museum
ARTHUR CHASE WATSON, A.B.

Curator of the Dard Hunter Paper Museum
DARD HUNTER, Litt.D.

DIVISION OF INDUSTRIAL COÖPERATION

NATHANIEL MCLEAN SAGE
Director; Placement Officer

ROBERT COLLINS EDDY, Grad. U.S.M.A.
Associate Professor. On special assignment

FRANKLIN LEROY FOSTER, SC.D.
Assistant to the Director

JOHN NEILON HIGGINS, S.B., A.M.
Assistant to the Placement Officer

Research Associate

DÉSIRÉE SIDONIE LE BEAU, PH.D.

Research Assistants

FREDERICK EDWARD BARSTOW, S.M.
JAMES ELI FORBES, S.M.
ERNEST RALPH KASWELL, S.B.
HORACE NEWTON LEE, B.S., A.M.
JOSEPH STEVENS LUKESH, S.M.
VICTOR GEORGE MOORADIAN, SC.D.
LELIA JUSTINE WINN, B.S.
GEORGE BACON WOOD, JR., S.B.

SECTION OF GRAPHICS

Professors

JOHN THOMAS RULE, S.B.
Associate Professor of Drawing and Descriptive Geometry; in charge of the Section

ERVIN KENISON, S.B.
Associate Professor of Drawing and Descriptive Geometry, Emeritus

ARTHUR LINDSAY GOODRICH, S.B.
Associate Professor of Drawing and Descriptive Geometry

STEPHEN ALEC BREED, S.B.
Associate Professor of Drawing and Descriptive Geometry, Emeritus

EARL FRANCIS WATTS, S.B.
Assistant Professor of Drawing and Descriptive Geometry

CHARLES HILL ROE MABIE
Assistant Professor of Drawing and Descriptive Geometry

Instructors

ROY GIBSON BURNHAM, S.B.
WALTER CARL EBERHARD, S.B.
CHARLES MATTHEW CURL, S.B.
DOUGLAS PAYNE ADAMS, S.B., A.M.
GERALD PUTNAM, S.B.

INSTRUCTING STAFF

ALBERT FARWELL BEMIS FOUNDATION

PROFESSOR JOHN ELY BURCHARD, S.M., *Director*

Research Assistants

WILLIAM EGLER HAIBLE, B.S., B.ARCH. MARGARET CLARK HOPKINS BENJAMIN LEONARD KRAUSE, B.ARCH.

STAFF OF THE INSTITUTE LIBRARY

WILLIAM NATHANAEL SEAVER, A.B.
BERTHA PRESTON TRULL, A.B.
RUTH MCGLASHAN LANE, ED.M.
MIRIAN SPRAGUE SMITH, B.S.
MARGUERITE CHAMBERLAIN, A.B., B.S.

GUESTS OF THE INSTITUTE

HARLAN TRUE STETSON, PH.D.

RESEARCH FELLOWS

BIOLOGY AND PUBLIC HEALTH

GEORGE WILLIAM SCOTT, JR., PH.D., *Haskins Laboratory Fellow*

CHEMISTRY

MARYALICE CONLEY, S.B., *Ellen Richards Fellow*
ROBERT BYRON JACOBS, PH.D. *Lalor Fellow*
HARRY PEARLMAN, PH.D.
Arthur D. Little Post-Doctorate Fellow

ELECTRICAL ENGINEERING

WILLIAM WEBSTER HANSEN, PH.D., *Sperry Gyroscope Company Special Research Fellow*

GEOLOGY

JOHN NATHANIEL ADKINS, PH.D., *National Research Fellow*

PHYSICS

ODON HECTOR GODART, SC.D.
Fellow of the Belgian-American Educational Foundation
HENRY HEMMENDINGER, PH.D.
Bausch and Lomb Research Fellow
ROCKWELL KENT, III, S.B.

FACULTY COMMITTEES

GRADUATE SCHOOL

DEAN OF THE GRADUATE SCHOOL (*Chairman*)*
DIRECTOR OF ADMISSIONS (*Secretary*)*
L. B. CHAPMAN
W. M. FIFE
W. P. FISKE
R. E. FREEMAN
C. E. FULLER
M. F. GARDNER
E. H. HUNTRESS
W. R. MACCORNACK
B. E. PROCTOR
H. B. PHILLIPS
T. K. SHERWOOD
H. W. SHIMER
J. C. SLATER
R. H. SMITH
R. S. WILLIAMS

* Ex officio

COURSE IX

	(*Term Expires*)
R. G. HUDSON (*Chairman*)*	
C. L. SVENSON	1941
D. C. STOCKBARGER	1942
R. M. CUNNINGHAM	1943
N. A. MILAS	1944

UNDERGRADUATE COURSES

	(*Term Expires*)
E. B. MILLARD (*Chairman*)	1942
J. C. BOYCE	1941
J. T. NORTON	1941
R. H. ROBNETT	1942
J. C. BALSBAUGH	1943
E. N. GELOTTE	1943
P. E. KYLE	1944
W. C. VOSS	1944

PETITIONS

	(*Term Expires*)
Assistant Secretary (*Chairman*)*	
Secretary*	
Dean of Students*	
B. E. Proctor	1941
E. L. Gamble	1942
J. Wulff	1943
D. Peabody, Jr.	1944

ADMISSIONS

	(*Term Expires*)
Director of Admissions (*Chairman*)*	
Dean of Students*	
Registrar*	
J. W. Horton	1941
S. G. Simpson	1941
W. M. Hall	1942
G. P. Wadsworth	1942
E. F. Langley	1943
A. W. Adkins	1943

GENERAL STUDIES

	(*Term Expires*)
Dean of Humanities (*Chairman*)	
H. R. Bartlett	1941
H. L. Beckwith	1942
G. Scatchard	1943
P. M. Morse	1944
F. M. Currier	1945

PROVISIONAL STUDENTS AND DISCIPLINE

Dean of Students (*Chairman*)*
Registrar*

G. B. Wilkes	1941
J. W. Howard	1942
A. A. Schaefer	1943

NOMINATING COMMITTEE 1940–1941

H. W. Shimer (*Chairman*)
J. C. Riley
H. B. Dwight
C. E. Turner
H. L. Seaver

COMMITTEE ON THE LIBRARY

	(*Term Expires*)
Executive Board	
Librarian (*Secretary*)*	
W. P. Allis	1941
W. L. Barrow	1944
E. H. Huntress	1943
M. W. Jennison	1941
J. M. Lessells	1942
P. Roberts	1943

UNDERGRADUATE SCHOLARSHIPS

	(*Term Expires*)
Dean of Students (*Chairman*)*	
T. S. Gray	1941
W. C. Voss	1941
A. R. Davis	1942
J. T. Rule	1942
R. M. Cunningham	1943
H. E. Rossell	1943
P. C. Eaton	1944
A. Sloane	1944
H. L. Beckwith	1945
F. W. Sears	1945

COMMITTEES ON JOINT PROJECTS

ACOUSTICS

R. D. Fay (*Chairman*)
P. M. Morse

H. B. Phillips
E. Buckingham
M. P. Horwood
E. S. Taylor
E. N. Gelotte

HEAT TRANSFER

W. H. McAdams (*Chairman*)
H. C. Hottel
J. H. Keenan
C. F. Taylor
G. B. Wilkes

W. C. Voss
P. Franklin
E. Burtner
E. R. Schwarz
T. K. Sherwood

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J. Holt
H. C. Hottel
R. D. Bennett
C. S. Draper
M. P. Horwood
W. H. Jones
H. Peters (*Absent*)
C. G. A. Rossby (*Absent*)
E. R. Schwarz
T. K. Sherwood
M. W. Jennison

HOUSING

F. J. Adams (*Chairman*)
H. L. Beckwith
M. P. Horwood
W. C. Voss
D. S. Tucker
J. E. Burchard
D. L. Palmer

EXPLOSION HAZARDS IN ANAESTHESIA

J. W. Horton (*Chairman*)
F. G. Keyes
H. C. Hottel
R. D. Bennett
J. Holt
P. D. Woodbridge, M.D.

SOLAR ENERGY CONVERSION

H. C. Hottel (*Chairman*)
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G. W. Swett
E. H. Huntress
A. R. von Hippel

L. Harris
G. R. Harrison
G. Scatchard
T. K. Sherwood
G. B. Wilkes

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W. K. Lewis (*Chairman*)
R. S. Williams
J. Wulff

E. B. Millard
L. B. Chapman
J. S. Newell
M. deK. Thompson
C. M. Wareham

* Ex officio

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CONDUCT OF EXAMINATIONS

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J. D. Mitsch
C. H. R. Mabie
S. G. Simpson
A. Sloane
G. P. Wadsworth
L. M. Dawes
A. T. Gifford

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B. A. Thresher
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R. H. Frazier

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Dard Hunter
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F. K. Morris
F. W. Sears
E. R. Schwarz

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R. S. Williams
K. C. Reynolds
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R. D. Douglass
J. H. Keenan
K. C Reynolds
T. P. Pitre

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E. R. Gilliland
A. F. Holmes
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J. C. MacKinnon
B. E. Warren

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E. L. Moreland (*Chairman*)
A. C. Hardy
F. G. Keyes
E. L. Bowles

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L. F. Hamilton (*Chairman*)
H. E. Lobdell
D. L. Rhind
A. A. Ashdown
W. C. Wood

LOAN BOARD

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

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G. R. Harrison
E. H. Huntress
E. L. Bowles
F. G. Fassett, Jr.
R. T. Jope
H. L. Seaver

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H. E. Worcester
D. L. Rhind
H. E. Lobdell
R. T. Jope

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J. A. Stratton
D. J. Struik
M. S. McIlroy
K. D. Fernstrom
W. M. Fife
D. S. Tucker

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S. C. Prescott
E. L. Moreland
R. G. Caldwell
H. E. Lobdell
W. J. Mead
H. S. Ford
J. R. Killian, Jr.

ADVISORY COMMITTEE ON FINE ARTS AND MEMORIALS

S. C. Prescott (*Chairman*)
H. W. Gardner
C. R. Hayward
A. C. Watson
H. B. Richmond

ADVISORY COMMITTEE ON THE BEMIS FOUNDATION

Alan C. Bemis
W. R. MacCornack
E. L. Moreland
M. L. Colean
A. J. Eken
O. M. W. Sprague
R. E. Zimmerman

ADVISORY COMMITTEE ON THE DIVISION OF INDUSTRIAL COÖPERATION

N. McL. Sage (*Chairman*)
R. D. Bennett
A. V. deForest
G. R. Harrison
W. K. Lewis
E. B. Millard
R. S. Williams
F. L. Foster (*Secretary*)

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 educational buildings and laboratories, infirmary, Walker Memorial (the student union), student houses, and athletic plant, including gymnasia, playing fields, field houses, sailing pavilion, and boat house. The new William Barton Rogers Building is the latest addition to the educational group of buildings, while the Frank Harrison Briggs Field House and the Alumni Swimming Pool have recently been added to the athletic group.

To supplement its educational facilities in Cambridge, the Institute maintains a well-equipped summer engineering camp in Maine; and practice schools and training outposts in large industrial plants in several eastern cities.

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 By-Laws consists "of its Chairman, President, Vice-President, and Treasurer and, if eligible, the President of the Alumni Association *ex officio*, of the *ex officiis* members as provided in the 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 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, Executive Committee, and other committees on Membership, Finance, 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 By-Laws 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. . . . In the absence of the President, the Vice-President shall have all the powers and shall perform all the duties and functions of the President."

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 Executive Assistant to the 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, 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 and Vice-President, the Deans, Director of Admissions, Registrar, Librarian, and the Associate Dean of Students. 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 students of the four undergraduate years.

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 their submission for action at the general Faculty meetings. Its members are: the

President, Vice-President, the Deans, the Chairman and Secretary of the Faculty, the Chairman of the Summer Session Committee, the Registrar, and the Heads of the Departments and Professional Courses.

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, the School of Science, the School of Engineering, the Division of Humanities, and the Division of Industrial Coöperation.

In the Schools of Architecture, Engineering, and Science are grouped those departments of study which lead to degrees and which embody the primary educational objectives 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 whose activities are devoted wholly or in part to the assistance of industry in solving its problems or developing 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 of Architecture in City Planning (B.Arch. in C.P.); the latter, to the degrees of Master of Science (S.M.), Master in Public Health (M.P.H.), Master in Architecture (M.Arch.), Master in City Planning (M.C.P.), Doctor of Philosophy (Ph.D.), Doctor of Science (Sc.D.) or Doctor of Public Health (Dr.P.H.). It also affords to advanced students and to experienced investigators opportunities for the pursuit of original scientific investigations.

COÖPERATIVE ARRANGEMENTS 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. (One year with summer work may be sufficient in Chemical Engineering in favorable cases.) 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 best 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 coöperative 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 (with an intermediate summer term in some cases) 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 coöperative 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: Bowdoin College, Miami University, Middlebury College, Ohio Wesleyan University, Reed College, Ripon College, St. Lawrence University, Washington and Jefferson College, College of William and Mary, Williams College, and the College of Wooster.

GENERAL REGULATIONS

Academic Year. Exercises of the Institute begin on the last Monday in September and end early in June (see calendar, page 2). The exercises are omitted on the following Massachusetts legal holidays: January 1, February 22, 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 no exercises on Saturday after 1 P.M. Students who withdraw during the term should give advance notification to the Dean of Students and 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 the first term must be made up during the second term on Saturday afternoons beginning in March; those received at the end of the second term must be made up the following September. 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 September and March 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 Department of Hygiene is organized to protect the health of the students. The work is done in the Homberg Memorial Infirmary under the supervision of the Medical Director, Dr. George W Morse. A staff of four doctors conducts clinics daily, except Sunday.

A graduate nurse is on duty from 8.30 A.M. to 5 P.M., and a doctor is present from 8.30–10 A.M., 10.30 A.M.–12 M.; 12 M.–1.30 P.M.; 3.30–5 P.M. (excepting Saturday). Any student may receive medical or surgical treatment in this clinic without charge.

In addition to the clinic, the Homberg Memorial Infirmary has a hospital equipped to care for thirty-six bed patients. There are two finely appointed, attractive wards, five private rooms, and a large solarium. There is a well-equipped kitchen, and excellent food is provided. The hospital is open twenty-four hours daily throughout the year with a staff of graduate nurses and a visiting physician. Students are received at any time of the day or night.

The charges are most reasonable: food, nursing, and medical care in the wards costing one dollar a day, while the same service in a private room is furnished at two dollars a day.

Every male undergraduate student is required to report to the Medical Director for a complete physical examination during the first term of each academic year, and every male graduate student is required to report for such examination during his first term of residence as a graduate student.

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 and 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, 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

Tuition Fees. For all students pursuing regular courses, undergraduate or graduate, the tuition fee of $600 per academic year must be paid *in advance* as follows: $300 before the opening of each academic term, the date and hour to be specified in the Registration Instructions issued prior to the opening of the particular 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.

Tuition fees for required Summer Session subjects will be found in the Summer Session Bulletin.

For convenience, the tuition fees for students taking coöperative work in II-A or VI-A after the second year are $200 for the summer term and $200 for each of the two regular academic terms. If the student does not register or attend in the summer term, the regular tuition fee of $300 per academic term is required.

Sons of regular Army, Navy, Marine Corps and Coast Guard Officers who are admitted as undergraduate students to the Institute, will pay one-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. Holders of these scholarships, if recommended by the Committee, may continue at the half tuition rate during their second and succeeding undergraduate years.

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, 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 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 chemicals and laboratory supplies will be charged.

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

If the total of chemicals and supplies exceeds the amount of this deposit, an additional amount sufficient to cover this excess must be paid. Unused balance of deposits *will be returned at the end of the year upon application*, or held for credit the following year.

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

Graduate and Undergraduate Dues. From the tuition fee of each student registered, the Institute will appropriate the sum of $3.50 per term ($7 per year) 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 entertain-

* Although the tuition fee paid by students is fixed at $600 per year, the average annual expenditure by the Institute for items directly involved in its educational program amounts to $780 per undergraduate student and $1,070 per postgraduate student. If interest on the investment in the permanent plant is included, these costs total $920 and $1,260 respectively. The difference between these amounts and the $600 tuition fee represents the annual contribution to each student's education made by past and present benefactors of the Institute.

ment that is not open without charge to every qualified member of the student body in good standing.

These dues 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, dues will be apportioned as follows:

Institute Committee	$0.50
Class Dues	.44
Athletics	5.80
Reserve and Contingent Fund	.26

In addition to the amount made available through these dues, the Institute yearly appropriates from its operating budget about $75,000 to cover athletic coaching salaries and the maintenance and operation of Walker Memorial, Athletic Fields, the Boat House, Sailing Pavilion, launches, and Swimming Pool.

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

Estimated Expenses. For the school year 1940–1941, a period of 38 weeks, an estimate of expenses exclusive of personal expenditures such as transportation, clothing, recreation, etc., is given below:

FOR A PERIOD OF 38 WEEKS

Tuition	$600
Board	300
Room	205
Books and materials	70
	$1,175

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 2,140 men have borrowed more than $1,480,000 from the Technology Loan Fund; that, during 1940–41, approximately $90,000 and $100,000 will be available for undergraduate and graduate scholarship aid respectively.

For regulations and full information on Student Aid of all types consult Appendix A ("Student Aid") of this Catalogue.

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 are brought together in a group of conjoined buildings containing approximately one million square feet of floor space.

This unity and coördination of structure permits flexibility in the allotment of space to the departments and promotes 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 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 Spectroscopy Laboratory, the Guggenheim Aeronautical Laboratory, the Wright Brothers Memorial Wind Tunnel, the Pierce Engineering Laboratories, the Sloan Automotive Engine Laboratory, and the Laboratories of Steam and Compressed Air, Refrigeration, Testing Materials, Hydraulics, Gas Engines, Metallurgy, Chemical Engineering, Physical Chemistry, Applied Physics, Electrical Engineering, Biology, 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 well-organized branches, containing all together approximately 370,000 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, public health, and mechanical and electrical engineering. Especially notable is the Vail Collection in electrical engineering, described at length on page 105. The literature of the humanities, such as history, biography, travel, essays, poetry, drama, is not neglected.

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. During the summer it will be open from 8.45 A.M. to 8 P.M.; closed Saturdays and Sundays. Individual reference service, bibliographical aid, and assistance in the use of the card catalogue are given at the two reference desks in the Central Library and in the larger 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 Library does not own can often be obtained from other libraries on interlibrary loan, 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. A certificate, obtainable at the main circulation desk, enables students to obtain borrowing privileges at the Boston Public Library.

The following branch libraries, located near the departments which they serve, supplement the work of the Central Library: Aeronautics, Arthur Rotch (architecture, housing, and city planning), Dewey (civil and mechanical engineering, 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-mentioned being a "browsing library" for recreational reading. The material in all these libraries is listed in the Central Library catalogue, and telephone interconnection affords a well-integrated service.

Museums. A museum of science, engineering and industry has been growing during the past few years 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 hand-made paper and paper-making equipment in the world; and the Nautical Museum, containing a magnificent collection of ship models and prints, and the loan exhibit of the Henry P. Kendall whaling collection.

Summer Surveying Camp. 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 outdoor 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 and geodetic surveying as well as opportunities for hydrographic field work and the study of limnology.

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, a seismograph station, a limnological laboratory, extra space for drafting or classroom usage, 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.

STUDENT HOUSING

Complete information on the Student Houses, both Graduate and Undergraduate, including floor plans, and details regarding application, allotment of rooms, equipment, rentals, payments, occupancy, government and so forth, is presented in Appendix C (Student Housing) of this Bulletin. Reprints will be supplied on request. For further information regarding the Undergraduate Houses, address D. L. Rhind, Bursar. Inquiries and applications for the Graduate House should be addressed to Manager of the Graduate House, 305 Memorial Drive, Cambridge, Mass.

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 lockers and dressing rooms, offices for the various student activities, and rooms for handball. Below are recreation and reading rooms, 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 additional facilities for conducting Technology's recreational program of seventeen sports.

The Barbour Field House, opened in September, 1934, has, in addition to modern shower and locker facilities, special rooms for visiting teams. Connected with the Field House there is another gymnasium with a regulation basketball court, a movable boxing ring, wrestling mats, and indoor jumping pits, and a Squash Building with eight courts. To care for the needs of the track men during the winter, an outdoor board track is provided, near the Barbour Field House.

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 the spring of 1939. The new Briggs Field House for serving these sports, also built in 1939, provides ample shower and locker facilities, as well as spacious quarters for visiting teams.

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's fleet of forty-two dinghies.

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, in response to the student interest, 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.

Alumni of the Institute are now raising funds to enlarge the recreational facilities, particularly those for athletics.

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 authorities, but disbursed by the Undergraduate Association. An Advisory Council of Alumni works with the students and 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, boxing, fencing, golf, gymnastics, hockey, lacrosse, rifle and pistol shooting, soccer, swimming, tennis, squash racquets, wrestling. Class teams are organized informally in football and baseball.

Nautical Association. The Nautical Association offers every student an opportunity to learn sailing. A fleet of forty-two dinghies, constituting a special Technology class designed by Technology men, and two 24 foot sloop 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.

Sailing activities of the Nautical Association are under the advisory direction of a sailing master who is an experienced yachtsman. 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 excellent opportunities to broaden contacts and to receive practical experience in the field of journalism — experience that in after years frequently proves to be of material value. All work incident to the editing and financing of the publications is carried on by the students, with an Alumni Advisory Council available for consultation.

There are four self-supporting undergraduate publications: *The Tech*, a bi-weekly newspaper; *The Tech Engineering News*, a monthly technical journal; *Technique*, the year book; and *Voo Doo*, a comic magazine. The staffs are chosen as a result of open competition. *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 year book, which is issued as a large volume, 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.

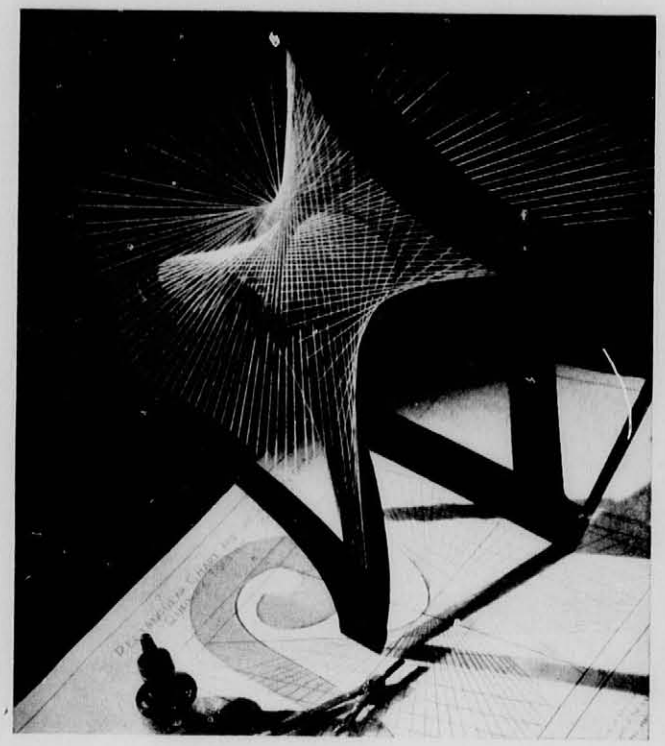
Music, Drama, and Public Speaking. The Combined Musical Clubs, consisting of the Glee, Instrumental and Banjo Clubs, provide opportunities for training and expression in instrumental and vocal music. The Dramashop produces plays. Members of the Debating Society participate in inter-collegiate debates and exhibition contests. The Technology Union holds public meetings for debating and discussing current problems.

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 student activity aims to be of practical service to every student 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. Subcommittees 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.



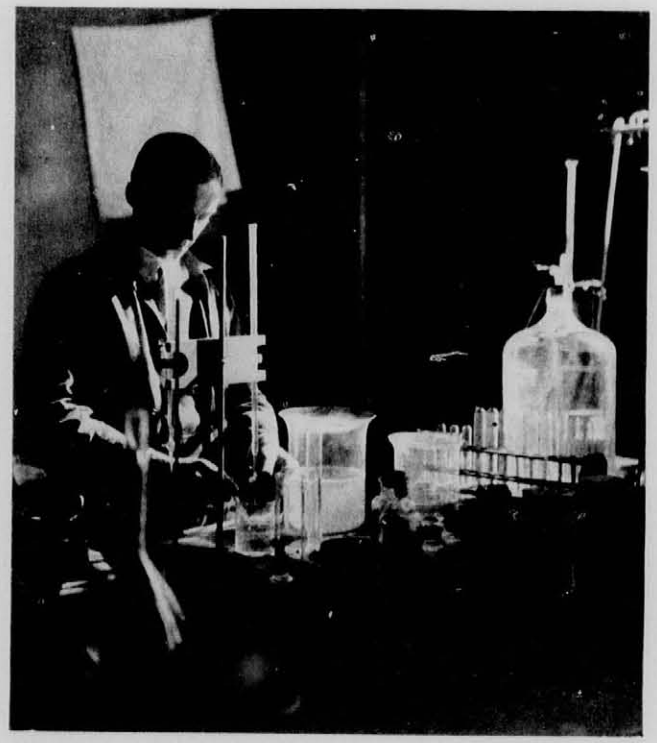
Mathematics



Physics

FUNDAMENTALS

WHEN the freshman begins his work, he finds that the subjects of study consist mainly of such fundamentals as physics, chemistry, mathematics, and English. It is not until the third year that students in different Courses find their paths diverging, but even as they then begin to major in selected fields they find a continued emphasis on fundamental science and design.

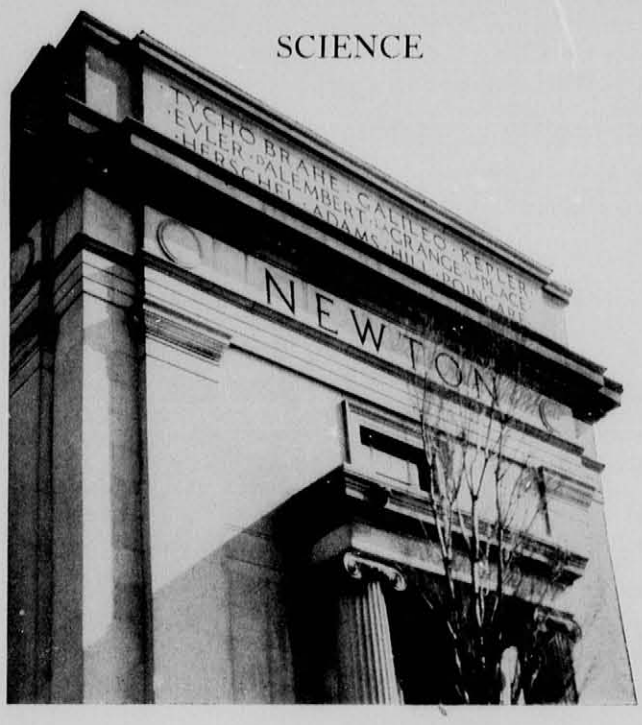


Chemistry

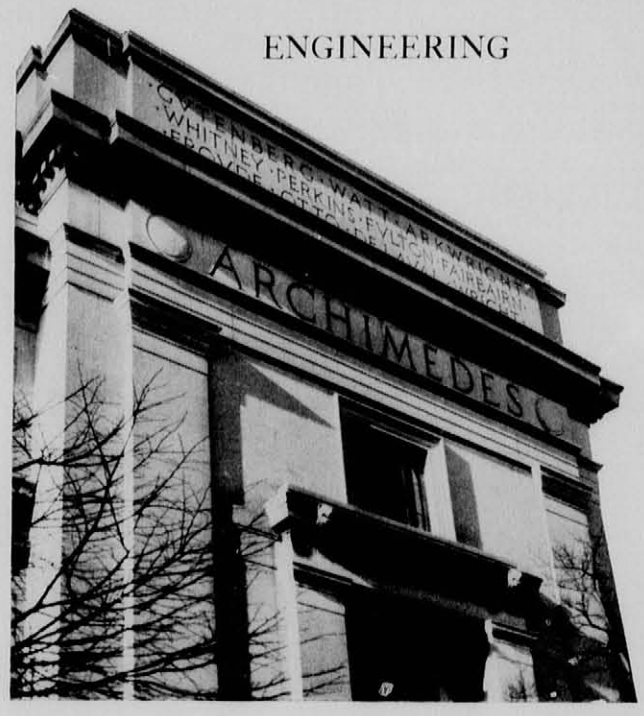


The Humanities

SCIENCE



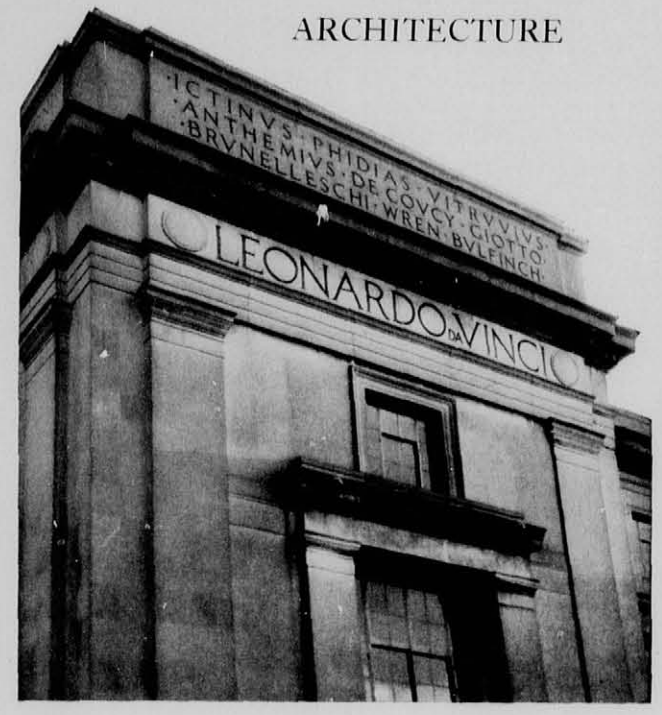
ENGINEERING



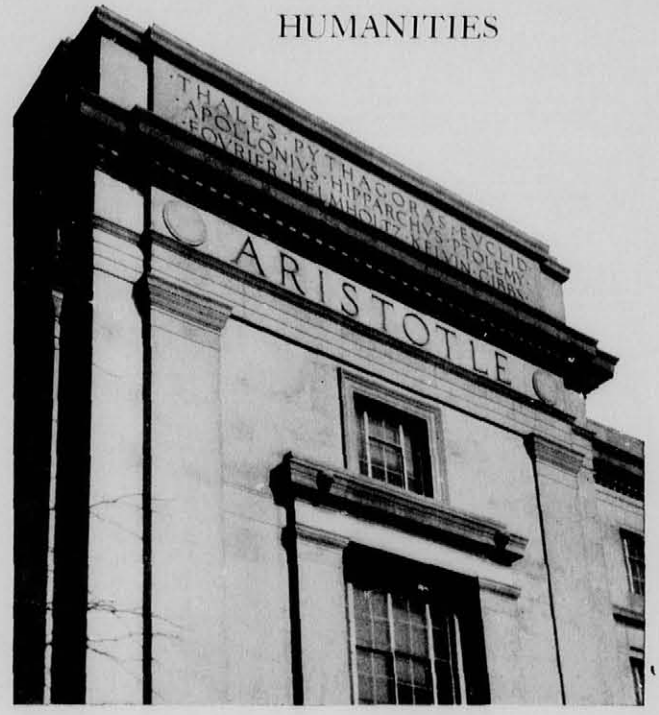


Fairchild

ARCHITECTURE



HUMANITIES



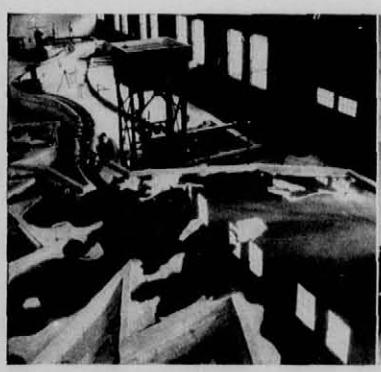
SCOPE—UNITY—COÖRDINATION

THE characteristic spirit of M. I. T. finds its material embodiment in the great group of educational buildings. Here the many departments of study and instruction are brought together under a single roof. Corresponding to this structural unity is vital unity of coöperation in work and teaching.

Never, as here at Technology, have the problems of research and of technical proficiency been dealt with as coöperative projects, to be studied and solved coöperatively. This spirit, distinctive of the methods of study and instruction at the Institute, is in perfect agreement with that ancient yet most modern of philosophic generalizations according to which the entire field of scientific knowledge is seen as fundamentally one. Valuable, too, is the close contact that this unity of plant and work permits between undergraduate and graduate students and between both these groups and the staff.

Within this unity there also exists a diversity that gives the student great flexibility in selecting a course of study best suited to his abilities and wishes. This adaptability arises out of the provision by the Institute of over forty programs of study, and from the division of the Institute into the following groups: the Graduate School, the School of Architecture, the School of Science, the School of Engineering, the Division of Humanities, and of Industrial Coöperation.

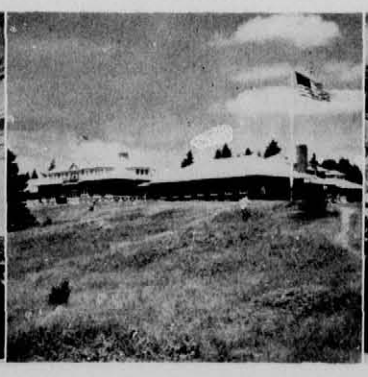
In the Schools of Architecture, Engineering and Science are grouped those departments of study which lead to degrees and which embody the primary educational objectives of the Institute. In the Division of Humanities are grouped the studies which are provided in order that students may supplement the cultural values inherent in their scientific and engineering studies with the 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 devoted wholly or in part to the assistance of industry.



Laboratories



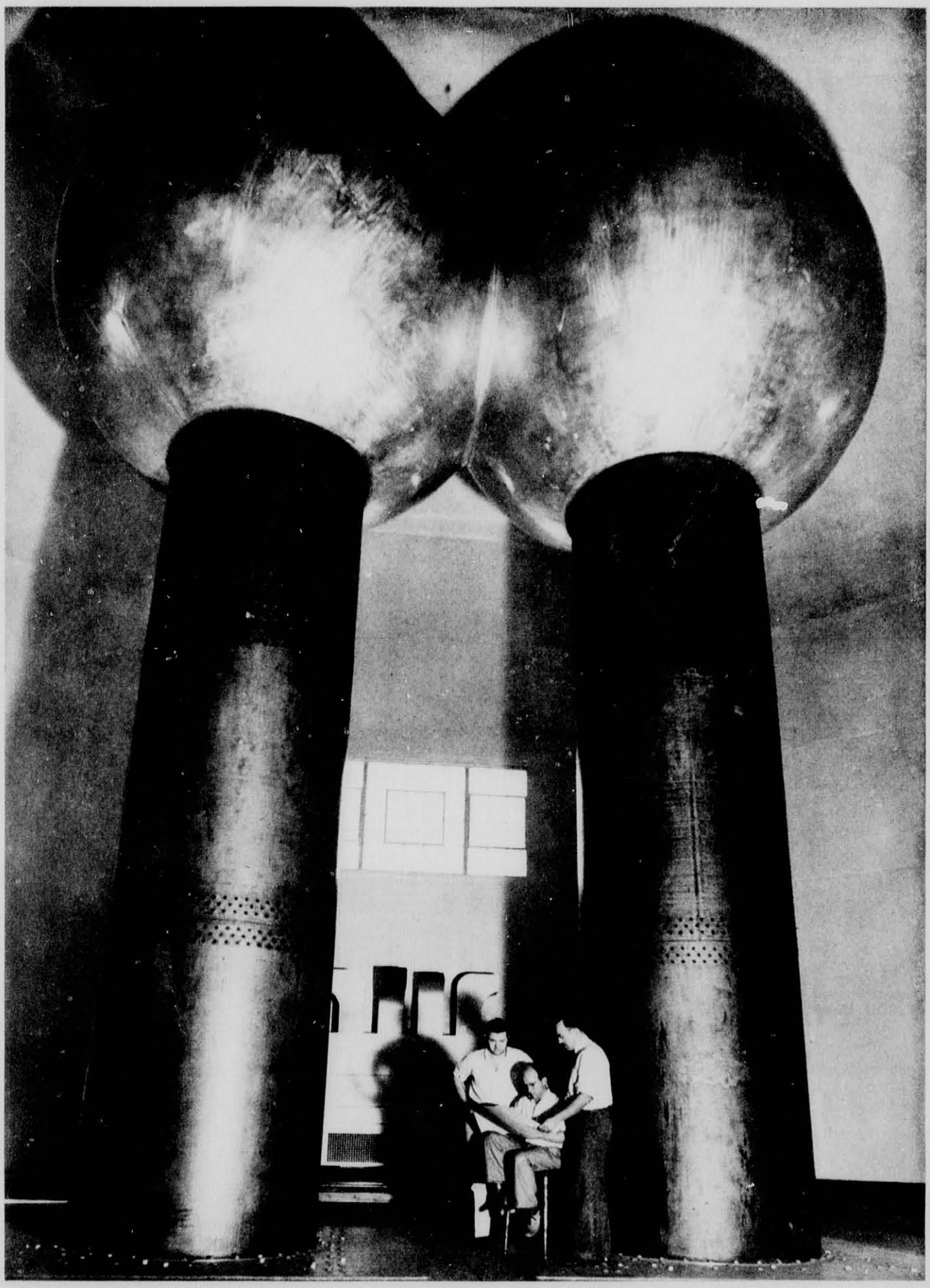
Libraries



Engineering Camp



Museums



The Van de Graaff electrostatic generator for high-voltage nuclear research. Together with the cyclotron it provides unexcelled facilities for high-voltage research

REQUIREMENTS FOR ADMISSION

ADMISSION FROM SECONDARY SCHOOLS

Selection of Applicants. Under the plan for stabilization of the Institute enrollment the size of the First Year classes admitted in 1940 and 1941 may not exceed six hundred. Since it is expected that the number of applicants will be more than six hundred, the Faculty Committee on Admissions will exercise discretionary powers of selection.

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 (from June 15 to September 1, the office will be closed on Saturdays); 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 before March 1 of the year in which the student plans to enter.

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 his 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. It is presupposed that a candidate's training in English has been such that he can properly express his ideas. Unless he has completed preparation in three units of English, he must otherwise demonstrate to the satisfaction of the Committee on Admissions that he has this ability. The candidate should bear in mind that the broader his intellectual training and the more extensive his general attainments, the greater will be the advantages he may expect to gain. The better high and preparatory schools will, in general, afford suitable preparation.

Attention is called particularly to the necessity of thorough preparation in mathematics, not merely as to the extent and amount of work done, but as to its quality. Candidates should be thoroughly grounded in fundamental principles, operations and definitions.

The following subjects are specifically required of each applicant (the figure in parentheses after each subject indicates the usual unit rating. In general a unit represents a full year's study in a secondary school subject taken four or five times a week):

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

Further evidence of adequate preparation, amounting to seven units of elective subjects is required and may be offered from the following groups:

Foreign Language	Mathematics
Social Science	Mechanic Arts
(History, Civics, etc.)	Mechanical Drawing
Biological Science	Commercial Studies
(Biology, Zoölogy, etc.)	Fine Arts, Drama, and
Physical Science	Music
(Chemistry, General Science, etc.)	

In the choice of electives, the following limitations are imposed:

1. Not less than two units of any language will be accepted. The following languages may be offered: French, German, Spanish, Italian, Latin, and Greek.
2. A total of not more than two units will be accepted from the following groups: Mechanic Arts, Mechanical Drawing, Commercial Studies, Fine Arts, Drama, and Music.

In order that an applicant may arrange his program of study to provide the most suitable preparation, the following electives, though not required, are recommended:

Chemistry. A one-year course in Chemistry is highly desirable to provide a background for the first year required work at the Institute.

History. The study of history is advisable in order that a student may have a better understanding of contemporary civilization.

French or *German*. If it is impracticable to present three units of French or three units of German, it is recommended that two units of each be offered. Since preparation in these languages is necessary in certain Courses, an applicant who does not offer them may be required after admission to study one or both before becoming eligible for the Bachelor's degree. In such cases, the specific language requirement is indicated in the description of the Course in the catalogue.

When planning his entrance program, a student who intends to pursue graduate work should consider that one (or sometimes both) of these languages will be required.

A knowledge of Spanish is recommended for those whose later work may bring them in contact with Latin-American countries.

Application Procedure.

1. A Preliminary Application form, which may be obtained from the Director of Admissions, should be filed, preferably by December 15 previous to the date of expected entrance.
2. A Final Application form and two Personal Endorsement forms will be sent about January 1, to each student who has filed a Preliminary Application, and who expects to enter the following September.
3. 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. These forms will be returned *directly* to the Institute by the school. A final report will be obtained from the school in June.
4. Beginning March 1, the Committee on Admissions will review applications which are complete (i.e. those for which a Final Application, School Report forms, and two Personal Endorsements have been received). About May 15, a preliminary report on his admission will be sent to each such applicant.
5. A candidate tentatively selected for admission on May 15 will receive a final report about August 1, if he completes the requirements specified in the tentative report.
6. Applications completed after March 1, will be considered by the Committee on Admissions, but it may be necessary to place such applications on a waiting list for action when vacancies occur in the selected group.

Methods of Admission.

I. *Admission without Examination*

1. The applicant must have completed preparation in the subjects specifically required for admission and in seven units of electives chosen from the list given above.
2. In general the privilege of admission without examination applies only to candidates who rank in the highest 20 per cent of the graduating class in schools which have qualified for this privilege. Such qualification is based upon the attainment of satisfactory records at the Institute by several graduates of the school. Eligibility for admission without examination can be determined only after the candidate's records have been reviewed.

II. *Admission by Examinations*

1. The applicant must present satisfactory school records, or pass examinations in English, Physics and seven units of electives chosen from the list on page 37. Preference will be given to applicants who present school records of "certificate" grade in these subjects.
2. He must pass examinations covering Elementary Algebra, Plane Geometry, Solid Geometry, and Trigonometry under the auspices of one of the following "agencies":

a. College Entrance Examination Board.

The C. E. E. B. offers the "Mathematics Gamma" examination, which is a comprehensive attainment test covering all the mathematics required for admission to the First Year class at the Institute. A satisfactory grade in the "Mathematics Beta" examination will be accepted for Algebra and Plane Geometry. No credit will be granted for the "Mathematics Alpha" examination. The examination results will be sent to the Institute directly by the Board.

C. E. E. B. examinations are held about the third week of June in the principal cities of the United States and in Canada, London, Paris, Geneva and other foreign centers. They are also held about the second week in September in a number of centers in the United States. A list of places and dates of the examinations is published by the Board each year about March 1.

For information and an application form, the candidate should write to the Secretary of the College Entrance Examination Board, 431 West 117th Street, New York City. If the application is received sufficiently early, the examination fee will be $5. The student should apply as a "Class A" candidate.

b. New York State Board of Regents.

In general, only applicants residing in the State of New York may offer Regents examinations. The minimum passing grade in the specifically required examination subjects is 80 per cent. The official report of these examinations will be secured by the Institute from the State Board of Regents at Albany.

c. Matriculation Examinations

An applicant residing in a foreign country may offer satisfactory grades in foreign matriculation examinations. These are accepted for credit by the Committee if they cover the usual requirements in the several subjects. The applicant is expected to arrange to have the results of the examinations sent to the Institute as soon as they are available. In such cases, the applicant should write to the Director of Admissions well in advance of the date of expected entrance to determine whether all of the requirements will have been completed.

d. M. I. T. Summer Session Courses

The Institute gives courses in many of the entrance subjects during the month of August. Satisfactory grades in the courses are accepted as completing the corresponding entrance requirements. A schedule of these courses, including fees, may be obtained from the Director of Admissions after March 1.

ADMISSION WITH ADVANCED STANDING

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. During this period he will be an Unclassified student.

Students who plan to attend another college with the intention of later applying for admission to the Institute should note the Coöperative Plan in effect between the Institute and certain colleges (page 30).

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. As soon as possible after March 1 of the year in which he expects to enter, 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 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 June grades are available.

It is desirable in many cases for a student to attend the Institute Summer Session (see page 2 for the opening date) in order to complete subjects prerequisite to those scheduled for the following year or to preclude irregularities in his subsequent schedule.

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

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 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.

UNDERGRADUATE COURSES OF STUDY

IN the Schools of Architecture, Engineering, and Science the undergraduate may elect any one of the professional Courses of Study listed below. In all 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.

School of Architecture

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

School of Engineering

AERONAUTICAL ENGINEERING Course XVI.
BUILDING ENGINEERING AND CONSTRUCTION, Course XVII.
BUSINESS AND ENGINEERING ADMINISTRATION, Course XV, with options in Engineering based on Physical Sciences and on Chemical Sciences.
CHEMICAL ENGINEERING, Course X, and Chemical Engineering Practice, X-B.
CIVIL ENGINEERING, Course I.
ELECTRICAL ENGINEERING, Course VI. Also options in Illuminating Engineering, VI-B, and in Electrical Communications, VI-C, and Coöperative Course in Electrical Engineering, VI-A.
GENERAL ENGINEERING, Course IX-B.
MARINE TRANSPORTATION, Course XIII-C.
MECHANICAL ENGINEERING, Course II, with options. General (1), Automotive (2), Refrigeration and Air Conditioning (3), Materials and Design (4). Also Coöperative Course in Mechanical Engineering, II-A.
METALLURGY, Course III.
NAVAL ARCHITECTURE AND MARINE ENGINEERING, Course XIII.
SANITARY ENGINEERING, Course XI.

School of Science

BIOLOGY AND PUBLIC HEALTH, Course VII, with options. Biology and Public Health (1a), Biology (1b), Public Health Engineering (2). Also Biophysics and Biological Engineering, Course VII-A, and Food Technology and Industrial Biology, Course VII-B.
CHEMISTRY, Course V.
GENERAL SCIENCE, Course IX-A.
GEOLOGY, Course XII, with options. Geology (1), Mineral Resources (2).
MATHEMATICS, Course XVIII, with options.
Pure Mathematics (1), Applied Mathematics (2), and Industrial Statistics (3).
PHYSICS, Course VIII, with options. General Physics (1), and Applied Physics (2).

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 intelligently to attack 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.

An important part of all of the professional courses consists of general cultural subjects given by the Division of Humanities, including English and history, economics and sociology, languages and the General Studies. The latter are required in the last three years and the student is encouraged to elect them in some one of the following four fields of interest:

HISTORY OF SCIENCE AND THOUGHT
HISTORY OF CIVILIZATION
LITERATURE AND THE FINE ARTS
SOCIAL SCIENCE

The required work in English and history in the first two years relates to and leads into these fields of interest in the humanities.

All of the Courses offered, except Architecture and City Planning, are identical in the first year. This 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, Courses (except Architecture and City Planning) are divided into two general groups, Engineering and Chemistry. In each group certain basic subjects are common to all Courses. In individual Courses the remaining time is given to introductory professional subjects.

Architecture (Course IV), City Planning (Course IV-B), and Marine Transportation (Course XIII-C) require five years for the Bachelor's degree. Courses II-A, VI-A, and VII-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 co-öperative courses requiring outside work in industry.

Course IV-C is of six years' duration, including three periods of outside office practice. Option 1 leads to the degrees of Bachelor of Architecture in City Planning, and Master in City Planning; Option 2 leads to the degrees of Bachelor of Science in Civil Engineering, and Master in City Planning.

PROFESSIONAL SUMMER SCHOOLS

To bring the students into closer relations with the practical side of their work, professional summer schools are held in the Departments of Civil Engineering, and Metallurgy. The students, accompanied by instructors, give their time to fieldwork, or visit and report on industrial establishments.

Summer School of Civil Engineering. With the exception of brief courses in the manipulation and use of the tape, transit and level, the fieldwork in surveying required of students in Courses mentioned below is given at Camp Technology on the shore of Gardner Lake near the town of East Machias, Maine.

The subjects given at the camp are required for students of Courses I, VII Option 2, XI, and XVII, but students from other Courses will be admitted. Properly qualified students from other colleges will also be admitted. The session is for seven and one-half weeks.

The fee, including room and board, for students registered at the Institute during the academic year, is $100.

Summer School of Metallurgy. Plant Visits 3.10, required of all students in Course III, and recommended for any others planning to register for Metallurgy 3.01, 3.031 or 3.12T. A number of metallurgical plants in eastern Pennsylvania and New Jersey are visited. The fee is $15 and each student will pay his own expenses estimated at $75 round trip from Boston.

RESERVE OFFICERS' TRAINING CORPS

In coöperation with the War Department of the Federal Government, the Institute maintains the following units in the R. O. T. C.: Coast Artillery, Engineer, Signal, Ordnance and Chemical Warfare.

REQUIREMENTS FOR THE BACHELOR'S DEGREE

To receive the Degree of Bachelor of Science (S.B.), Bachelor in Architecture (B.Arch.) or Bachelor of Architecture in City Planning (B.Arch. in 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 satisfactorily completed the prescribed subjects of his professional Course or equivalent work.

The student must, moreover, prepare a thesis on some subject included in his course of study. This may be an account of some research made by him; or an original report upon some machine, work of engineering, industrial works, mine, or mineral survey, or an original design accompanied by an explanatory memoir.

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.

For description of subjects see pages 124–188.

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	4·00 to 4·99
Chemistry	5·00 to 5·99
Electrical Engineering	6·00 to 6·99
Biology and Public Health	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
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
Hygiene	PT1 to PT2

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.

FIRST YEAR SCHEDULES

As explained on page 40 the programs of study are identical in the first year for all Professional Courses with the exceptions of Architecture (IV), City Planning (IV-B), and City Planning Practice, Option 1 ($IV\text{-}C_1$). Below are the first year schedules for these two groups. Schedules for the other years for the several professional courses are given on the following pages.

FIRST YEAR

	ALL COURSES (Except IV, IV-B and $IV\text{-}C_1$)			COURSES IV, IV-B and $IV\text{-}C_1$			
First Term	5·01	Chemistry, General	7–4	*First Term*	4·06	Graphics	6–0
	8·01	Physics	6–5		4·11	Shades and Shadows	2–2
	D11	Engineering Draw. & Desc. Geom.	6–0		4·12	Perspective	4–3
	E11	English Composition	3–5		4·711	Architectural Practice	10–0
	M11	Calculus	3–6		E11	English Composition	3–5
	MS11	Military Science	3–0		M111	Calculus	3–6
	PT1	Physical Training	1–0		MS11	Military Science	3–0
			29–20		PT1	Physical Training	1–0
							32–16
Second Term	5·02	Chemistry, General	7–4				
	8·02	Physics	6–5	*Second Term*	2·031	Structural Mechanics, Elem.	3–6
	D12	Engineering Draw. & Desc. Geom.	6–0		4·812	Abstract Design	10–5
	E12	English Composition	3–5		4·712	Architectural Practice	12–0
	M12	Calculus	3–6		E12	English Composition	3–5
	MS12	Military Science	3–0		MS12	Military Science	3–0
	PT2	Physical Training	1–0		PT2	Physical Training	1–0
			29–20				32–16

UNDERGRADUATE COURSE SCHEDULES FOR 1940–1941

I. CIVIL ENGINEERING

THE Course in Civil Engineering provides a training in the fundamental subjects of science and engineering with particular application to the broad field of design, construction, operation, and maintenance of structures and works necessary for modern industry and civilization. These include bridges, buildings, dams, and other fixed structures; hydraulic and sanitary works for water supply and sewerage, water power, river and harbor improvement; and facilities for transportation by railway, highway, water and air.

During the first three years, the Course includes the basic subjects of mathematics and science, and surveying, together with other introductory work in the field of civil engineering. In the fourth year, considerable time is devoted to structural theory and design, foundation problems, and construction methods, subjects which are essential in all branches of the Civil Engineering profession. In addition, the student has a choice of elective subjects which provide an opportunity for specialization in a particular field.

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

Students desiring to study Civil Engineering as a background for City Planning, are given an opportunity to modify the program of the fourth year in Civil Engineering to enable them to enter the fifth year of the Course in City Planning Practice in the following year. (See page 50 for details.)

First Year. See page 42

Second Year

First	1·00	Surveying	2–2
Term	1·01	Topographical Drawing	4–0
	1·39	Graphic Statics	3–1
	2·00	Applied Mechanics	3–5
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
			26–24
Second	1·12	Astronomy and Spher. Trig.	3–4
Term	1·21	Rail. and High. Curves	2–2
	2·01	Applied Mechanics	3–5
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			23–26

REQUIRED DURING SUMMER. AT CAMP TECHNOLOGY

1·05	Surveying	12–1
1·20	Rail. and High. Fieldwork	5–0
1·60	Hydrographic Surveying	5–0

Third Year

First	1·13	Geodesy	2–3
Term	1·21	Rail. and High. Curves	2–2
	2·04	Applied Mechanics	3–5
	6·40	Electrical Eng., Elem.	4–6
	6·89	Electrical Eng. Lab.	2–2
	12·321	App. Engineering Geology	5–2
	Ec11	Economic Principles	3–3
		General Study	6
			50
Second	1·22	Quantity Surveying	2–2
Term	1·35	Roads and Pavements	2–1
	1·40	Structures	7–4
	1·58	Des. Reinf. Concrete Structures	6–0
	1·62	Hydraulics	4–6
	2·371	Testing Materials Lab.	2–1
	15·52	Accounting	4–2
	Ec12	Economic Principles	3–3
			30–19

Fourth Year

First	1·25	Engineering Construction	4–1
Term	1·41	Structures	3–6
	1·48	Foundations	3–4
	1·501	Bridge Design	8–0
	2·411	Heat Engineering	2–4
		Professional Electives & Thesis*	14
			49
Second	1·42T	Structures	3–6
Term	1·502T	Structural Design	8–0
	2·421	Heat Engineering	2–4
	2·687	Hydraulic Laboratory	2–2
		General Study	6
		Professional Electives & Thesis*	15
			48

Professional Electives

Water Works and Sewerage

First	1·75	Hydraulic & Sanitary Engineering	4–6
Term	1·801	Hydraulic & Sanitary Design	3–0
Second	1·76	Sanitary Engineering	2–3
Term	1·79	Sanitary Design	2–0

Transportation

First			
Term	1·271	Transportation Engineering	6–5
Second			
Term	1·272	Transportation Engineering	5–4

Water Power and Flood Control

First			
Term	1·70	Hydrology	7–4
Second			
Term	1·71	Water Power Eng. & Flood Control	7–3

* Total Thesis 9 units (8, if taking Water Power and Flood Control).

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.

In the fourth year the student may choose a field of concentration by the election of one of the options listed.

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

At the beginning of the Senior year, a student must have acquired a reading knowledge of German or French. This requirement may be fulfilled by one of the following:

(1) Three years of a secondary school language (German or French).

(2) Two years of secondary school German and two years of secondary school French.

(3) Eight units of Language may be substituted for one General Study, except that both terms of Elementary French (L51, L52) or Elementary German (L11, L12) are required for substitution for one General Study.

(4) Demonstrating a reading knowledge of technical German or French.

II. Mechanical Engineering

First Year. See page 42

Second Year

First	2·00	Applied Mechanics	3–5
Term	2·70	Machine Drawing	4–0
	2·851	Machine Tool Lab.	4–0
	5·683	Phys. Chemistry, Elem.	2–2
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
			27–23
Second	2·01	Applied Mechanics	3–5
Term	2·30	Engineering Metals	3–1
	2·730	Machine Design	3–1
	2·852	Machine Tool Practice	4–0
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			28–22

Third Year

First	2·04	Applied Mechanics	3–5
Term	2·251	Fluid Mechanics	5–3
	2·31T	Engineering Materials	6–3
	2·40	Heat Engineering	4–5
	6·40	Electrical Eng. Elem.	4–6
	Ec11	Economic Principles	3–3
			25–25
Second	2·06	Applied Mechanics	3–5
Term	2·252	Fluid Mechanics	5–3
	2·37	Testing Materials Lab.	4–2
	2·42	Heat Engineering	4–5
	2·680	Engineering Laboratory	4–4
	2·731	Machine Design	4–1
	Ec12	Economic Principles	3–3
			27–23

Fourth Year. Option 1. General

First	2·081	Applied Mechanics	3–5
Term	2·43	Heat Engineering	3–5
	2·55	Power Plant Engineering	3–3
	2·682	Engineering Laboratory	3–3
	2·732	Machine Design	4–2
	6·47	App. of Elec. in Industry	4–4
	G79	Comp. Polit. Institutions	3–5
			25–27
Second	2·082	Applied Mechanics	3–5
Term	2·32	Engineering Metals	3–2
	2·56	Power Plant Engineering	3–3
		General Study	8
		Elective and Thesis*	22
			49

Suggested Electives

2·11	Industrial Plant Eng.	3–3
2·82	Diesel Engine Design	6–0
2·83	Steam Turbine Eng.	4–2
2·871	Manufacturing Eng.	2–4
2·872	Prep. for Manufacturing	2–4

* Thesis not less than 10 units.

II. Mechanical Engineering Continued

Fourth Year. OPTION 2. AUTOMOTIVE

First	2·081	Applied Mechanics	3–5
Term	2·32	Engineering Metals	3–2
	2·734(a)	Machine Design	3–1
	2·791	Automotive Engines	4–4
	2·793	Automotive Engine Des.	4–0
	2·795	Automotive Vehicles	2–3
	6·47	App. of Elec. in Industry	4–4
	16·81(b)	Aeronautics	3–1
	G79	Comp. Polit. Institutions	3–5
			26–24
Second	2·082	Applied Mechanics	3–5
Term	2·79	Automotive Dynamics	2–2
	2·792	Automotive Engines	4–4
	2·794	Automotive Engine Des.	4–0
	2·796	Automotive Vehicles	3–5
		General Study	8
		Thesis	10
			50

Fourth Year. OPTION 3. REFRIGERATION AND AIR CONDITIONING

First	2·43	Heat Engineering	3–5
Term	2·51	Heat Measurements	3–3
	2·55	Power Plant Engineering	3–3
	2·621	Refrigeration Eng.	3–3
	2·66	Heat, Vent. & Air. Cond.	3–5
	6·47	App. of Elec. in Industry	4–4
	G79	Comp. Polit. Institutions	3–5
			22–28
Second	2·56	Power Plant Eng.	3–3
Term	2·622	Refrigeration Eng.	3–5
	2·69	Refrig. & Air Cond. Lab.	6–6
		General Study	8
		Elective and Thesis*	16
			50

Fourth Year. OPTION 4. MATERIALS AND DESIGN

First	2·081	Applied Mechanics	3–5
Term	2·32	Engineering Metals	3–2
	2·35	Adv. Metals & Testing	4–4
	2·732	Machine Design	4–2
	3·30	Metallography	4–1
	6·47	App. of Elec. in Industry	4–4
	G79	Comp. Polit. Institutions	3–5
			25–23
Second	2·082	Applied Mechanics	3–5
Term	2·33	Adv. Engineering Metals	3–2
	2·77	Design of Prod. Machinery	4–2
	3·33	App. of Metallography	3–2
	3·50	X-Ray Metallography	3–3
		General Study	8
		Thesis	10
			48

*Thesis not less than 10 units.

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.

II-A. MECHANICAL ENGINEERING

IN COÖPERATION WITH THE GENERAL ELECTRIC COMPANY

THE Coöperative Course in Mechanical Engineering affords training for the technical and executive responsibilities of the manufacturing phases of any representative large industry.

The Course covers a period of five years, of which the first two years are identical with those of Course II. The last three years, including the summers, are spent partly at the Institute and partly at the plants of the General Electric Company.

Instruction in the first four years is essentially the same in content as that given in Course II. No omissions are made in the fundamental and professional subjects, and the subjects omitted from the regular Course II curriculum have their counterparts in the program at the works.

The final year of graduate study and research is to be planned for each student in accordance with the requirements of the Graduate School. Training at the plants is planned and carried out with a view to its educational value and is closely correlated with the instruction at the Institute. During the final term at the works much freedom may be exercised in the assignment of students to the research departments of the Company. This is planned to develop special and individual aptitudes of the various men.

The number of students that can be accommodated is limited and, consequently, registration in the

II-A. Mechanical Engineering Continued

Coöperative Course is restricted to students of marked aptitude who have clear records in the first two years of Course II. Admission to the Course is subject to the approval of the Institute and the coöperating Company. College transfer students may be admitted under equivalent conditions as to adequacy of preparation and aptitude.

It is assumed that students who are admitted to the Course with the approval of the Institute and of the General Electric Company will carry the Course through to completion, unless exceptional circumstances prevent. Students at the works are subject to the usual regulations of the Company and receive regular compensation, the total of which approximates the tuition charges for the three years of the Coöperative Course.

The Course leads to the degree of Master of Science in Mechanical Engineering together with the degree of Bachelor of Science in Mechanical Engineering as of the preceding year.

II-A. Mechanical Engineering

Same as regular Course II to the beginning of the third year

Third Year

At Works

Summer	2·04	Applied Mechanics	3–5
Term	2·951	Manufacturing Practice (General Electric Co.)	40 h.p.w.

At M. I. T.

First	2·06	Applied Mechanics	3–5
Term	2·253	Fluid Mechanics	7–5
	2·351	Materials of Eng.	2–2
	2·40	Heat Engineering	4–5
	2·731	Machine Design	4–1
	Ec11	Economic Principles	3–3
		General Study	6
			50

At Works

Second	2·42	Heat Engineering	4–5
Term	2·952	Manufacturing Practice (General Electric Co.)	40 h.p.w.

Fourth Year

At M. I. T.

Summer	2·37	Testing Materials Lab.	4–2
Term	2·43	Heat Engineering	3–5
	6·40	Electrical Eng., Elem.	4–6
	6·89	Electrical Eng. Lab.	2–2
	Ec12	Economic Principles	3–3
			16–18

At Works

First	2·08	Applied Mechanics	4–8
Term	2·953	Manufacturing Practice (General Electric Co.)	40 h.p.w.

At M. I. T.

Second	2·082	Applied Mechanics	3–5
Term	2·51	Heat Measurements	3–3
	2·551	Power Plant Eng.	3–5
	2·680	Engineering Laboratory	4–4
	2·733	Machine Design	5–3
	2·82	(a) Diesel Engine Design	6–0
	2·83	(b) Steam Turbine Eng.	4–2
		General Study	6
			50

Graduate Year

At Works

Summer	2·96	Study and Research	6
Term	2·954	Manufacturing Practice (General Electric Co.)	40 h.p.w.

At M. I. T.

First Term		Graduate Study & Research	48

At M. I. T.

Second Term		Graduate Study & Research	48

III. METALLURGY

Including Ceramics

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. Although the fields of Metallurgy and Mineral Dressing are differentiated in some industries, it is felt that broad training requires an acquaintance with each branch. As a result the 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, and particularly physical chemistry, to the various branches of Metallurgy.

In the senior year 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 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.

III. METALLURGY

First Year. See page 42

Second Year

First Term	5·11	Qualitative Analysis	7–2
	8·03	Physics	5–5
	12·01	Mineralogy	8–2
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
			29–20
Second Term	2·854	Machine Tool Laboratory	3–0
	3·00	Introduction to Metallurgy	3–1
	5·12	Quantitative Analysis	7–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		General Study	2–2
			30–20

REQUIRED DURING SUMMER

3·10	Metallurgical Plant Visits	3–1

Third Year

First Term	2·011	Applied Mechanics	3–5
	3.01	Non-Ferrous Metallurgy I	4–4
	3·04T	Metallurgical Laboratory	5–0
	3·31	Metallography	5–2
	3·81	Mineral Dressing I	4–2
	5·61	Physical Chemistry I	4–4
	5·612	Physical Chemistry Lab. I	2–0
	Ec11	Economic Principles	3–3
			30–20
Second Term	2·042	Applied Mechanics	3–5
	2·50	Heat Measurements	3–1
	3·12T	Metal. Iron & Steel	4–3
	3·32	Metallog. & Heat Treat.	6–4
	3·82	Mineral Dressing II	4–2
	5·62	Physical Chemistry II	4–4
	Ec12	Economic Principles	3–3
			27–22

Fourth Year. OPTION 1. METALLURGY

First Term	2·371	Testing Materials Lab.	2–1
	3·20T	Metall. Thermodynamics	4–5
	3·33	Appl. of Metallography	3–2
		General Study	6
		Electives*	25
			48
Second Term	6·40	Electrical Eng., Elem.	4–6
	6·81	Electrical Eng. Lab.	2–2
		General Study	6
		Thesis	12
		Electives*	18
			50

ELECTIVES

2·30	Engineering Metals	3–1
2·32	Engineering Metals	3–2
2·872	Prep. for Manufacturing	2–4
3·02	Non-Ferrous Metallurgy II	3–3
3·05	Metallurgy, General	3–3
3·21T	Prin. of Steel Making	2–4
3·41	Light Alloys	2–4
3·50	X-ray Metallography	3–3
3·51	Physics of Metals	2–4
5·66	Surface and Colloid Chemistry	2–3
8·15	Photography	2–1
15·52	Accounting	4–2

Fourth Year. OPTION 2. MINERAL DRESSING

First Term	3·20T	Metall. Thermodynamics	4–5
	3·83	Mineral Dressing Plant	3–2
	3·85T	Flotation	3–3
	3·87	Quant. Mineragraphy	4–0
	12·91	Elements of Mining	4–4
		General Study	6
		Electives*	10
			48
Second Term	3·84	Mineral Dressing Practice	2–2
	3·86T	Comminution	2–3
	12·40	Economic Geology	3–6
		General Study	6
		Thesis	12
		Electives*	14
			50

ELECTIVES

3·02	Non-Ferrous Metallurgy II	3–3
3·50	X-ray Metallography	3–3
3·70	Ceramics	5–3
3·88	Ore Testing	6–2
5·41	Organic Chemistry I	4–3
10·29	Chemical Engineering	4–5
10·661	Int. to Colloid Chemistry	2–4
10·662	Colloid Chemistry	2–4
12·211	Optical Crystallography	5–2
15·52	Accounting	4–2
15·61	Law of Contracts	3–6

*Electives must form a coördinated program of study.

IV. ARCHITECTURE

THE School of Architecture comprises Course IV, Architecture; Course IV-B, City Planning; Course IV-C, City Planning Practice.

The method of teaching followed in the School is founded upon individual criticism. This applies particularly to architectural design, modeling, color and freehand drawing where criticism at the drafting board is accompanied by careful direction in the use of the library material.

In order that the students may acquire self-reliance and sound critical judgment, they are increasingly thrown upon their own resources as they advance from year to year. Thus in the last years in architectural design, criticism is given only when satisfactory progress has been made since the instructor's last visit.

That deserving students in need of financial aid may not have to forego the opportunities that we offer, scholarship aid is available for both men and women. This assistance in Course IV is supplemented by many cash prizes given throughout the year, and conspicuous ability is rewarded by a Traveling Scholarship.

In recognition of the many directions toward which an architectural education may guide the varying qualities of students in this field, the School of Architecture announces herewith that electives in related work may be chosen by students of good standing with the approval of the Head of the School in substitution for certain required subjects.

It is assumed that a student in the School of Architecture will retain from his entrance requirements in language the ability to read at sight simple narrative prose in French or some other modern language. An hour examination to establish this ability will be given during the course in European Civilization and Art of the third year (4.461). For a clear record in the European Civilization and Art subjects, a passing grade in such an examination will be required.

All drawings and designs made during the course of study become the property of the School to be retained, published, exhibited, or returned at the discretion of the School.

The Course in Architecture covers five years and leads to the degree of Bachelor in Architecture.

IV. ARCHITECTURE

First Year

First	4·06	Graphics	6-0
Term	4·11	Shades and Shadows	2-2
	4·12	Perspective	4-3
	4·711	Architectural Practice	10-0
	E11	English Composition	3-5
	M111	Calculus	3-6
	MS11	Military Science	3-0
	PT1	Physical Training	1-0
			32-16
Second	2·031	Structural Mechanics El	3-6
Term	4·312	Abstract Design	10-5
	4·712	Architectural Practice	12-0
	E12	English Composition	3-5
	MS12	Military Science	3-0
	PT2	Physical Training	1-0
			32-16

Second Year

First	2·032	Structural Mechanics	2-4
Term	4·021	Freehand Drawing	4-0
	4·421	Architectural History	4-5
	4·721	Architectural Design II	13-1
	4·93	General Science	4-2
	E21	Literature and History	3-5
	MS21	Military Science	3-0
			33-17
Second	2·033	Structural Mechanics	2-4
Term	4·022	Freehand Drawing	4-0
	4·422	Architectural History	4-5
	4·722	Architectural Design II	13-1
	4·94	General Science	4-2
	E22	Literature and History	3-5
	MS22	Military Science	3-0
			33-17

Third Year

First	4·031	Freehand Drawing	4-0
Term	4·071	Modeling	3-0
	4·461	Europ. Civilization & Art	3-4
	4·641	Principles of City Planning	2-2
	4·731	Architectural Design III	15-3
	4·811	Construction	7-0
	17·75	Materials	4-1
			38-10
Second	4·032	Freehand Drawing	4-0
Term	4·072	Modeling	3-0
	4·462	Europ. Civilization & Art	3-4
	4·732	Architectural Design III	15-3
	4·812	Construction	7-0
	17·76	Materials	4-1
	E42	Problem Analysis	2-2
			38-10

Fourth Year

First	2·651	Mech. Equip. of Bldgs	2-2
Term	4·041	Freehand Drawings	4-0
	4·081	Color, Comp., Th. & App	1-3
	4·471	Europ. Civilization & Art	2-3
	4·741	Architectural Design IV	24-1
	Ec11	Economic Principles	3-3
			36-12
Second	4·042	Freehand Drawing	4-0
Term	4·082	Color, Comp., Th. & App	1-3
	4·472	Europ. Civilization & Art	2-3
	4·742	Architectural Design IV	28-1
	Ec12	Economic Principles	3-3
			38-10

IV. Architecture Continued

Fifth Year

First Term	4·051	Freehand Drawing	6–0
	4·091	Color, Comp., Th. & App.	1–4
	4·481	Europ. Civilization & Art.	2–3
	4·53	Professional Relations	1–2
	4·751	Architectural Design V	29–0
			39–9
Second Term	4·052	Freehand Drawing	6–0
	4·092	Color, Comp., Th. & App.	1–4
	4·482	Europ. Civilization & Art.	2–3
	4·752	Architectural Design V	14–0
		Thesis	18
			48

IV-B. CITY PLANNING

THIS Course follows the Architectural curriculum for three years, a major change in emphasis coming in the second term of the fourth year.

The instruction given in the fourth and fifth years is divided into two major divisions. The first is the work done in the drafting room in City Planning Design. Here actual problems in planning are worked out under supervision, the student being encouraged to develop his imagination and initiative in arriving at his solution. The second consists of lectures dealing with the various technical and cultural elements entering into the practice of City Planning, and instruction in the fundamental principles of planning as applied to specific problems. These are given in two comprehensive Courses, one of which deals with the social and economic phases of city planning and the other with its theory and practice, the aim being to unify the economic, sociological, and structural factors and to relate them to design in the drafting room.

Subjects covering engineering problems in their relation to City Planning Design are given in surveying, site planning and construction details, municipal engineering, and the principles of sanitary science and public health. In the teaching of these and other subjects, the School of Architecture has the full coöperation of the Departments of Civil and Sanitary Engineering, Economics and Social Science, and Biology and Public Health.

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

IV-B. CITY PLANNING

SAME AS COURSE IV, ARCHITECTURE, THROUGH THE THIRD YEAR

Fourth Year

First Term	1·02	Surveying	3–1
	4·041	Freehand Drawing	4–0
	4·081	Color, Comp., Th. & App.	1–3
	4·471	Europ. Civilization & Art.	2–3
	4·741	Architectural Design IV	24–1
	Ec11	Economic Principles	3–3
			37–11
Second Term	4·082	Color, Comp., Th. & App.	1–3
	4·472	Europ. Civilization & Art.	2–3
	4·62	Site Plan. and Construction	6–0
	4·642	Theory of Site Planning	2–3
	4·672	City Planning Design	18–0
	Ec12	Economic Principles	3–3
	G86	San. Sci. & P. H. Prin.	2–2
			34–14

Fifth Year

First Term	1·34	Municipal Engineering	3–4
	4·481	Europ. Civilization & Art.	2–3
	4·651	Theory & Prac. City Planning	3–3
	4·681	City Planning Design	24–0
	Ec83	Urban Sociology	2–4
			34–14
Second Term	4·482	Europ. Civilization & Art.	2–3
	4·652	Theory & Prac. City Planning	3–3
	4·682	City Planning Design	12–0
	Ec84	Social & Econ. Factors, C. P.	2–4
		Thesis	18
			47

IV-C. CITY PLANNING PRACTICE

THE curriculum for the Course in City Planning Practice provides for a year of varied experience in the offices of local, state, and regional planning boards, and is so arranged that it may be taken by students with undergraduate preparation either in architecture or in civil engineering. The offices of the City Planning Board, the Massachusetts State Planning Board, the Division of Metropolitan Planning, and the New England Regional Planning Commission are all within easy reach, and these four planning agencies have agreed to coöperate with the Institute in this program. Almost every city and town in the Boston metropolitan region has a local planning board, and over one hundred and thirty such planning boards are functioning in the Commonwealth — or about 10 per cent of the planning boards in the United States. It is therefore no exaggeration to say that the City of Boston is located in a region in which geographical, social, economic, and political characteristics combine to create a laboratory of comprehensive planning unsurpassed in the country.

IV-C. City Planning Practice Continued

During each period of office practice a problem in design or research will be assigned of a type which has a definite relation to the activities of the Planning Commission and at the same time has a teaching value, and will be supervised at regular intervals by a member of the instructing staff. The students normally receive no compensation for their periods of office practice.

Each of the three periods is spent in a different office. The first period is spent in the office of the City Planning Board of Boston. The student is expected to profit from experience in a field of planning limited in scope before embarking on the second period of office practice, which would be with either the Division of Metropolitan Planning or the State Planning Board. In the latter case he comes in contact with an agency whose purpose is the coördination of the work of local planning boards throughout the Commonwealth and the development of a program of comprehensive planning for transportation, recreation, and other functions that can be dealt with adequately only on a state-wide basis. He spends his third period of office practice at the New England Regional Planning Commission, in the office of which the planning proposals for the six New England States are being coördinated. This Commission is directly responsible to the National Resources Committee in Washington, and therefore provides the student with a picture of the relation between local, state, and national planning.

By dividing the office practice into three periods, each of which is spent in a different office, graduates of the Course are enabled to complete a year of varied experience during which time their work is keyed to a constantly widening horizon, beginning with the local problems of an individual community and ending with the far-reaching problems of soil-conservation, water pollution, inter-state transportation, etc. Such an arrangement does not preclude a student who is more interested in city than in regional planning from returning to a city planning board for his final period of office practice.

With such a background the student not only approaches his academic work with a more realistic viewpoint, but graduates with a better understanding of the professional field he is entering and with greater certainty of his being of immediate value to his employers.

Two options are offered in City Planning Practice, one based on undergraduate preparation in architecture and the other on preparation in civil engineering. Option 1 leads to the degree of Master in City Planning, together with the degree of Bachelor of Architecture in City Planning as of the preceding year. Option 2 leads to the degree of Master in City Planning, together with the degree of Bachelor of Science in Civil Engineering as of the senior year in Course I.

IV-C. Option 1. City Planning Practice

Same as Course IV-B, City Planning, through the fourth year

Fifth Year

At Planning Commission

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

At M. I. T.

First Term	1·34	Municipal Engineering	3–4
	4·481	European Civilization and Art	2–3
	4·651	Theory & Prac. City Planning	3–3
	4·681	City Planning Design	24–0
	Ec83	Urban Sociology	2–4
			34–14

At Planning Commission

Second Term	4·482	European Civilization and Art	2–3
	4·51	*Office Practice	30–0
	4·652	Theory & Prac. City Planning	3–3
	Ec84	Social & Econ. Factors in City Planning	2–4
			37–10

Graduate Year

At Planning Commission

Summer	4·52	*Office Practice	30–0

At M. I. T.

First Term	4·60	Plan. & Housing Legislation	2–4
	4·661	City Planning Research	2–4
	4·691	City Planning Design, Adv.	30–0
		Thesis Research	6–0
			40–8

At M. I. T.

Second Term	4·63	City Planning Administration	2–4
	4·662	City Planning Research	2–4
	4·694	City Planning Design, Adv.	6–0
		Thesis	30–0
			40–8

IV-C. Option 2. City Planning Practice

Students register in Course I, Civil Engineering, through the third year (See page 43)

Fourth Year

Students register in Course I, and take that schedule with the changes noted below

First Term	Omit:	2·411	Heat Engineering	2–4
			Prof. Elective & Thesis	14
	Add:	1·75	Hydraulic & Sanitary Eng.	4–6
		4·021	Freehand Drawing	4–0
		4·641	Prin. of City Planning	2–2
Second Term	Omit:	2·421	Heat Engineering	2–4
			Prof. Elective & Thesis	15
	Add:	1·76	Sanitary Engineering	2–3
		4·022	Freehand Drawing	4–0
		4·62	Site Plan. & Construction	6–0
		4·642	Theory of Site Planning	2–3

IV-C. City Planning Practice Continued

Fifth Year

AT PLANNING COMMISSION

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

AT M. I. T.

First	4·031	Freehand Drawing	4–0
Term	4·081	Color, Comp., Th. & App.	1–3
	4·651	Theory & Prac. City Planning	3–3
	4·683	City Planning Design	30–0
	Ec83	Urban Sociology	2–4
			40–10

AT PLANNING COMMISSION

Second	4·032	Freehand Drawing	4–0
Term	4·082	Color, Comp. Th. & Appl.	1–3
	4·51	*Office Practice	30–0
	4·652	Theory & Prac. City Planning	3–3
	Ec84	Social & Econ. Factors in C. P.	2–4
			40–10

Graduate Year

SAME AS COURSE IV-C, OPTION 1

*With Boston City Planning Board, Division of Metropolitan Planning (Boston), Massachusetts State Planning Board, the New England Regional Planning Commission, the Massachusetts State Board of Housing, or the New Hampshire State Planning and Development Commission.

V. CHEMISTRY

THE main objective of the Course in Chemistry is to provide a general and fundamental education based on science. Its secondary objectives are to train men (1) who seek only the Bachelor's degree and a career in some field in which a sound knowledge of chemistry is important, (2) 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, physical, and industrial 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, electives are available enabling students to extend their knowledge in fields of special interest to them. Students intending to take graduate work, for example, may elect a series of subjects tending to enhance their ability to utilize the opportunities in graduate study. Students intending to enter industry may take subjects giving them a command of the fundamentals in a selected field of science or engineering. Elective time is also available for additional subjects in the humanities.

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. 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.

Elective series are available in inorganic, organic, and physical chemistry, ceramics, textiles, economics, metallography, mineralogy and geology, biology and biochemistry, industrial chemistry, and metallurgy.

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

V. CHEMISTRY

First Year. See page 42

REQUIRED DURING SUMMER

	5·10	Qualitative Analysis	14–4

Second Year

First	5·12	Quantitative Analysis	7–2
Term	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		Language	3–5
			24–23
Second	5·13	Quantitative Analysis	5–2
Term	5·14	Analytical Chemistry	3–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
			26–24

NOTE ON SECOND-YEAR LANGUAGE

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, and may be required to take Elementary French in place of an elective in the third year, particularly if they expect to be candidates for an advanced degree.

Third Year

First	*5·141	Analytical Chemistry	4–1
Term	5·41	Organic Chemistry I	4–3
	5·414	Organic Preparations	9–0
	5·61	Physical Chemistry I	4–4
	5·611	Physical Chem. Lab. I	4–0
	Ec11	Economic Principles	3–3
	L31T	German, Int.	2–3
		Elective	5
			49
Second	*5·417	Quant. Organic Anal.	4–0
Term	5·42	Organic Chemistry I	4–2
	5·424	Indentification of Organic Compounds	9–0
	5·62	Physical Chemistry II	4–4
	5·621	Physical Chem. Lab. II	4–0
	5·82	Chemical Literature	1–1
	Ec12	Economic Principles	3–3
		General Study	2–2
		Elective	5
			48

*Registration in 5·141 and 5·417 is limited by equipment. Students A-K omit 5·141, take 5·417 in 1st term, students L–Z omit 5·417, take 5·141 in 2d term.

V. Chemistry Continued

NOTE ON THIRD-YEAR LANGUAGE

Students who have completed Intermediate German will substitute elective for L31T by petition.

Fourth Year

First	5·061	Inorganic Chemistry	2–3
Term	5·63	Int. to Thermodynamics	3–5
	5·83	History of Chemistry	2–2
	10·203	Industrial Chemistry	3–4
		Thesis	16
		Elective	10
			50
Second	5·062	Inorganic Chemistry	2–3
Term	5·64	Int. to Radiation Chem.	2–3
	5·66	Surface & Colloid Chem.	2–3
	10·21	Industrial Chemistry	2–2
		General Study	2–2
		Thesis	16
		Elective	10
			49

Fourth year students may register for the Research Conferences in organic, physical, or inorganic chemistry, 5·941, 5·942, 5·943, 5·944, 5·945, 5·946, as a part of thesis, subject to the approval of the Registration Officer.

VI. ELECTRICAL ENGINEERING

GREAT importance is attached in Electrical Engineering to the study of mathematics, chemistry, physics and applied mechanics in the earlier years, and of the theory of electricity and magnetism beginning in the second year and continuing throughout the remainder of the Course. The work in Principles of Electrical Engineering is conducted by means of recitations and supervised problem work. Along with these are associated the essential principles of heat engineering, hydraulic power engineering, and economics. The electrical engineering instruction of the third and fourth years takes on a distinctly scientific character besides offering a variety of alternative subjects involving the applications of electricity and associated sciences to the various problems of power station design, manufacturing industries, electric machine design, communications, illumination, and electric railways.

The theoretical work runs parallel with an extended course in the laboratories, which begins with the work in chemistry and physics and extends through all of the scientific branches studied. The electrical measurements laboratories and the laboratories devoted to electrical machinery are component parts of the equipment. These laboratories are extensively provided with apparatus adapted to the needs of undergraduate and advanced study. The purpose of the laboratory work is not only to bring to the student's consideration methods and tests of fundamental importance in the art, but to aid him in the formation of habits of accurate observation and reflection, in the development of initiative, and in the cultivation of judgment in questions of balance between economy of time and precision of results. The work culminates in a thesis requiring originality and the application of acquired technique.

Competent students who desire for adequate reasons to make substitutions in the curriculum may be permitted to do so with the approval of the Head of the Department.

The Honors Group Plan*

At the end of the second year those students believed to have the courage and ability to accept the responsibility of carrying on their individual programs of study with unusual independence are given privileges designed to develop further their initiative, resourcefulness and self-reliance. Instead of attending the usual classes and following the regular assignments during the third and fourth years these students are expected to pursue substantially all of their studies independently under the direct guidance of staff conferees and to participate in seminar meetings conducted by the conferees. Instead of meeting the usual examinations, the students are expected to pass annual comprehensive examinations set by an examining board which includes practicing engineers.

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

At the beginning of the Senior year a student must have acquired a reading knowledge of German or French. This requirement may be fulfilled by one of the following:

(1) Three years of a secondary school language (French or German).
(2) Two years of secondary school German and two years of secondary school French.
(3) Eight units of Language may be substituted for one General Study, except that both terms of Elementary French (L51, L52) or Elementary German (L11, L12), are required for substitution for one General Study.
(4) Demonstrating a reading knowledge of technical German or French.

VI. Electrical Engineering

First Year. See page 42

Second Year

First	2·00	Applied Mechanics	3–5
Term	2·853	Machine Tool Laboratory	4–0
	6·09	Int. to Electrical Eng.	2–0
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		General Study	6
			50

*A circular describing the plan in more detail will be mailed on request addressed to the Department of Electrical Engineering.

VI. Electrical Engineering Continued

Second	2·01	Applied Mechanics	3–5
Term	6·00	Electrical Eng. Prin.	4–6
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			22–26

REQUIRED DURING SUMMER

	1·02	Surveying	3–1

Third Year

First	2·04	Applied Mechanics	3–5
Term	2·40	Heat Engineering	4–5
	6·01T	Electrical Eng., Prin.	5–7
	6·75T	Electrical Eng. Lab.	4–5
	Ec11	Economic Principles	3–3
	M31	Differential Equations	2–4
			21–29
Second	2·07	Applied Mechanics	3–5
Term	2·42	Heat Engineering	4–5
	6·02T	Electrical Eng., Prin.	5–7
	6·76T	Electrical Eng. Lab.	3–4
	6·77	Electrical Eng. Lab.	4–4
	Ec12	Economic Principles	3–3
			22–28

Fourth Year

First	1·64	Hydraulics	3–6
Term	2·686	Engineering Laboratory	3–3
	6·03	Electrical Eng., Prin.	6–8
	6·78	Electrical Eng. Lab.	4–5
		Thesis	1
		Professional Elective	3–6
			48
Second	6·04	Electrical Eng., Prin.	6–9
Term	6·79	Electrical Eng. Lab.	3–4
	G12	Biography in Science	3–3
		Thesis	11
		Professional Elective	3–6
			48

ELECTIVES

First	6·211	App. of Electricity in Industry	3–6
Term	6·221	Electric Power Generation	3–6
	6·241	Electric Railways	3–6
	6·251	Electric Machine Design	3–6
	6·26	Electric Insulation	3–6
	6·281	Prin. Wire Communications	3–6
	6·80	Electrical Eng. Lab.	Time arr.
	M77	Vector Analysis	3–6

ELECTIVES

Second	6·212	App. of Electricity in Industry	3–6
Term	6·222	Electric Power Generation	3–6
	6·242	Electric Railways	3–6
	6·252	Electric Machine Design	3–6
	6·27	Illuminating Eng., Prin.	5–4
	6·282	Prin. Radio Communications	3–6
	6·48	Electrical Equip. Bldgs.	1–2
	6·80	Electrical Eng. Lab.	Time arr.
	8·54	Electromagnetic Theory	3–6

ELECTRICAL ENGINEERING

OPTION VI-B. ILLUMINATING ENGINEERING

RECENT advances in the lighting art — the development of new fluorescent lamps, the use of built-in architectural lighting, and the growing consciousness of the necessity for careful planning of lighting to insure good vision — make the field of illuminating engineering increasingly attractive and important.

Option VI-B is especially designed to meet the requirements of the illuminating engineer. The fundamental subjects of physics, mathematics, and electrical theory are essentially as in Course VI; but considerable time is also devoted to optics, vision, color, and the design of lighting systems. Competent students wishing to make substitutions to fit themselves particularly for special phases of illuminating engineering may do so with the approval of the Head of the Department. A reading knowledge of German or French is required for a degree, as stated in detail on page 52.

The student will select subjects marked (a) or (b) depending upon whether his inclinations are primarily scientific or artistic. A mixture of electives in the two groups is generally inadvisable.

The Option leads to the degree of Bachelor of Science in Electrical Engineering.

VI-B. ILLUMINATING ENGINEERING

First Year. See page 42

Second Year

First	2·00	Applied Mechanics	3–5
Term	4·021	(b) Freehand Drawing	4–0
	6·09	Int. to Electrical Eng.	2–0
	8·03	Physics	5–5
	D21	(b) Perspective	2–2
	E21	Literature and History	3–5
	M21	Calculus	3–6
	M23	(a) Algebra and Geometry	3–6
	MS21	Military Science	3–0
			(a) 22–27
			(b) 25–23
Second	4·022	(b) Freehand Drawing	4–0
Term	6·00	Electrical Eng. Prin.	4–6
	8·04	Physics	6–4
	E22	Literature and History	3–5
	Ec11	(b) Economic Principles	3–3
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		(a) Elective	9
			(a) 49
			(b) 26–24

Third Year

First	4·031	(b) Freehand Drawing	4–0
Term	4·071	(b) Modeling	3–0
	4·421	(b) Architectural History	4–5
	6·01T	Electrical Eng. Prin.	5–7

VI-A. Electrical Engineering Continued

	6·751	Electrical Eng. Lab.	4–4
	8·161	Optics	3–6
	8·162	Optical Measurements	3–2
	8·50	(a) Heat and Thermodynamics	3–4
		(a) Elective	9
			(a) 50
			(b) 26–24
Second Term	6·02T	Electrical Eng. Prin.	5–7
	6·27	Illuminating Eng. Prin.	5–4
	6·76T	Electrical Eng. Lab.	3–4
	8·15	(a) Photography	2–1
	Ec11	(a) Economic Principles	3–3
	M77	(a) Vector Analysis	3–6
		(b) Electives	18
		General Study	2–2
			(a) 23–27
			(b) 50

ELECTIVES

4·312	Abstract Design	10–5
4·422	Architectural History	4–5
6·77	Electrical Eng. Lab.	4–4
8·15	(b) Photography	2–1
8·201	Electronics	3–5

Fourth Year

First Term	2·01	(b) Applied Mechanics	3–5
	4·081	(b) Color, Comp. Th. & App.	1–3
	6·03	(a) Electrical Eng. Prin.	6–8
	6·271	Illuminating Eng. Prin.	5–4
	8·461	(a) Int. Theoret. Physics I	4–8
	8·50	(b) Heat and Thermodynamics	3–4
		(a) Thesis* and Electives	9
		(b) Thesis* and Electives	16
		General Study	6
			50
Second Term	2·04	(b) Applied Mechanics	3–5
	4·082	(b) Color, Comp. Th. & App.	1–3
	6·272	Illuminating Eng. Prin.	5–4
	8·462	(a) Int. Theoret. Physics II	4–8
	Ec12	Economic Principles	3–3
	G12	Biography in Science	3–3
		Thesis* and Electives	17
			50

ELECTIVES

First Term	4·081	(a) Color, Comp. Th. & App.	1–3
	4·11	Shades and Shadows	2–2
	4·641	Prin. of City Planning	2–2
	4·721	Architectural Design II	13–1
	8·171	Advanced Optics	2–3
	D21	(a) Perspective	2–2
Second Term	4·032	Freehand Drawing	4–0
	4·072	Modeling	3–0
	4·082	(a) Color, Comp. Th. & App.	1–3
	8·15	(b) Photography	2–1
	8·173	Color Measurements	3–2
	8·311	Atomic Structure	3–5

*Total for thesis at least 10 units.

ELECTRICAL ENGINEERING

OPTION VI-C. ELECTRICAL COMMUNICATIONS

STUDENTS who wish to follow particularly the theory and practice underlying Electrical Communications may register for the Electrical Communications Option at the beginning of the junior year. For admission to this Option a student must have completed the first two years of the undergraduate Course VI at the Institute or their equivalent.

The Option embraces the scientific work underlying telegraphy and telephony by wire and radio. Electromagnetic wave theory, the properties and engineering applications of electron tubes and acoustics are included as a natural part of the work in this field. A reading knowledge of German or French is required for a degree, as stated in detail on page 52.

The Option leads to the degree of Bachelor of Science in Electrical Engineering.

VI-C. ELECTRICAL COMMUNICATIONS

SAME AS REGULAR COURSE VI TO THE BEGINNING OF THIRD YEAR

Third Year

First Term	2·04	Applied Mechanics	3–5
	6·01T	Electrical Eng. Prin.	5–7
	6·75T	Electrical Eng. Lab.	4–5
	8·50	Heat & Thermodynamics	3–4
	Ec11	Economic Principles	3–3
	M31	Differential Equations	2–4
			20–28
Second Term	6·02T	Electrical Eng., Prin.	5–7
	6·30	Electrical Com., Prin.	3–6
	6·76T	Electrical Eng. Lab.	3–4
	6·77	Electrical Eng. Lab.	4–4
	8·201	Electronics	3–5
	Ec12	Economic Principles	3–3
			21–29

Fourth Year

First Term	6·031	Electrical Eng., Prin.	4–6
	6·31	Electrical Com., Prin.	3–5
	6·331	Electrical Com. Lab.	3–4
	6·781	Electrical Eng. Lab.	3–4
	8·05	Vibrations and Sound	3–6
		Elective	3–6
			19–31
Second Term	6·32	Electrical Com., Prin.	4–8
	6·332	Electrical Com. Lab.	4–4
	G12	Biography in Science	3–3
		Thesis	13
		Elective	3–6
			48

ELECTIVES SAME AS FOR COURSE VI (See page 53)

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 practically identical in academic content with Course VI and Course VI-C, and the fifth or final year includes a complete academic year of graduate work subject to the provisions described in the catalogue section of the Graduate School. The Course leads to the degree of Master of Science, together with the degree of Bachelor of Science in Electrical Engineering as of the preceding year.

Five distinct programs of industrial experience are offered in the following options:

Option 1 — Manufacturing. In coöperation with the General Electric Company.

Option 2.— Public Utilities.

(a) Light and Power. In coöperation with the Boston Edison Company.

(b) Transportation. In coöperation with the Boston Elevated Railway.

Option 3 — Communications.

(a) Wire and Radio. In coöperation with the affiliated companies of the Bell System.

(b) Electronic Apparatus Manufacturing. In coöperation with the General Radio Company.

Option 1 affords training for the technical and executive responsibilities of electrical manufacturing industries. The manufacturing practice is taken in the plants of the General Electric Company in Lynn, Schenectady, Pittsfield and Philadelphia. The earlier assignments deal with manufacturing processes and planning, instrument repair and calibration, and the testing of manufactured products. The later assignments may include research or development projects in the various laboratories.

Option 2 offers experience in the maintenance, operation and administration of a company which furnishes electric light and power or transportation as a public service. Students trained in the plants of the Boston Edison 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 students trained in the plants of the Boston Elevated Railway are assigned to maintenance of way and signals, work in car shops, the operation of surface cars, trains and busses, and act as executive assistants in the General Manager's office.

Option 3 provides practical training for students preparing to enter the field of communications engineering.

Students who get their experience with the Bell System go first to an operating company, where they work with installers supplying customer service and in telephone exchanges on the maintenance and construction 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 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.

Candidates for admission to the third year are selected late in April 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

VI-A. Electrical Engineering Continued

promising scholastic record, and by the companies upon personal qualifications which indicate adaptability to the work of the company involved.

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

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 held 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 a degree as stated in detail on page 52.

VI-A. Electrical Engineering

First Year. See page 42

Required during Summer

	1·02	Surveying	3–1

Second Year. Same as Course VI

Group A

Option 1. Manufacturing

Option 2. Public Utilities

Third Year

At M. I. T.

Summer	2·04	Applied Mechanics	3–5
Term	6·01T	Electrical Eng., Prin.	5–7
	6·75T	Electrical Eng. Lab.	4–5
	M31	Differential Equations	2–4
			14–21

At Works

First	6·02T	Electrical Eng., Prin.	5–7
Term	6·901	(1) Manufacturing Practice (General Electric Co.)	40 h.p.w
	6·911	(2) Public Utility Practice (Boston Edison Co.)	40 h.p.w.
	6·921	(2) Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.

At M. I. T.

Second	2·07	Applied Mechanics	3–5
Term	2·371	Testing Materials Lab.	2–1
	6·03T	Electrical Eng., Prin.	6–8
	6·76T	Electrical Eng., Lab.	3–4
	6·77	Electrical Eng. Lab.	4–4
	G12	Biography in Science	3–3
			21–25

Fourth Year

At Works

Summer	6·04	Electrical Eng. Prin.	6–9
Term	6·902	(1) Manufacturing Practice (General Electric Co.)	40 h.p.w.
	6·912	(2) Public Utility Practice (Boston Edison Co.)	40 h.p.w.
	6·922	(2) Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.

At M. I. T.

First	1·64	Hydraulics	3–6
Term	2·40	Heat Engineering	4–5
	6·78	Electrical Eng. Lab.	4–5
	Ec11	Economic Principles	3–3
		General Study	6
		Graduate Study	9
			48

At Works

Second	6·903	(1) Manufacturing Practice (General Electric Co.)	40 h.p.w.
Term	6·913	(2) Public Utility Practice (Boston Edison Co.)	40 h.p.w.
	6·923	(2) Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.
		Graduate Study	12

Graduate Year

At M. I. T.

Summer	6·501	Seminar	2–10
Term		Graduate Study & Thesis	24
			36

At Works

First	6·904	(1) Manufacturing Practice (General Electric Co.)	40 h.p.w.
Term	6·914	(2) Public Utility Practice (Boston Edison Co.)	40 h.p.w.
	6·924	(2) Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.
		Thesis	14

At M. I. T.

Second	6·502	Seminar	2–2
Term	15·64	Law of Business Organization	3–6
		General Study	6
		Graduate Study & Thesis	30
			49

VI-A. Electrical Engineering, Group A Continued

Group A

Option 3. Communications

Third Year

At M. I. T.

Summer	2·04	Applied Mechanics	3–5
Term	6·01T	Electrical Eng., Prin.	5–7
	6·75T	Electrical Eng. Lab.	4–5
	M31	Differential Equations	2–4
			14–21

At Works

First	6·02T	Electrical Eng., Prin.	5–7
Term	6·941	Communications Practice (Operating Telephone Company of the Bell System)	40 h.p.w.
	6·951	Electronic Apparatus Mfg. Pract. (General Radio Co.)	40 h.p.w.

At M. I. T.

Second	2·371	Testing Materials Lab.	2–1
Term	6·031T	Electrical Eng., Prin.	3–4
	6·30	Electrical Com., Prin.	3–6
	6·76T	Electrical Eng. Lab.	3–4
	6·77	Electrical Eng. Lab.	4–4
	8·201	Electronics	3–5
	G12	Biography in Science	3–3
			21–27

Fourth Year

At Works

Summer	6·31	Electrical Com. Prin.	3–5
Term	6·942	Communications Practice (Western Electric Co.)	40 h.p.w.
	6·952	Electronic Apparatus Mfg. Pract. (General Radio Co.) (Starting in 1941)	40 h.p.w.

At M. I. T.

First	2·371	Testing Materials Lab.	2–1
Term	3·333	Electrical Com. Lab.	6–6
	6·781	Electrical Eng. Lab.	3–4
	8·05	Vibrations and Sound	3–6
	8·50	Heat & Thermodynamics	3–4
	Ec11	Economic Principles	3–3
		General Study	6
			50

At Works

Second	6·32	Electrical Com., Prin.	4–8
Term	6·943	Communications Practice (Bell Telephone Lab.)	40 h.p.w.
	6·953	Electronic Apparatus Mfg. Prac. (General Radio Co.) (1941–42)	40 h.p.w.
		Grad. Study	3

Graduate Year

At M. I. T.

Summer	6·501	Seminar	2–10
Term		Graduate Study & Thesis	24
			36

At Works

First	6·944	Communications Practice (Bell Telephone System)	40 h.p.w.
Term	6·954	Electronic Apparatus Mfg. Prac. (General Radio Co.) (1942–43)	40 h.p.w.
		Thesis	14

At M. I. T.

Second	6·502	Seminar	2–2
Term	15·64	Law of Business Organization	3–6
		General Study	6
		Grad. Study & Thesis	30
			49

Group B

Option 1. Manufacturing
Option 2. Public Utilities

Third Year

At M. I. T.

Summer	6·01T	Electrical Eng., Prin.	5–7
Term	6·901	(1) Manufacturing Practice (General Electric Co.)	40 h.p.w.
	6·911	(2) Public Utility Practice (Boston Edison Co.)	40 h.p.w.
	6·921	(2) Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.

At M. I. T.

First	2·04	Applied Mechanics	3–5
Term	6·02T	Electrical Eng., Prin.	5–7
	6·75T	Electrical Eng. Lab.	4–5
	6·77	Electrical Eng. Lab.	4–4
	Ec11	Economic Principles	3–3
	M31	Differential Equations	2–4
			21–28

At Works

Second	6·03T	Electrical Eng., Prin.	6–8
Term	6·902	(1) Manufacturing Practice (General Electric Co.)	40 h.p.w.
	6·912	(2) Public Utility Practice (Boston Edison Co.)	40 h.p.w.
	6·922	(2) Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.

Fourth Year

At M. I. T.

Summer	2·04	(1) Applied Mechanics	3–5
Term	6·04	Electrical Eng., Prin.	6–9
	6·76	(2) Electrical Eng. Lab.	4–5
	6·78	Electrical Eng. Lab.	4–5
			(1) 13–19
			(2) 14–19

At Works

First	6·903	(1) Manufacturing Practice (General Electric Co.)	40 h.p.w.
Term	6·913	(2) Public Utility Practice (Boston Edison Co.)	40 h.p.w.
	6·923	(2) Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.
		Graduate Study	9

VI-A. Electrical Engineering, Group B — Option 2, Continued

At M. I. T.

Second Term	1·64	Hydraulics	3–6
	2·07	Applied Mechanics	3–5
	2·371	Testing Materials Lab.	2–1
	2·40	Heat Engineering	4–5
	Ec12	Economic Principles	3–3
	G12	Biography in Science	3–3
		Graduate Study*	6
			47

Graduate Year

At Works

Summer Term	6·904	(1) Manufacturing Practice (General Electric Co.)	40 h.p.w.
	6·914	(2) Public Utility Practice (Boston Edison Co.)	40 h.p.w.
	6·924	(2) Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.
		Seminar* and Thesis	10

At M. I. T.

First Term		General Study	6
		Graduate Study* & Thesis	42
			48

At M. I. T.

Second Term	6·502	Seminar	2–2
		General Study	6
		Graduate Study & Thesis	38
			48

Group B

Option 3. Communications

Third Year

At Works

Summer Term	6·01T	Electrical Eng., Prin.	5–7
	6·941	Communications Practice (Operating Telephone Company of the Bell System)	40 h.p.w.
	6·951	Electronic Apparatus Mfg. Prac. (General Radio Co.)	40 h.p.w.

At M. I. T.

First Term	6·02T	Electrical Eng., Prin.	5–7
	6·75T	Electrical Eng. Lab.	4–5
	6·77	Electrical Eng. Lab.	4–4
	8·50	Heat & Thermodynamics	3–4
	Ec11	Economic Principles	3–3
	M31	Differential Equations	2–4
			21–27

At Works

Second Term	6·30	Electrical Com., Prin.	3–6
	6·942	Communications Practice (Western Electric Co.)	40 h.p.w.
	6·952	Electronic Apparatus Mfg.Prac. (General Radio Co.)	40 h.p.w.

Fourth Year

At M. I. T.

Summer Term	2·04	Applied Mechanics	3–5
	6·031	Electrical Eng. Prin.	4–6
	6·76	Electrical Eng. Lab.	4–5
	6·781	Electrical Eng. Lab.	3–4
			14–20

At Works

First Term	6·31	Electrical Com., Prin.	3–5
	6·943	Communications Prac. (Bell Telephone Lab.)	40 h.p.w.
	6·953	Electronic Apparatus Mfg. Prac. (General Radio Co.) (1941–42)	40 h.p.w.

At M. I. T.

Second Term	2·371	Testing Materials Lab.	2–1
	6·32	Electrical Com., Prin.	4–8
	6·333	Electrical Com. Lab.	6–6
	8·201	Electronics	3–5
	Ec12	Economic Principles	3–3
	G12	Biography in Science	3–3
			21–26

Graduate Year

At Works

Summer Term	6·944	Communications Practice (Bell Telephone System)	40 h.p.w.
	6·954	Electronic Apparatus Mfg. Prac. (General Radio Co.) (1942–43)	40 h.p.w.
		Seminar* & Thesis	10

At M. I. T.

First Term		General Study	6
		Graduate Study* & Thesis	42
			48

At M. I. T.

Second Term	6·502	Seminar	2–2
		General Study	6
		Graduate Study* & Thesis	38
			48

*6.501 required some time before the second term of Graduate year.

VII. BIOLOGY AND PUBLIC HEALTH

THIS Department has as its objective the broad training of students in the biological sciences which may prepare them for positions in biological research, public health administration, and sanitation, or in the numerous technical applications in the food, biochemical, and fermentation industries. The first two years are largely devoted to fundamental subjects in mathematics, physics, chemistry, and an introduction to biology, and to studies of a general cultural character. The later work becomes more specialized and, to meet the various demands, five groups or options of professional studies have been established.

Coöperative arrangements have been set up with the W. K. Kellogg Foundation of Battle Creek, Michigan, by which a few students with special qualifications may undertake field studies and practical training in public health administration; holders of Kellogg Foundation Fellowships may secure credit

VII. Biology and Public Health Continued

toward the Master's degree for work done at the Foundation.

Students will begin their work with the Kellogg Foundation in the middle of the senior year, spend one year in the various divisions of the Foundation, followed by a year or more of graduate work at the Institute. This program leads to the degree of Master of Science together with the degree of Bachelor of Science as of the previous year.

OPTION 1a. BIOLOGY AND PUBLIC HEALTH. This option deals primarily with the biological sciences in general, and with their applications to public health administration and sanitation. The official health agencies of the government, federal, state, and city, as well as private corporations and unofficial health organizations utilize men well trained in bacteriology, sanitation, and the technique of health administration procedures.

The field of Public Health Administration includes a wide variety of positions, such as those of health officer, epidemiologist, sanitary inspector, statistician, etc., or experts in other phases of municipal sanitation. Closely related is industrial hygiene, which involves special inquiry into the hygiene and sanitation of industry, occupational accidents, industrial hazards, defective ventilation, and control of communicable diseases, and the special health problems in the factory or industrial plant.

This option leads to the degree of Bachelor of Science in Biology and Public Health.

OPTION 1b. BIOLOGY. Students of special promise looking forward to graduate work in Biology without reference to its technical application may be allowed to substitute advanced subjects in biology, physics, and chemistry for those subjects starred in the following schedule.

To such students the degree of Bachelor of Science in Biology may be awarded on satisfactory completion of an approved program.

OPTION 2. PUBLIC HEALTH ENGINEERING. This option is arranged to meet the increasing demand for men trained in the principles of bacteriology and sanitation, industrial hygiene, and public health administration, as well as in engineering. It includes the pl. ıning, supervising, and control of water supplies and waste disposal systems; the engineering supervision of milk supply; the development of engineering projects for securing healthful environment through proper housing and working conditions; the elimination of pests; drainage, etc. This type of engineer will find a most useful field in state and county health work, in factory sanitation and control, and in the type of work carried out by the United States Public Health Service and some of the large private health organizations.

This option leads to the degree of Bachelor of Science in Public Health Engineering.

VII. BIOLOGY AND PUBLIC HEALTH

OPTION 1 (a). BIOLOGY AND PUBLIC HEALTH
(b). BIOLOGY*

First Year. See page 42

Second Year

First Term	5·11	Qualitative Analysis	7-2
	7·01	Biology, General	5-2
	8·03	Physics	5-5
	E21	Literature and History	3-5
	M21	Calculus	3-6
	MS21	Military Science	3-0
		General Study	2-2
			28-22
Second Term	5·12	Quantitative Analysis	7-2
	7·06	Botany	6-3
	7·14	Comparative Anatomy	8-2
	8·04	Physics	6-4
	E22	Literature and History	3-5
	MS22	Military Science	3-0
			33-16

REQUIRED DURING SUMMER

	5·41	Organic Chemistry I	4-3
	5·428	Organic Chemistry Lab	10-0

Third Year

First Term	5·684	Physical Chemistry, Elem	3-3
	7·10	Invertebrate Zoölogy	7-4
	7·301	Bacteriology	6-4
	7·41	Chemistry of Water*	4-1
	7·50	Communicable Diseases	3-3
	Ec11	Economic Principles	3-3
		General Study	2-2
			28-20
Second Term	7·08	Parasitology	2-4
	7·20	Physiology	6-4
	7·302	Bacteriology	6-3
	7·42	Chemistry of Foods*	5-1
	7·57	Municipal Sanitation*	4-3
	Ec12	Economic Principles	3-3
		General Study	2-2
			28-20

Fourth Year

First Term	7·22	Pers. Hygiene & Nutrition	2-2
	7·36	Microbiology*	3-2
	7·541	Public Health Admin.*	2-3
	7·551	Public Health Lab. Meth.	8-3
	7·58	Vital Statistics*	2-3
	7·80	Biochemistry	8-5
		General Study	2-2
			27-20
Second Term	7·03	Theoretical Biology	2-3
	7·52	Industrial Hygiene*	5-3
	7·542	Public Health Admin.*	2-3
	7·552	Immunological Methods	6-1
		Thesis	16
		Elective	6
			47

*Option 1 (*b*). BIOLOGY. Students pursuing a course leading to the S.B. degree in *Biology* without reference to Public Health application may substitute with approval of the registration officer courses in biology, chemistry and physics for subjects designated by an asterisk in the above program.

VII. Biology and Public Health Continued

Option 2. Public Health Engineering

First Year. See page 42

Second Year

First	5·11	Qualitative Analysis	7-2
Term	7·01	Biology, General	5-2
	8·03	Physics	5-5
	E21	Literature and History	3-5
	M21	Calculus	3-6
	MS21	Military Science	3-0
		General Study	2-2
			28-22
Second	1·18	Map Read. and Top. Draw.	2-0
Term	2·011	Applied Mechanics	3-5
	5·12	Quantitative Analysis	7-2
	8·04	Physics	6-4
	E22	Literature and History	3-5
	M22	Differential Equations	3-6
	MS22	Military Science	3-0
			27-22

Required during Summer. At Camp Technology

1·041	Surveying	12-1
1·60	Hydrographic Surveying	5-0
7·34	Limnological Fieldwork	5-0

Third Year

First	2·042	Applied Mechanics	3-5
Term	5·41	Organic Chemistry I	4-3
	7·301	Bacteriology	6-4
	7·41	Chemistry of Water	4-1
	7·50	Communicable Diseases	3-3
	7·53	Air Examination	2-2
	Ec11	Economic Principles	3-3
		General Study	2-2
			27-23
Second	1·22	Quantity Surveying	2-2
Term	1·401	Structures	3-5
	1·62	Hydraulics	4-6
	7·302	Bacteriology	6-3
	7·57	Municipal Sanitation	4-3
	Ec12	Economic Principles	3-3
		General Study	2-2
			24-24

Fourth Year

First	1·25	Engineering Construction	4-1
Term	1·41	Structures	3-6
	1·75	Hydraulic & Sanitary Eng.	4-6
	1·801	Hydraulic & Sanitary Des.	3-0
	7·541	Public Health Admin.	2-3
	7·58	Vital Statistics	2-3
	7·59	Sanitation	5-3
		General Study	2-2
			25-24
Second	1·421	Structures	2-4
Term	1·78	Sanitary Engineering	3-4
	1·802	Sanitary Design	5-0
	2·65	Mech. Equip. Bldgs. H. & V.	4-3
	7·52	Industrial Hygiene	5-3
	7·542	Public Health Admin.	2-3
		Thesis	12
			50

VII-A. BIOPHYSICS AND BIOLOGICAL ENGINEERING

THE purpose of this course of study is to prepare for work in experimental biology of essentially research character. General biology deals with life, the environmental conditions of living matter, and the products of living things. Biochemistry is concerned with the chemistry of these matters, and biophysics with their physical aspects. The application of biological data, often best obtained by utilizing the technics of physics and chemistry for precise measurements, to problems of human welfare with planned method constitutes biological engineering.

Heretofore it has been necessary for those entering upon this field of endeavor to prepare separately in biology, chemistry, and physics. Course VII-A is designed to train the student simultaneously in the essentials of biology and of various theoretical and experimental aspects of related sciences, and to illustrate through the solving of actual research problems, under guidance, the methods of applying the various skills he has acquired.

Electives in the fourth and fifth years will permit the selection, subject to approval of the registration officer, of subjects which have a bearing upon the specialized fields of applied biology which are open to an investigator, such as metabolism, preventive or curative medicine, food technology, industrial fermentations, economic entomology, biochemistry, biophysics or electro-physiology.

Because of the diversified technical courses of study prescribed in this curriculum, only students with a demonstrated ability to handle mathematical and other precise technical subjects with facility are considered qualified to attempt the program. Each applicant for admission to Course VII-A should interview the registration officer for this Course.

This Course leads to the degree of Master of Science in Biological Engineering, and the degree of Bachelor of Science in Biophysics as of the preceding year.

VII-A. Biophysics and Biological Engineering

First Year. See page 42

Second Year

First	5·11	Qualitative Analysis	7-2
Term	7·01	Biology, General	5-2
	8·03	Physics	5-5
	E21	Literature and History	3-5
	M21	Calculus	3-6
	MS21	Military Science	3-0
		General Study	2-2
			28-22
Second	5·12	Quantitative Analysis	7-2
Term	7·14	Comparative Anatomy	8-2
	8·04	Physics	6-4
	E22	Literature and History	3-5
	M22	Differential Equations	3-6
	MS22	Military Science	3-0
			30-19

VII-A. Biophysics and Biological Engineering Continued

REQUIRED DURING SUMMER

	5·41	Organic Chemistry I	4–3
	5·428	Organic Chemistry Lab.	10–0

Third Year

First Term	5·61	Physical Chemistry I	4–4
	5·611	Physical Chemistry Lab. I	4–0
	7·10	Invertebrate Zoölogy	7–4
	7·301	Bacteriology	6–4
	Ec11	Economic Principles	3–3
		Language	3–5
			27–20
Second Term	5·62	Physical Chemistry II	4–4
	5·621	Physical Chemistry Lab. II	4–0
	6·00	Electrical Engineering Prin	4–6
	7·20	Physiology	6–4
	Ec12	Economic Principles	3–3
		Language	3–5
			24–22

Fourth Year

First Term	6·01	Electrical Eng. Prin.	4–6
	6·75	Electrical Eng. Lab.	3–4
	7·80	Biochemistry	8–5
	8·09	Physical Meas.	3–2
	8·161	Optics	3–6
	8·162	Optical Measurements	3–2
			24–25
Second Term	7·84	Biophysics	6–3
	8·311	Atomic Structure	3–5
	8·312	Atomic Structure Lab.	3–2
		General Study	2–2
		Electives	20
			46

Graduate Year

First Term	7·321	Bacteriology, Adv.	3–4
	7·81	Zymology	6–3
	7·91	Biological Eng. I	6–3
	10·661	Intro. Colloid Chemistry	2–4
		Elective	9
		Thesis	10
			50
Second Term	7·82	Biochemistry, Adv.	6–3
	7·92	Biological Eng. II	4–2
	10·662	Colloid Chemistry	2–4
		Elective	9
		Thesis	20
			50

VII-B. FOOD TECHNOLOGY AND INDUSTRIAL BIOLOGY

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 the personnel to interpret the significance of such developments in commercial practice.

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

This training is equally valuable for those desiring to enter the rapidly growing fermentation industries yielding glycerine, industrial alcohols, solvents, organic acids, or other commercial products of organic origin; the wood preservation industries, and numerous others which are concerned with the control of biological agencies 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 and Industrial Biology.

VII-B. FOOD TECHNOLOGY AND INDUSTRIAL BIOLOGY

First Year. See page 42

Second Year

First Term	5·11	Qualitative Analysis	7–2
	7·01	Biology, General	5–2
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		General Study	2–2
			28–22
Second Term	5·12	Quantitative Analysis	7–2
	7·06	Botany	6–3
	7·14	Comparative Anatomy	8–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	MS22	Military Science	3–0
			33–16

REQUIRED DURING SUMMER

	5·41	Organic Chemistry I	4–3
	5·428	Organic Chemistry Lab.	10–0

Third Year

First Term	5·684	Physical Chemistry, Elem.	3–3
	7·17	Biology of Food Supplies	3–2
	7·301	Bacteriology	6–4
	7·41	Chemistry of Water	4–1
	7·701	Technology & Chem. Food Supplies	7–4
	Ec11	Economic Principles	3–3
		General Study	2–2
			28–19

VII-B. Food Technology and Industrial Biology Continued

Second	5·141	Analytical Chemistry	4–1
Term	7·20	Physiology	6–4
	7·302	Bacteriology	6–3
	7·33	Plant Diseases	1–2
	7·57	Municipal Sanitation	4–3
	7·702	Technology & Chem. Food Supplies	4–4
	Ec12	Economic Principles	3–3
			28–20

Fourth Year

First	2·60	Food Engineering	2–2
Term	7·22	Pers. Hygiene & Nutrition	2–2
	7·361	Industrial Microbiology	5–2
	7·711	Technology Food Products	6–4
	7·80	Biochemistry	8–5
		General Study	2–2
		Thesis or Elective	6
			48
Second	2·601	Food Engineering	3–3
Term	7·362	Industrial Microbiology	4–4
	7·52	Industrial Hygiene	5–3
	7·712	Technology Food Products	5–4
		Thesis	12
		General Study	2–2
			47

VIII. PHYSICS

PHYSICS in recent years has been one of the most rapidly developing sciences, and at the same time is the basic science for most branches of engineering. The Course in Physics, with its two options, is intended to be sufficiently broad to provide for the needs of those who desire to prepare for graduate work and research in pure physics, either experimental or theoretical, as well as for those who desire to go into work in industrial and applied physics. Students are given a sound fundamental training in the various branches of physics, as well as in mathematics, chemistry, and liberal subjects. Laboratory instruction is given in the more important phases of experimental physics, including modern physics, and training in theoretical physics is provided.

OPTION 1. GENERAL PHYSICS. This option is for students preparing for a career of research and teaching of physics, often after pursuing graduate work. There is thorough training in the classical foundations of physics, but also much work in modern physics, atomic structure, and similar fields in which most of the recent progress of physics has been made. Mathematics and mathematical physics, as well as experimental physics of all types, are stressed. In the third and fourth years considerable elective work is included, some of which may be taken in other departments. Electives are to be chosen in consultation with the registration officer, who can give specific suggestions regarding them. A few types of electives follow:

Experimental or theoretical subjects in physics, such as optics, acoustics, electricity and electronics, X-rays, spectroscopy, and various topics in theoretical physics; mathematical subjects, such as mechanics, analysis, advanced calculus, higher algebra; chemical subjects, such as quantitative analysis, organic chemistry, and physical chemistry.

OPTION 2. APPLIED PHYSICS. Physics is fundamental to engineering, and the techniques of physics are tools of great value in many branches of industry. For effective industrial work, however, physics, particularly in its more classical and experimental phases, should be supplemented with chemistry, metallurgy, and electrical engineering, all of which are essential in industrial laboratories. The option in applied physics includes thorough training in these fields, and graduates of the option should have just the sort of training needed for a wide variety of industrial openings, while being well prepared at the same time for further graduate study.

Electives are included in the fourth year, some of which may be taken outside the department, in fields of scientific or engineering interest. In some cases, minor rearrangements and substitutions of required subjects and electives may be made to fit in with special programs of work. The registration officer should be consulted in regard to such rearrangements.

Both options of Course VIII lead to the degree of Bachelor of Science in Physics.

OPTION 1. GENERAL PHYSICS

First Year. See page 42

Second Year

First	5·11	Qualitative Analysis	7–2
Term	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		Language	3–5
			24–23
Second	2·855	Machine Tool Laboratory	2–0
Term	6·00	Electrical Eng., Prin.	4–6
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
			24–26

Third Year

First	6·11	Electrical Eng., Prin.	4–6
Term	6·82	Electrical Eng. Lab.	2–3
	8·09	Physical Measurements	3–2
	8·161	Optics	3–6
	8·162	Optical Measurements	3–2
	8·511	Thermodyn. & Statis. Mech.	3–4
	Ec11	Economic Principles	3–3
			21–26

VIII. Physics Continued

Second Term	8·201	Electronics	3–5
	8·202	Electronics Laboratory	3–2
	8·311	Atomic Structure	3–5
	8·312	Atomic Structure Lab.	3–2
	Ec12	Economic Principles	3–3
	M77	Vector Analysis	3–6
		Elective	6
			47

Fourth Year

First Term	8·11	Experimental Physics	8–4
	8·461	Int. Theoretical Physics I	4–8
	8·471	Hist. Develop. Physics	3–6
		General Study	2–2
		Elective and Thesis	12
			49
Second Term	8·12	Experimental Physics	2–4
	8·13	Colloquium	2–2
	8·462	Int. Theoretical Physics II	4–8
		General Study	2–2
		Elective and Thesis	23
			49

Option 2. Applied Physics

First Year. See page 42

Required during Summer

	5·11	Qualitative Analysis	7–2

Second Year

First Term	5·12	Quantitative Analysis	7–2
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		Language	3–5
			24–23
Second Term	2·855	Machine Tool Laboratory	2–0
	6·00	Electrical Eng., Prin.	4–6
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
			24–26

Third Year

First Term	5·61	Physical Chemistry I	4–4
	6·11	Electrical Eng., Prin.	4–6
	6·82	Electrical Eng. Lab.	2–3
	8.09	Physical Measurements	3–2
	8·161	Optics	3–6
	8·162	Optical Measurements	3–2
	Ec11	Economic Principles	3–3
			22–26
Second Term	3·30	Metallography	4–1
	5·62	Physical Chemistry II	4–4
	8·201	Electronics	3–5
	8·202	Electronics Lab.	3–2
	8·311	Atomic Structure	3–5
	8·312	Atomic Structure Lab.	3–2
	Ec12	Economic Principles	3–3
		Elective	5
			50

Fourth Year

First Term	5·41	Organic Chemistry I	4–3
	8·11	Experimental Physics	8–4
	8·461	Int. Theoretical Physics I	4–8
		General Study	2–2
		Elective and Thesis	14
			49
Second Term	8·12	Experimental Physics	2–4
	8·13	Colloquium	2–2
	8·462	Int. Theoretical Physics II	4–8
		General Study	2–2
		Elective and Thesis	23
			49

IX-A. GENERAL SCIENCE

(Administered by a Committee of the Faculty)

THE Course in General Science provides an opportunity for the study of all the fundamental sciences. It is designed to develop in the student a comprehensive sense of the orientation and coördination of science in general. Since one-third of the units required for graduation are elective, opportunity is also offered for specialization in that branch of science in which the student by contact and trial becomes most interested.

The Course occupies a position in the technical school similar to those courses in the university leading to the degree of bachelor of arts. In one case the student acquires a general knowledge of many of the sciences with considerable emphasis upon one. In the university the student graduates with a general knowledge of many of the liberal arts with some degree of specialization in one.

The choice of electives is subject to the approval of the Committee on Course IX and in all cases must follow a definite objective. Substitutions may be made for many of the subjects in the stated schedule if such substitutions afford better preparation for a particular objective. Fifteen units are assigned to the thesis, five in the first term and ten in the second, unless the subject demands an extension. The composite group of science subjects must comprise an amount of scientific training equivalent to that obtained in the standard science Courses.

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

IX-A. General Science Continued

IX-A. General Science

First Year. See page 42

Second Year

First Term	5·11	Qualitative Analysis	7–2
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		Language†	3–5
			24–23
Second Term	5·12	Quantitative Analysis	7–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
			25–22

Third Year

First Term	2·501	Heat Measurements	2–1
	5·41	Organic Chemistry I	4–3
	7·01	Biology, General	5–2
	12·01	Mineralogy	8–2
	12·321	App. Engineering Geology	5–2
	Ec11	Economic Principles	3–3
		Elective*	6
			46
Second Term	5·418	Organic Preparations	6–0
	Ec12	Economic Principles	3–3
		Elective*	35
			47

Fourth Year

First Term	Elective* and Thesis	50
Second Term	Elective* and Thesis	50

IX-B. GENERAL ENGINEERING

(Administered by a Committee of the Faculty)

THE Course in General Engineering contains a comprehensive survey of the applications of science to the primary branches of engineering. It is designed to develop in its graduates the ability to visualize and adjust the correlated problems encountered in all fields of engineering. Since nearly one-third of the units required for graduation are elective, opportunity is also provided for specialization in that branch of engineering in which the student by contact and trial becomes most interested.

Standard engineering courses cannot be expected to embrace all of the technical requirements of the industrial world. The demand for new courses in special fields of engineering will constantly arise and the educational opportunity is provided in this Course for their introduction and development.

*Electives must include a total of not less than 8 units of General Study; 16 units if language omitted.

†Accepted as a General Study.

The choice of electives is subject to the approval of the Committee on Course IX and in all cases must follow a definite engineering objective. Substitutions may be made for many of the subjects in the stated schedule if such substitutions afford better preparation for a particular objective. Fifteen units are assigned to the thesis, five in the first term and ten in the second, unless the subject demands an extension. The composite group of engineering subjects must also comprise an amount of professional engineering training equivalent to that obtained in the standard engineering curricula.

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

IX-B. General Engineering

First Year. See page 42

Second Year

First Term	2·00	Applied Mechanics	3–5
	2·701	Machine Drawing	6–0
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		Elective*	6
			50
Second Term	1·02	Surveying	3–1
	2·01	Applied Mechanics	3–5
	2·854	Machine Tool Laboratory	3–0
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			24–21

Third Year

First Term	2·04	Applied Mechanics	3–5
	2·40	Heat Engineering	4–5
	Ec11	Economic Principles	3–3
		Elective*	24
			47
Second Term	1·401	Structures	3–5
	1·62	Hydraulics	4–6
	2·42	Heat Engineering	4–5
	6·40	Electrical Eng. Elem.	4–6
	Ec12	Economic Principles	3–3
		Elective*	6
			49

Fourth Year

First Term	2·686	Engineering Laboratory	3–3
	6·85	Electrical Eng. Lab.	2–3
		Elective* and Thesis	37
			48
Second Term		Elective* and Thesis	48

*Electives must include a total of not less than 16 units of General Study.

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

REQUIRED DURING SUMMER

	5·10	Qualitative Analysis	14–4

Second Year

First Term	5·12	Quantitative Analysis	7–2
	8·03	Physics	5–5
	10·11	Prob. of the Chem. Engr.	1–0
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		Language	3–5
			25–23
Second Term	5·13	Quantitative Analysis	5–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
		General Study	2–2
			25–24

Students will take one year of Language, as outlined below, except that those credited with Intermediate German and Elementary French may substitute other studies (including at least four units of General Study).

Students not credited with German will take Elementary German. Students credited with German but not with French will take Elementary French. Students credited with Elementary German and French but not with Intermediate German will take Intermediate German.

Third Year

First Term	2·011	Applied Mechanics	3–5
	5·41	Organic Chemistry I	4–3
	5·416	Organic Preparations	7–0
	5·61	Physical Chemistry I	4–4
	5·612	Physical Chem. Lab. I	2–0
	10·28	Chemical Engineering	4–6
	Ec11	Economic Principles	3–3
			27–21
Second Term	2·042	Applied Mechanics	3–5
	5·42	Organic Chemistry I	4–2
	5·426	Ident. of Org. Compounds	5–0
	5·62	Physical Chemistry II	4–4
	5·622	Physical Chem. Lab. II	2–0
	10·17	Industrial Chemistry	3–2
	10·29	Chemical Engineering	4–5
	Ec12	Economic Principles	3–3
			28–21

Fourth Year

First Term	2·371	Testing Materials Lab.	2–1
	6·40	Electrical Eng. Elem.	4–6
	6·85	Electrical Eng. Lab.	2–3
	10·18	Industrial Chemistry	4–6
	10·26	Industrial Chemical Lab.	5–1
	10·31	Chemical Engineering	4–5
		General Study	2–2
		Thesis	3
			50
Second Term	2·688	Engineering Laboratory	3–3
	10·15	Thesis Reports	2–2
	10·21	Industrial Chemistry	2–2
	10·32	Chemical Engineering	4–5
		Prof. Elective and Thesis	22
		General Study	2–2
			49

The time devoted to Electives must be not less than 8 units and not more than 12 units, the time adjustment being made with the hours assigned to thesis. Students admitted to Course X-A should take Analytical Chemistry 5·16 (4–1) as an elective subject in the second term of the fourth year.

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, on the program given below. 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.

X-B. Chemical Engineering Practice Continued

X-B. Chemical Engineering Practice

Fourth Year

First	2·371	Testing Materials, Lab.	2–1
Term	6·40	Electrical Eng. Elem.	4–6
	6·85	Electrical Eng. Lab.	2–3
	10·18	Industrial Chemistry	4–6
	10·31	Chemical Engineering	4–5
	10·32	Chemical Engineering	4–5
		General Study	2–2
			22–28
Second	10·26	Industrial Chemical Lab.	5–1
Term	10·30	Engineering Equipment	4–1
		*Field Station	12
		*Field Station	12
		Thesis	15
			50

*Students will take two of the following Stations:

10·84	Bangor	12
10·85	Parlin	12
10·86	Buffalo	12

XI. SANITARY ENGINEERING

(Administered by the Department of Civil and Sanitary Engineering)

THE curriculum for the Course in Sanitary Engineering includes training in the basic sciences underlying the field of sanitation and its relation to the public health. The professional subjects are arranged especially for training in the principles of operation and design of water works, water treatment plants, sewerage systems and works for the disposal of sewage and other wastes; and for the study of the principles of sanitation of public waters.

The course of study includes surveying, structures, hydraulics and other civil engineering subjects essential to complete engineering service in connection with the construction of sanitary engineering works, and also such subjects in mechanical and electrical engineering as are required to familiarize the student with the principles underlying the selection of mechanical equipment. Much time is devoted to instruction and laboratory work in analytical, organic, physical and sanitary chemistry and to the biology and bacteriology of water and sewage. Extended subjects run throughout the fourth year in the principles of the treatment processes and in the design and operation of water works, water treatment plants, sewerage systems and sewage and waste disposal works. Graduate subjects are offered which deal intensively with the principles of the treatment processes, including the self-purification of public waters, and the design of treatment works.

Opportunities are offered to fourth year and graduate students for group inspection of nearby water and sewage works. Facilities are available in the Sanitary Engineering Laboratory and in other laboratories of the Institute for research work in sanitary hydraulics and in the treatment of water and wastes.

Graduates of this Course are prepared for service with private or public engineering organizations engaged in the operation and in the design and supervision of construction of water and sewage works; for employment with contractors or manufacturers engaged in the building of water and sewage works or equipment therefor; and for service in the broader fields of municipal, state or national public health work.

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

XI. Sanitary Engineering

First Year. See page 42

Second Year

First	5·11	Qualitative Analysis	7–2
Term	7·01	Biology, General	5–2
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		General Stduy	2–2
			28–22
Second	1·18	Map Read. and Top. Draw.	2–0
Term	2·011	Applied Mechanics	3–5
	5·12	Quantitative Analysis	7–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			27–22

Required during Summer. At Camp Technology

1·041	Surveying	12–1
1·60	Hydrographic Surveying	5–0
7·34	Limnological Fieldwork	5–0

Third Year

First	2·042	Applied Mechanics	3–5
Term	5·41	Organic Chemistry I	4–3
	5·418	Organic Preparations	6–0
	6·40	Electrical Eng. Elem.	4–6
	6·89	Electrical Eng. Lab.	2–2
	7·41	Chemistry of Water	4–1
	Ec11	Economic Principles	3–3
		General Study	6
			52
Second	1·22	Quantity Surveying	2–2
Term	1·40	Structures	7–4
	1·58	Des. Reinf. Concrete Structures	6–0
	1·62	Hydraulics	4–6
	2·371	Testing Materials Lab.	2–1
	7·29	Bacteriology	6–2
	Ec12	Economic Principles	3–3
			30–18

XI. Sanitary Engineering Continued

Fourth Year

First Term	1·25	Engineering Construction	4–1
	1·41	Structures	3–6
	1·48	Foundations	3–4
	1·75	Hydraulic & San. Eng.	4–6
	1·801	Hydraulic & San. Des.	3–0
	2·411	Heat Engineering	2–4
	5·684	Physical Chemistry, Elementary	3–3
		Thesis	2
			48
Second Term	1·42T	Structures	3–6
	1·52	Structural Design	3–0
	1·78	Sanitary Engineering	3–4
	1·802	Sanitary Design	5–0
	2·421	Heat Engineering	2–4
	2·687	Hydraulic Laboratory	2–2
		General Study	6
		Thesis	7
			47

XII. GEOLOGY

TWO optional Courses of study are offered in this Department.

OPTION 1, GEOLOGY. This is planned for students who wish to make geology in its theoretical and practical aspects their principal subject of study. An adequate foundation of subjects in physics, chemistry and mathematics is followed by the foundational subjects in geology (general geology and mineralogy), which in turn are followed by more advanced and specialized subjects of the Department.

The option is designed for students seeking a broad general preparation, as well as for those planning to follow one of the several lines of specialization in the field of geology. The schedule of this option is sufficiently flexible to permit an adequate range of specialization by means of substitution of equivalent subjects for those designated, and through the use of electives. Students whose interests and aptitudes have led to a choice of specialization may upon consultation with their major professor arrange a schedule of subjects designed to attain the type of instruction and training desired. 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.

OPTION 2, MINERAL RESOURCES. Planned to afford a suitable schedule of subjects for students desiring to prepare for professional work in the mineral industries. This schedule of subjects provides a thorough preparation in the fundamentals of mathematics, physics, chemistry, and geology, with emphasis on the economic aspects of mineral resources. The course is made sufficiently flexible, particularly in the last year, for such specialization as the individual student may desire.

Both options of Course XII lead to the degree of Bachelor of Science in Geology.

XII. OPTION 1. GEOLOGY

First Year. See page 42

Second Year

First Term	5·11	Qualitative Analysis	7–2
	8·03	Physics	5–5
	12·301	General Geology	7–2
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
			28-20
Second Term	8·04	Physics	6–4
	12·302	General Geology	7–2
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Elective	9
			48

XII. Geology Continued

Third Year

First Term	12·01	Mineralogy	8–2
	12·211	Optical Crystallography	5–2
	12·70	Structural Geology	3–6
	Ec11	Economic Principles	3–3
		Language	3–5
		Elective	8
			48
Second Term	12·15	Petrography	8–2
	12·40	Economic Geology	3–6
	Ec12	Economic Principles	3–3
		General Study	6
		Language	3–5
		Elective	9
			48

Fourth Year

First Term	12·38	Geomorphology	3–6
	12·581	Sedimentation	5–2
		General Study	6
		Elective and Thesis*	26
			48
Second Term		Elective and Thesis*	48

*Total Thesis not less than 15 units.

XII. Option 2. Mineral Resources

First Year. See page 42

Second Year

First Term	5·11	Qualitative Analysis	7–2
	8·03	Physics	5–5
	12·301	General Geology	7–2
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
			28–20
Second Term	2·011	Applied Mechanics	3–5
	8·04	Physics	6–4
	12·302	General Geology	7–2
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			25–22

Third Year

First Term	2·042	Applied Mechanics	3–5
	5·61	Physical Chemistry I	4–4
	12·01	Mineralogy	8–2
	12·70	Structural Geology	3–6
	Ec11	Economic Principles	3–3
		Elective	7
			48
Second Term	5·62	Physical Chemistry II	4–4
	12·15	Petrography	8–2
	12·40	Economic Geology	3–6
	Ec12	Economic Principles	3–3
	Ec32	Statistics	3–3
		Elective	9
			48

Fourth Year

First Term	6·40	Electrical Eng., Elem.	4–6
	6·85	Electrical Eng. Lab.	2–3
	12·91	Elements of Mining	4–4
		General Study	6
		General Study	4
		Elective and Thesis*	15
			48
Second Term	12·92	Mining Methods & Practice	5–4
		General Study	3–3
		Elective and Thesis*	33
			48

*Total Thesis not less than 15 units.

XIII. NAVAL ARCHITECTURE AND MARINE ENGINEERING

THE Course in Naval Architecture and Marine Engineering provides instruction in the theory and methods of designing and building ships, together with a study of the properties requisite for safety and steadiness at sea. It aims to furnish a well-rounded training for those who expect to be shipbuilders, ship designers or marine engine builders, or who desire to enter allied industries.

In addition to the literary, mathematical and scientific studies requisite for a general training and for preparation for the special work of the course, instruction is given in heat engineering, applied mechanics, fluid mechanics, steam turbines, electrical engineering and marine engineering. It is believed that a proper coördination of the design of a steamship and its propelling machinery can be attained only by a naval architect who is familiar with both branches of his profession.

Lectures are given on theoretical naval architecture and marine engineering, treating of displacement and stability, launching, theory of waves, rolling of ships, strength of ships, propulsion of ships, steering and maneuvering, and also of power, proportions and strength of marine engines, auxiliary machinery and the application of steam turbines and Diesel engines to marine propulsion.

After preliminary instruction in ship drawing, each student carries through the design of a ship and its machinery for a given service in a systematic manner as in good practice, giving attention both to

XIII. Naval Architecture and Marine Engineering Continued

the logical development of the design and to the requirements for registration, for insurance and governmental inspection. Drawings and all customary computations are made of the structure and arrangements of hull, engines and propellers. To explain and unify the work of design, lectures are given on the materials and methods of construction of ships of wood and of steel, and on their equipment.

Such items as economy of cost during construction, the influence of marine insurance, and the rules of the Registration Societies, the stability at beginning and end of voyage and its effect on the behavior of the ship at sea, the freeboard and tonnage laws, types of propelling machinery and the general sequence of work in the shipbuilding yard are described, and their effects on the problems of design are discussed.

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

Naval Architecture and Marine Engineering

First Year. See page 42

Second Year

First	2·00	Applied Mechanics	3–5
Term	2·851	Machine Tool Lab.	4–0
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		General Study	6
			48
Second	2·01	Applied Mechanics	3–5
Term	2·852	Machine Tool Practice	4–0
	8·04	Physics	6–4
	13·40	Yacht Architecture	6–1
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			28–21

Third Year

First	2·04	Applied Mechanics	3–5
Term	2·251	Fluid Mechanics	5–3
	2·40	Heat Engineering	4–5
	13·01	Naval Architecture	3–5
	13·34	Ship Construction	4–4
	13·41	Ship Drawing	3–0
	Ec11	Economic Principles	3–3
			25–25
Second	2·06	Applied Mechanics	3–5
Term	2·42	Heat Engineering	4–5
	2·683	Engineering Laboratory	2–2
	13·02	Naval Architecture	3–5
	13·43	Ship Design	6–0
	13·52	Marine Engineering	4–4
	Ec12	Economic Principles	3–3
			25–24

Fourth Year

First	6·40	Electrical Eng., Elem.	4–6
Term	6·89	Electrical Eng. Lab.	2–2
	13·45	Ship Design	10–1
	13·54	Marine Engineering	2–3
	13·61	Marine Engineering Design	7–1
		General Study	2–2
		Elective	6
			48
Second	2·311	Engineering Materials	6–3
Term	2·371	Testing Materials Lab.	2–1
	2·684	Engineering Laboratory	2–2
	13·55	Marine Engineering	2–3
	13·62	Marine Engineering Design	6–0
		Thesis and Elective	16
		General Study	6
			49

XIII-C. MARINE TRANSPORTATION

THIS five-year Course is intended 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 will ordinarily be spent in the engine room and part on deck. In some cases, it will also include duty in the purser's department. Three months may be spent on the piers in connection with cargo handling.

While at sea the students will be assigned regular duties in connection with the operation of the ship for which they will receive a moderate amount of pay. The year at sea is considered an integral part of the student's educational program and he will be 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 co-

XIII-C. Marine Transportation Continued

ordinate with the year at sea. In the second and third year, subjects are given in heat engineering, marine engineering, port facilities, 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. Electives are also offered in the fifth year to allow the student to specialize in some phase of marine transportation.

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 covers five years and leads to the degree of Bachelor of Science in Marine Transportation.

XIII-C. Marine Transportation

First Year. See page 42

Second Year

First	2·00	Applied Mechanics	3–5
Term	2·854	Machine Tool Lab.	3–0
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		Language	3–5
			23–26
Second	2·01	Applied Mechanics	3–5
Term	8·04	Physics	6–4
	15·52	Accounting	4–2
	E22	Literature and History	3–5
	G28	Economic Geography	3–3
	MS22	Military Science	3–0
		Language	3–5
			25–24

Third Year

First	2·04	Applied Mechanics	3–5
Term	2·40	Heat Engineering	4–5
	13·01	Naval Architecture	3–5
	13·34	Ship Construction	4–4
	13·83	Port Facilities	3–4
	Ec11	Economic Principles	3–3
			20–26
Second	2·42	Heat Engineering	4–5
Term	2·685	Engineering Laboratory	4–4
	13·021	Naval Architecture	2–3
	13·52	Marine Engineering	4–4
	Ec12	Economic Principles	3–3
		General Study	2–2
		Elective	6
			46

Fourth Year

Students spend the fourth year (12 months) in practical work with a steamship company, with at least nine months' service at sea. After this year, they return to the Institute for the work of the fifth year.

Fifth Year

First	6·40	Electrical Eng. Elem.	4–6
Term	6·89	Electrical Eng. Lab.	2–2
	13·34	Ship Construction*	4–4
	13·56	Marine Engineering	3–3
	13·81	Ship Operation	3–5
	Ec61	Labor Relations	2–4
		Elective	6
			48
Second	13·47	Ship Design	6–0
Term	13·82	Ship Operation	3–5
	15·20	Ocean Shipping Administration	2–4
	Ec54	Corporations	3–3
		Thesis and Elective	18
		General Study	6
			50

*Ship Construction is taken in the Senior Year by the class of 1941 only. For classes after 1941, Ship Construction will be replaced by Law of Contracts (15·61).

XV. BUSINESS AND ENGINEERING ADMINISTRATION

THE Course in Business and Engineering Administration provides a special curriculum for men who combine an aptitude for engineering with a potential capacity for important managerial responsibility. It was first established and has continued 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.

Students enrolled in Course XV 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 and the general public. 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 options, depending upon whether the student desires to base his technical work on the physical or the chemical sciences. These options have been approved by the Engineers' Council for Professional Development, and thus fulfil state requirements for the practice of engineering.

In Option 1, in which the engineering subjects are based on the physical sciences, the student is offered in his last two years a considerable amount of lati-

XV. Business and Engineering Administration Continued

tude as to the particular type of engineering which he desires to study. This flexibility is accomplished by the provision of a considerable number of elective hours in the third and fourth years. These elective hours are used for engineering subjects, and a coördinated program of study in some particular branch of engineering is organized by the student, prior to the third year, in collaboration with his registration officer. For example, coördinated third and fourth year programs elected in mechanical, aeronautical, civil and electrical engineering have incorporated fields of study as follows:

Civil Engineering:

Surveying, topographical drawing, railway and highway curves and field work, hydrographic surveys, quantity surveys, structures and structural design, engineering construction, foundations, and transportation engineering.

Mechanical Engineering:

Machine drawing and design, machine tool laboratory and practice, engineering metals and materials testing laboratory, heat engineering, refrigeration and air conditioning, engineering laboratory, industrial plant engineering, manufacturing engineering, preparation for manufacturing, diesel engine design, and principles of textile fabric structure.

Electrical Engineering:

Introduction to electrical engineering, electrical engineering and principles, electrical engineering laboratory, application of electricity in industry, electrical equipment of buildings.

Aeronautical Engineering:

Airplane shop work, aircraft production methods, introduction to aeronautical mechanics, aerodynamic airplane design, aircraft structures, aeronautical laboratory, synoptic meteorology, and meteorological laboratory.

In Option 2, 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 Option undertakes a dependent sequence of technical subjects which begins the coördinated three-year program:

Qualitative Analysis (Summer Session)
Physics (two terms)
Quantitative Analysis

With this background, he is prepared to undertake, in the third year, the following subjects:

Organic Chemistry
Physical Chemistry (two terms)
Chemical Engineering (two terms)
Industrial Chemistry

In the fourth year, the applications of chemistry and chemical engineering in industry will be presented as follows (in effect 1941–42):

Industrial Chemistry (two terms)
Industrial Chemistry Laboratory
Chemical Engineering (two terms)

The program of business and economic subjects offered in the undergraduate course 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. He then undertakes the study of economics, in which he learns the nature of the forces which underlie business phenomena. At an early stage he receives training in statistics, which later serves as a useful analytical tool. In his third year he begins his study of business relationships, with marketing, law of contracts, and banking. 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 and labor relations. 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 term in residence, 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 options of the Course lead to the degree of Bachelor of Science in Business and Engineering Administration.

For men interested in shipping administration, ship management and other branches of marine transportation the Institute offers a course in Marine Transportation (XIII-C).

XV. Business and Engineering Administration Continued

XV. Option 1

(Engineering — Based on Physical Sciences)

First Year. See page 42

Second Year

First Term	2·00	Applied Mechanics	3–5
	8·03	Physics	5–5
	15·01	Field of Business Manage	1–0
	15·70	Production	3–6
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
			20–27
Second Term	2·01	Applied Mechanics	3–5
	8·04	Physics	6–4
	Ec11	Economic Principles	3–3
	Ec32	Statistics	3–3
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			24–26

Required during Summer

Reading in Economics or Business Subjects

Third Year

First Term	2·04	Applied Mechanics	3–5
	15·50	Accounting	5–4
	15·61	Law of Contracts	3–6
	Ec12	Economic Principles	3–3
	E35	Reports	2–4
		Engineering Electives†	10
			48
Second Term	6·40	Electrical Eng., Elem.	4–6
	6·89	Electrical Eng. Lab.	2–2
	15·81	Marketing	3–6
	Ec40	Money and Banking	3–3
		Engineering Electives†	15
		General Study	6
			50

Required during Summer

Business experience approved by the Department as to amount and nature. May include employment in industry or commerce, reports on industrial plants or communities, or an advanced course of reading.

Fourth Year

First Term	1·63	Hydraulics	2–3
	15·41	Finance	3–6
	Ec61	Labor Relations	2–4
		Business or Economic Elective	9
		Engineering Electives†	14
		General Study	6
			49
Second Term	15·92	Industrial Problems	2–6
		Business or Economic Electives	18
		Engineering Elective†	8
		General Study	6
		Thesis	10
			50

† Engineering Electives are to form a coördinated program of study in some field of engineering or science. The student's entire program of electives is to be approved by his registration officer prior to the beginning of the *first term of the third year.*

Business and Economic Electives

2·872	Preparation for Manufacturing	2–4
15·42	Financial Problems	3–6
15·51	Industrial Accounting	5–4
15·62	The Law of the Market	3–6
15·64	Law of Business Organization	3–6
15·71	Production	3–6
15·72	Technique of Executive Control	3–6
15·73	Management Laboratory	3–3
15·82	Sales Management	3–6
15·83	Marketing Research	3–6
Ec62	Personnel and Labor Problems	2–4
Ec72	American Government	3–6
Ec81	Human Problems in Industry	2–4
Ec83	Urban Sociology	2–4
Ec84	Social & Econ. Factors in City Planning	2–4
M54	Mathematical Laboratory	3–6

XV. Option 2

(Engineering — Based on Chemical Sciences)

First Year. See page 42

Required during Summer

5·10	Qualitative Analysis	14–4

Second Year

First Term	8·03	Physics	5–5
	15·01	Field of Business Manage	1–0
	15·70	Production	3–6
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		General Study	6
			46
Second Term	5·12	Quantitative Analysis	7–2
	8·04	Physics	6–4
	Ec11	Economic Principles	3–3
	Ec32	Statistics	3–3
	E22	Literature and History	3–5
	MS22	Military Science	3–0
		General Study	6
			48

Required during Summer

Reading in Economics or Business Subjects

Third Year

First Term	5·41	Organic Chemistry I	4–3
	5·61	Physical Chemistry I	4–4
	10·28	Chemical Engineering	4–6
	15·61	Law of Contracts	3–6
	15·81	Marketing	3–6
	Ec12	Economic Principles	3–3
			21–28

XV. Business and Engineering Administration Continued

Second	5·62	Physical Chemistry II	4–4
Term	10·17	Industrial Chemistry	3–2
	10·29	Chemical Engineering	4–5
	15·50	Accounting	5–4
	Ec40	Money and Banking	3–3
	E35	Reports	2–4
		General Study	6
			49

REQUIRED DURING SUMMER

Business experience approved by the Department as to amount and nature. May include employment in industry or commerce, reports on industrial plants or communities, or an advanced course of reading.

Fourth Year

First	10·201	Industrial Chemistry	4–4
Term	10·26	Industrial Chemical Lab.	5–1
	10·31	Chemical Engineering	4–5
	15·41	Finance	3–6
	Ec61	Labor Relations	2–4
		Business or Economic Elective	6
		General Study	6
			50

Second	10·21	Industrial Chemistry	2–2
Term	10·32	Chemical Engineering	4–5
	15·92	Industrial Problems	2–6
		Business or Economic Electives	12
		General Study*	6
		Thesis	10
			49

BUSINESS AND ECONOMIC ELECTIVES

(See listing under Option 1)

* Each student must have taken 16 units of General Study to meet requirements for graduation.

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, such as internal combustion engines or meteorology.

The theoretical work in airplane design is supplemented by a small amount of demonstration flying at the East Boston Airport, carried out under the supervision of the Institute by a competent local operator who serves as both instructor and pilot. Participation in such flight demonstrations is optional with the student and no fee is charged.

The students' Aeronautical Engineering Society, affiliated with the Institute of Aeronautical Sciences, serves to bring its members in touch with professional developments through the National Society and its Journal. Members of the A. E. S. have a meeting place and workshop in which gliders are designed and built for use in competitive glider meets.

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 spring examinations. Toward the end of the second year, a limited number of additional applications will be considered.

Students who wish to enter this Course by transfer from other colleges, unless their previous work has been of unusual distinction, are required to enter the Institute as unclassified students. They may then take the subjects for which they are prepared and will be permitted to enroll in Course XVI only if they show themselves capable of doing work of the required standard.

The professional work of the fourth year presupposes preparation in theoretical and applied aerodynamics and structures (16·01, 16·02, and 16·10 and 16·20). *These subjects are offered during the summer session for transferring students who are otherwise prepared for fourth year work, if there is sufficient demand.*

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.

XVI. Aeronautical Engineering Continued

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.

Economics and Engineering Course

The five-year course leading to the degree of Master of Science in Economics and Engineering together with the degree of Bachelor of Science in Aeronautical Engineering is described on page 121. This course is open to Juniors in Aeronautical Engineering.

XVI. Aeronautical Engineering

First Year. See page 42

Second Year

First	2·00	Applied Mechanics	3–5
Term	5·683	Physical Chemistry, E'em	2–2
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		Language	3–5
			22–28
Second	2·01	Applied Mechanics	3–5
Term	2·730	Machine Design	3–1
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
			24–26

Students credited with French will take German. Students credited with German will take French. Students credited with neither will take German.

Required during Summer

16·71	Airplane Shopwork	8–2
16·72	Aircraft Production Methods	8–2

Third Year

First	2·04	Applied Mechanics	3–5
Term	2·351	Materials of Engineering	2–2
	2·40	Heat Engineering	4–5
	2·701	Machine Drawing	6–0
	6·40	Electrical Eng., Elem	4–6
	16·01	Int. Aeronautical Mechanics	6–6
			25–24
Second	2·37	Testing Materials Lab	4–2
Term	2·42	Heat Engineering	4–5
	6·89	Electrical Eng. Lab	2–2
	16·02	Int. Aeronautical Mechanics	6–4
	16·10	Aerodyn. Airplane Design	3–3
	16·20	Structures	3–5
	Ec11	Economic Principles	3–3
			25–24

Fourth Year

First	2·686	Engineering Laboratory	3–3
Term	16·11	Aerodyn. Airplane Design	6–4
	16·17	Airplane Design Practice	8–0
	16·21	Structures	3–5
	16·62	Aeronautical Laboratory	4–3
		Elective	4
		General Study	2–2
			47
Second	16·22	Aircraft Structures	3–5
Term	16·75	Const. Details Aircraft	7–2
	Ec12	Economic Principles	3–3
		General Study	2–2
		Thesis and Elective*	18
			45

Electives

First	1·135	Int. to Vibration Theory	3–2
Term	2·791	Automotive Engines	4–4
	3·30	Metallography	4–1
	15·11	Int. Business Management	3–3
		General Study	2–2

Electives

Second	2·792	Automotive Engines	4–4
Term	15·12	Int. Business Manage	3–3
	16·14	Airplane Des. Problems	6–6
	16·63	Aero. Lab. & Res. Methods	4–2

* Thesis not less than 10 units.

XVII. BUILDING ENGINEERING AND CONSTRUCTION

THE objective of the Course in Building Engineering and Construction is to provide a sound training in subjects basic to the engineering design and construction of buildings. It should develop in the student a conception of the related problems of the architect, the engineer, the builder and the materials manufacturer in the process of planning and erecting structures, to the end that he may eventually become either a principal or a responsible manager in any of these fields.

About three-fourths of the entire Course is devoted to fundamental and applied science. The strictly professional work is provided in progressive and correlated subjects in engineering, construction and materials during the third and fourth years.

In his senior year the student may direct his efforts toward building engineering or building construction by the selection of structural design or construction problems with such additional electives as will best fit his needs.

The Course leads to the degree of Bachelor of Science in Building Engineering and Construction.

XVII. Building Engineering and Construction Continued

BUILDING ENGINEERING AND CONSTRUCTION

First Year. See page 42

Second Year

First	2·00	Applied Mechanics	3–5
Term	4·43	Architectural History	3–3
	5·844	Engineering Chemistry	3–3
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
			23–27
Second	2·01	Applied Mechanics	3–5
Term	4·78	Planning Principles	3–1
	8·04	Physics	6–4
	17·22	Building Construction	6–2
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			27–23

REQUIRED DURING SUMMER

	1·042	Surveying (At Camp Technology)	22–1
	1·401	Structures (At M.I.T.)	3–5
	2·04	Applied Mechanics (At M.I.T.)	3–5

Third Year

First	1·41	Structures	3–6
Term	2·373	Testing Materials Lab	5–3
	2·41	Heat Engineering	3–5
	17·31	Building Construction	6–2
	17·73T	Materials	3–2
	E35	Reports	2–4
	Ec11	Economic Principles	3–3
			25–25
Second	1·422	Structures	3–6
Term	17·32	Building Construction	6–2
	17·52	Structural Problems	7–3
	17·74T	Materials	6–4
	Ec12	Economic Principles	3–3
		General Study	6
			49

Fourth Year

First	1·41	Structures	3–6
Term	1·48	Foundations	3–4
	2·66	Heat. Vent. & Air Cond.	3–5
		General Study	2–2
		Thesis* and Elective†	22
			50
Second	1·422	Structures	3–6
Term	15·52	Accounting	4–2
	17·40	Estimating & Job Manage.	5–1
		General Study	6
		Thesis* and Elective†	23
			50

* 11 Thesis units required.

† Required for the Engineer.

First Term	17·53	Structural Design	11–3
Second Term	17·54	Structural Design	11–3

Required for the Constructor.

First	17·41	Construction Prob.	4–0
Term	17·531	Structural Design	7–3
Second	17·42	Construction Prob.	4–0
Term	17·541	Structural Design	7–3

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.

The following schedules show merely one arrangement in which the various subjects may be taken. Some of these subjects are offered only in alternate years, but the precise order in which they are taken is not important and an equivalent schedule will be arranged for a student entering at the beginning of any year.

OPTION 1. PURE MATHEMATICS

Option 1 is a preparation for graduate work in pure mathematics and is designed primarily for students planning for a career of research and teaching.

OPTION 2. APPLIED MATHEMATICS

Option 2 is intended for students possessing mathematical aptitude but interested in technical applications of mathematics rather than in research in pure mathematics.

OPTION 3. INDUSTRIAL STATISTICS

Option 3 is adapted to those preparing for industrial work where the statistical interpretation of data is important, or for the actuarial profession.

Students intending to enter one of these options should consult the registration officer as early as practicable.

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

XVIII. OPTION 1. PURE MATHEMATICS

First Year. See page 42

Second Year

First	8·03	Physics	5–5
Term	E21	Literature and History	3–5
	M21	Calculus	3–6
	M23	Algebra and Geometry	3–6
	MS21	Military Science	3–0
		Language	3–5
			20–27

XVII. Mathematics Option 1 Continued

Second Term	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	M77	Vector Analysis	3–6
	MS22	Military Science	3–0
		Language	3–5
			21–26

Third Year

First Term	Ec11	Economic Principles	3–3
	M731	Mechanics	3–6
	M831	Analysis	3–6
		Language	3–5
		General Study	2–2
		Elective	9
			45
Second Term	Ec12	Economic Principles	3–3
	M62	Modern Algebra	3–6
	M732	Mechanics	3–6
	M832	Analysis	3–6
		Language	3–5
		General Study	2–2
			17–28

Fourth Year

First Term	8·511	Thermodyn. & Statis. Mechanics	3–4
	M841	Analysis	3–6
		Thesis and Elective	33
			49
Second Term	8·54	Electromagnetic Theory	3–6
	M442	Diff. Geometry, Elem.	3–6
	M842	Analysis	3–6
		Thesis and Elective	22
			49

XVIII. Option 2. Applied Mathematics

First Year. See page 42

Second Year

First Term	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	M23	Algebra and Geometry	3–6
	MS21	Military Science	3–0
		Language	3–5
			20–27
Second Term	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	M77	Vector Analysis	3–6
	MS22	Military Science	3–0
		Language	3–5
			21–26

Third Year

First Term	Ec11	Economic Principles	3–3
	M331	Math. Theory of Statistics	3–6
	M731	Mechanics	3–6
	M851	Advanced Calculus	3–6
		General Study	2–2
		Engineering Elective	9
			46
Second Term	Ec12	Economic Principles	3–3
	M54	Mathematical Laboratory	3–6
	M732	Mechanics	3–6
	M852	Advanced Calculus	3–6
		General Study	2–2
		Engineering Elective	9
			46

Fourth Year

First Term	8·511	Thermodyn. & Statis. Mechanics	3–4
		Engineering Elective	3–6
		Elective and Thesis	31
			47
Second Term	8·54	Electromagnetic Theory	3–6
	M442	Diff. Geometry, Elem.	3–6
		Engineering Elective	3–6
		Elective and Thesis	22
			49

XVIII. Option 3. Industrial Statistics

First Year. See page 42

Second Year

First Term	8·03	Physics	5–5
	15·70	Production	3–6
	E21	Literature and History	3–5
	M21	Calculus	3–6
	M23	Algebra and Geometry	3–6
	MS21	Military Science	3–0
			20–28
Second Term	8·04	Physics	6–4
	Ec11	Economic Principles	3–3
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	M62	Modern Algebra	3–6
	MS22	Military Science	3–0
			21–24

Third Year

First Term	2·872	Prep. for Manufacturing	2–4
	15·50	Accounting	5–4
	Ec12	Economic Principles	3–3
	M331	Math. Theory of Statistics	3–6
	M341	Actuarial Mathematics	3–6
	M731	Mechanics	3–6
			19–29

XVIII. Mathematics Option 8 Continued

Second Term	6·40	Electrical Engineering, Elem.	4–6
	M332	Math. Theory of Statistics	3–6
	M342	Actuarial Mathematics	3–6
	M732	Mechanics	3–6
		Elective	9
			46

Fourth Year

First Term	15·51	Industrial Accounting	5–4
	Ec33	Design of Experiments	3–6
	M851	Advanced Calculus	3–6
		Language	3–5
		General Study	2–2
		Engineering Elective	9
			48
Second Term	Ec34	Sp. Problems in Ind. Statistics	4–2
	M852	Advanced Calculus	3–6
		Language	3–5
		General Study	2–2
		Elective and Thesis	21
			48

UNDERGRADUATE SCHEDULES FOR RESERVE OFFICERS' TRAINING CORPS

THE general object of the Reserve Officers' Training Corps is to qualify students for positions of leadership in time of national emergency. For this purpose, five units of the senior division of the R. O. T. C. are maintained. The instruction consists of two courses, the basic course and the advanced course, each of two academic years. The basic course is required; the advanced course is elective and includes one summer camp period.

Basic Course

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 satisfactorily the entire basic course, unless exempted therefrom on conscientious grounds as approved by the Faculty. Similarly qualified students who enter in the second year are required to complete the second year of the basic course unless exempted therefrom on conscientious grounds as approved by the Faculty. Students who have received instruction in the R. O. T. C. at another institution under an officer of the Army will receive credit therefor upon presentation of suitable evidence to the Professor of Military Science and Tactics.

For instruction in the first year of the basic course, the students are organized as an infantry regiment. Cadet sergeants and corporals are selected from first-year students who demonstrate especial aptitude for military instruction. Cadet sergeants may be selected for appointment from such second-year students as are especially qualified and who volunteer to attend drill. A band of about forty instruments is organized from qualified members of the R. O. T. C.

The instruction in the second year of the basic course is mainly theoretical. During the year, opportunity is given the student to elect the unit in which he prefers to continue his instruction.

While the training offered at the Institute leads to commissions only in the five branches of the army mentioned below, it is possible for graduates to obtain commissions in other branches, such as the Quartermaster Corps, by completing certain Army Extension Courses or by doing the corresponding work in the Military Science Department. Students interested in such commissions should see the Professor of Military Science and Tactics for details.

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	Military map reading, field engineering and basic military subjects	3–0
Second Term	MS221	Coast Artillery Unit: Elements of heavy artillery	3–0
	MS222	Engineer Unit: Elements of engineer training	3–0
	MS223	Signal Unit: Tactics and signal communications	3–0
	MS224	Ordnance Unit: General characteristics of ordnance matériel and ammunition	3–0
	MS226	Chemical Warfare Unit: Elements of chemical warfare training	3–0

Advanced Course

The object of the advanced course is to qualify for a commission in the Officers' Reserve Corps of the Army of the United States a limited number of students who have demonstrated exceptional qualities of leadership. Graduates of the four-year course (including the advanced camp) should be reasonably well qualified to perform the duties of a second lieutenant of the branch in which they have been trained.

The course is open to students who have satisfactorily completed two years in the basic course at this Institute or elsewhere, who are acceptable to the Professor of Military Science and Tactics, and who have received the approval of the professor in charge of the course in which they are registered. A student enrolled in the advanced course receives commutation of uniform at the approximate rate of twenty-nine dollars for the first year and seven dollars for the second year, and commutation of subsistence at the rate of twenty-five cents per day from date of enrollment until the end of the second Institute year there-

Reserve Officers' Training Corps Continued

after, including one summer vacation, except for the period of the R. O. T. C. camp, when he will be subsisted by the Government. To enroll, he must execute a contract to continue the course of instruction for two years, should he remain that length of time at the Institute, and the fulfillment of this contract then becomes a prerequisite for graduation. The contract includes the obligation to attend a six weeks' R. O. T. C. 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. In very exceptional cases, attendance at camp may be postponed until after the senior year.

A student enrolled in the R. O. T. C., in order to obtain his M. I. T. degree and his commission in the Army, must have fulfilled all the requirements set down by the Faculty and, in addition, he must have obtained a clear record in military taught subjects and have fulfilled all military obligations.

The head of a department is authorized to allow, at his option, credit towards graduation for military taught subjects.

G27 (3–3) (for one term only) Military History and Policy of the United States is required of all students taking the advanced course.

Coast Artillery Unit

Open to students in all courses. Omissions and other approved changes in Course schedules are noted on page 79 under the number of the Course.

Third Year

First Term	MS31	Leadership	1–0
	MS311	Fire control and gunnery for heavy artillery	2–1
		(MS411-B may be taken in this term.)	
Second Term	MS32	Leadership	1–0
	MS321	Fire control and gunnery for antiaircraft artillery	2–1

Fourth Year

First Term	MS41	Leadership	1–0
	MS411A	Coast Artillery organization and matériel	2–1
	MS411B	Orientation, field engineering and combat orders	2–2
Second Term	MS42	Leadership	1–0
	MS421	Tactical employment of antiaircraft and heavy artillery	2–1

Engineer Unit

Open only to students in Courses I, II, II-A, III, IV, VI,V I-A, VII_2, IX-B, X, XI, XIII, XIII-C, XV_1, XVI, and XVII.

Third Year

First Term	MS31	Leadership	1–0
	MS312	Combat principles of small units; to include the infantry and engineer platoon.	2–1
Second Term	MS32	Leadership	1–0
	MS322	Military engineering; including problems in field engineering	2–1

Fourth Year

First Term	MS41	Leadership	1–0
	MS412	Military engineering and tactical problems	1–1
Second Term	MS42	Leadership	1–0
	MS422	Military engineering and problems applying principles of field engineering	1-1

Signal Unit

Open only to students in Courses VI, VI-A, VI-B, VI-C, VIII, IX-B, XV_1, and XVI. Except in the subjects indicated below, instruction is given by Institute personnel. Approved changes in schedules are noted under the number of the Course.

Third Year

First Term	MS31	Leadership	1–0
	MS313	Signal Corps tactics; message centers; elements of cryptanalysis; code practice	2–1
Second Term	MS32	Leadership	1–0
	MS323	Military telegraphy and telephony; radio sets	2–1

Fourth Year

First Term	MS41	Leadership	1–0
	MS413	Training methods; Reserve Corps regulations; procurement	1–1
Second Term	MS42	Leadership	1–0
	MS423	Maintenance of signal transportation	1–1

Ordnance Unit

Open only to students in Courses II, III, V, VIII, X, XV and XVI.

Third Year

First Term	MS31	Leadership	1–0
	MS314	Organization and duties of the Ordnance Department; ordnance engineering	2–1
Second Term	MS32	Leadership	1–0
	MS324	Ordnance matériel	2–1

Fourth Year

First Term	MS41	Leadership	1–0
	MS414	Storage, issue and maintenance of ordnance supplies	1–1
Second Term	MS42	Leadership	1–0
	MS424	Ordnance supply and maintenance in combat operations	1–1

Chemical Warfare Unit

Open only to students in Courses V, VII, VII-A, VII-B, X, and XV_2. Except in the subjects indicated below, instruction is given by Institute personnel. Approved changes in schedules are noted on page 79 under the number of the Course.

Third Year

First Term	MS31	Leadership	1–0
	MS316	Technique of chemical weapons and agents	2–1
Second Term	MS32	Leadership	1–0
	MS326	Technique of chemical weapons and agents	2–1

Fourth Year

First Term	MS41	Leadership	1–0
	MS416	Tactical employment of infantry and chemical troops	1–1
Second Term	MS42	Leadership	1–0
	MS426	Tactical employment of chemical weapons and agents	1–1

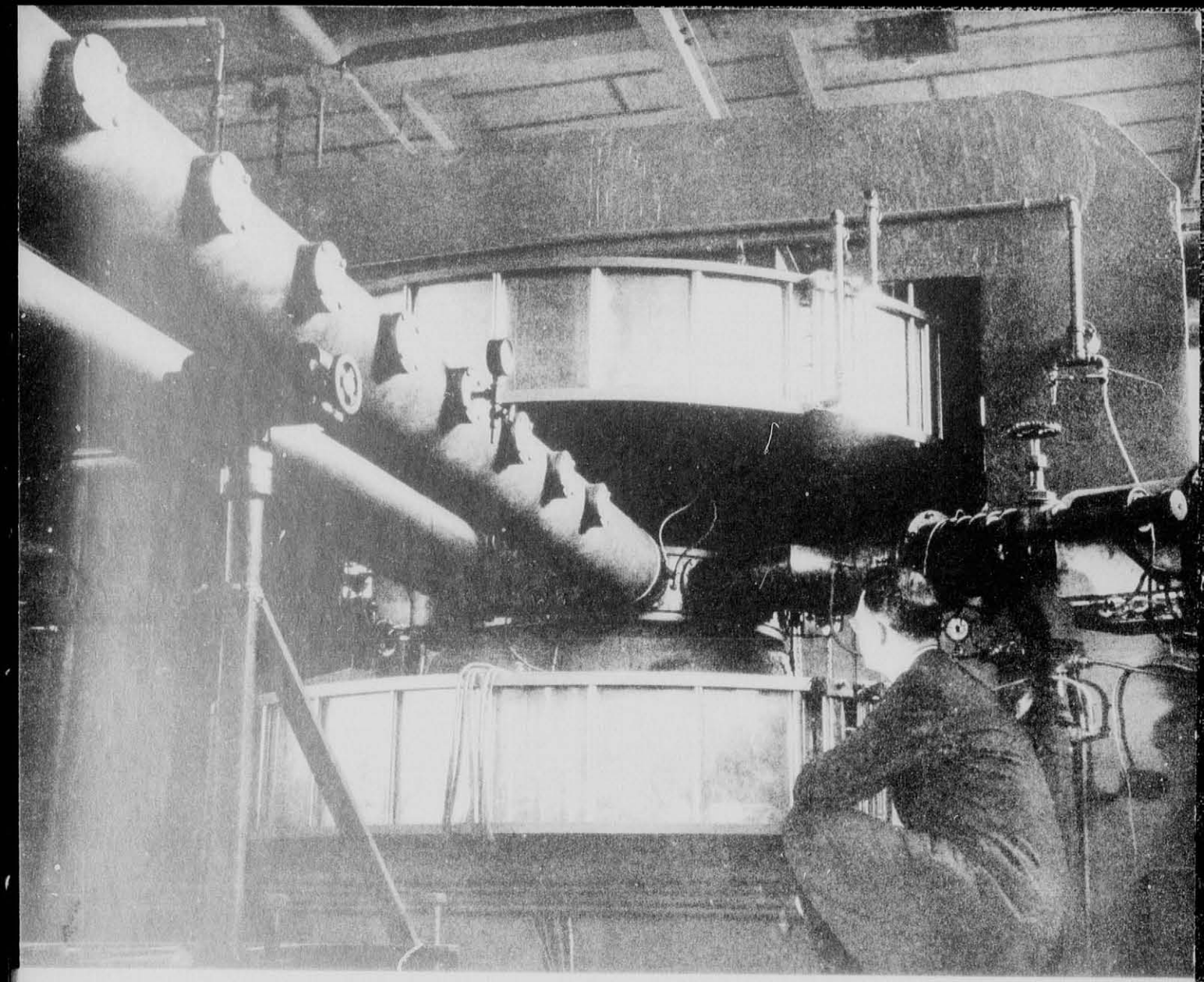
Reserve Officers' Training Corps Continued

CHANGES IN COURSE SCHEDULES FOR R. O. T. C.

The following table shows approved changes in Course Schedules for the various units of the R. O. T. C. *Changes shown in italics are required.* In all other cases, if advantage is taken of an omission, any accompanying addition becomes required.

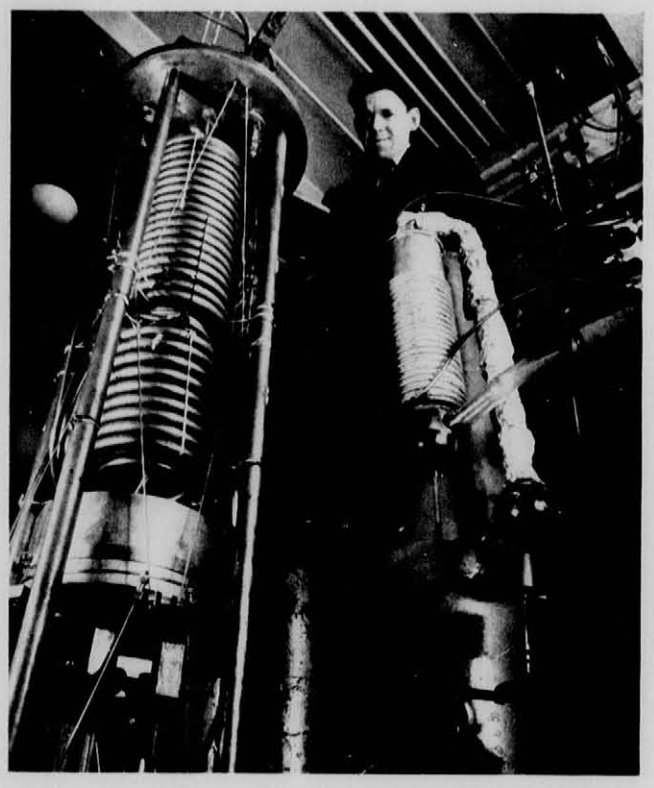
Course	*Yr.*		*Tm.*		*Change*	*Units*
I				C. A. C.	†	
II	4		1	C. A. C.	Omit: App. of Electricity in Industry 6·47	4–4
					Add: Elec. Eng. Lab. 6·89	2–2
III	3		2	C. A. C.	Omit: Heat Measurements 2·50	3–1
V	3	or	1	C. A. C.	Omit: Elective	4
	4		1			
	4		2	C. W. S.	Omit: Elective	4
					Add: *Powder, Explosives and War Agents 5·43*	2–2
VI	4		1	C. A. C.	Omit: Elective	3–6
VII				C. A. C.	†	
VII-B	4		1	C. A. C.	Omit: Elective	6
VIII	4		1	C. A. C.	Omit: Elective	4
	4		1	S. C.	*Include an Elective that meets S. C. requirements*	3–6
	4		2	S. C.	*Include an Elective that meets S. C. requirements*	3–6
IX	3	or	1	C. A. C.	Omit: Elective	4
	4		1			
	4		1	S. C.	*Include an Elective that meets S. C. requirements*	3–6
	4		2	S. C.	*Include an Elective that meets S. C. requirements*	3–6
X	4		1	C. A. C.	Omit: General Study	2–2
	4		2	C. A. C.	Omit: Prof. Elective	2
	4		2	C. W. S.	Omit: Prof. Elective	4
					Add: *Powder, Explosives and War Agents 5·43*	2–2
XI				C. A. C.	†	
XII	3		1	C. A. C.	Omit: Elective	4
XIII	4		2	C. A. C.	Omit: Elective	4
XIII-C	5		2	C. A. C.	Omit: Elective	4
XV_1	3	or	1	C. A. C.	Omit: Engineering Elective	4
	4		1			
XV_2				C. A. C.	Students should consult the department head for special arrangements.	
XVI	4		1	C. A. C.	Omit: Elective	4
XVII	4		1	C. A. C.	Omit: Elective	4
XVIII	4		1	C. A. C.	Omit: Elective	4

† Students in this Course in the Coast Artillery will be allowed to omit four units from the required course schedule r the term in which they take MS411B or a corresponding readjustment of time will be made in some other term by special arrangement in individual cases.





"THE ADVANCEMENT, DEVEL



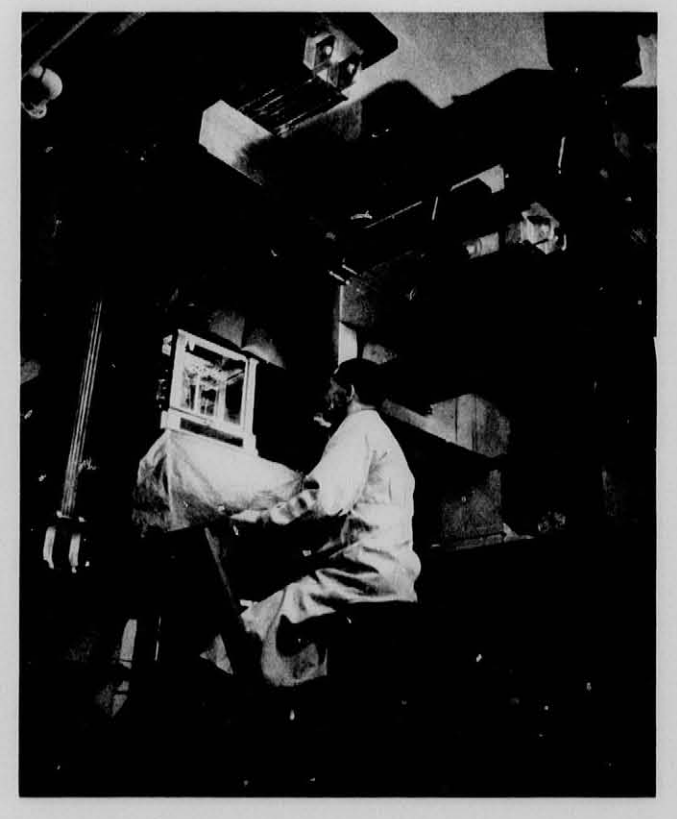
A highly efficient refrigerating machine developed in the Institute's Department of Chemistry to maintain cooling at 440 degrees Fahrenheit, below the temperature of melting ice. It is used for investigation of the properties of matter at low temperatures



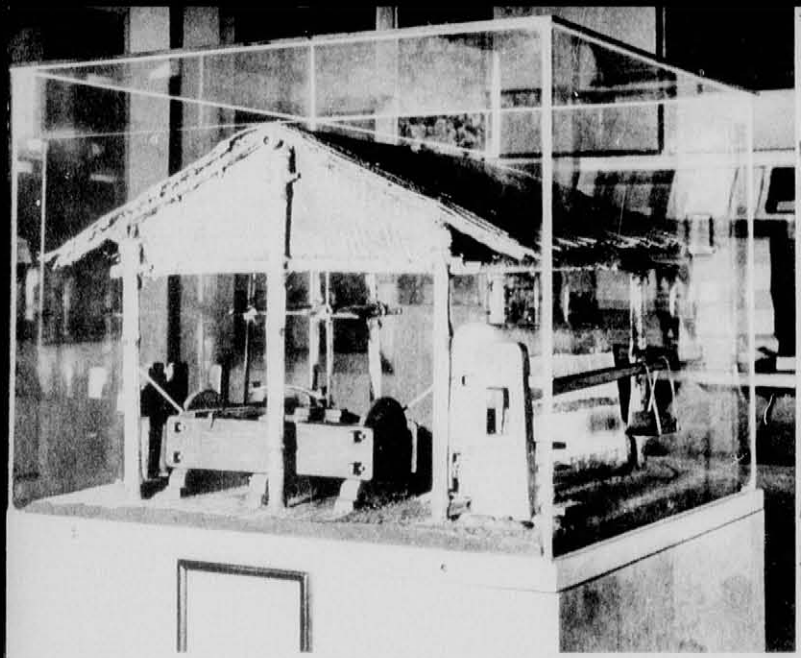
Solar Energy Laboratory where studies are being made of the direct conversion of solar energy into heat

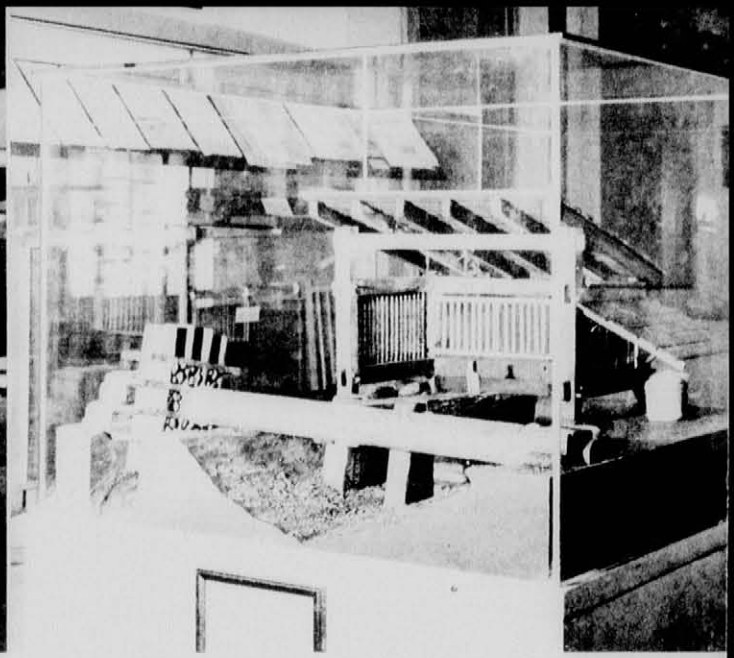


Testing water tanks with synthetic earthquakes. The white shadowgraph in the right foreground represents an actual quake, and through an electrical system causes the table upon which the tank stands to move as the ground did in the actual quake



In the Magnetics Laboratory where the strongest steady magnetic fields yet produced are utilized in a variety of researches. Here a study of alloys is in progress. Other magnets are used in low temperature research and in spectroscopy






NOLDS

THE GRADUATE SCHOOL

ARCHITECTURE, ENGINEERING, SCIENCE

ADMINISTRATION OF THE GRADUATE SCHOOL

PRESIDENT, KARL T. COMPTON, D.Sc., D.Eng., PH.D., LL.D.
DEAN OF THE GRADUATE SCHOOL,* JOHN W. M. BUNKER, PH.D.
HONORARY DEAN OF THE GRADUATE SCHOOL, HARRY M. GOODWIN, PH.D.

COMMITTEE ON THE GRADUATE SCHOOL

J. W. M. BUNKER, PH.D., *Dean, Chairman Ex-Officio*
B. A. THRESHER, S.B., A.M., *Director of Admissions, Secretary Ex-Officio*

L. B. CHAPMAN, S.B.
Professor of Marine Transportation and Marine Engineering

W. M. FIFE, S.M.
Associate Professor of C vil Engineering

W. P. FISKE, M.B.A., LL.B., LITT.D.
Professor of Accounting

R. E. FREEMAN, M.A., B.LITT.
Professor of Economics

C. E. FULLER, S.B.
Professor of Theoretical and Applied Mechanics

M. F. GARDNER, S.M.
Associate Professor of Electrical Engineering

E. H. HUNTRESS, PH.D.
Associate Professor of Organic Chemistry

W. R. MACCORNACK, S.B.
Dean of Architecture

H. B. PHILLIPS, PH.D.
Professor of Mathematics

B. E. PROCTOR, PH.D.
Associate Professor of Food Technology

T. K. SHERWOOD, Sc.D.
Associate Professor of Chemical Engineering

H. W. SHIMER, PH.D., Sc.D.
Professor of Paleontology

J. C. SLATER, PH.D.
Professor of Physics

R. H. SMITH, PH.D.
Professor of Aeronautical Engineering

R. S. WILLIAMS, PH.D.
Professor of Physical Metallurgy

CHAIRMEN† OF DEPARTMENT AND COURSE COMMITTEES ON GRADUATE STUDENTS

Aeronautical Engineering	R. H. SMITH
Architecture	W. R. MACCORNACK
Biology and Public Health	B. E. PROCTOR
Business and Engineering Administration	W. P. FISKE
Chemical Engineering	T. K. SHERWOOD
Chemistry	E. H. HUNTRESS
Civil and Sanitary Engineering	W. M. FIFE
Economics and Social Science	R. E. FREEMAN
Electrical Engineering	H. L. HAZEN
Geology	H. W. SHIMER
Mathematics	H. B. PHILLIPS
Mechanical Engineering	C. E. FULLER
Metallurgy	R. S. WILLIAMS
Naval Architecture and Marine Engineering	H. H. W. KEITH
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 respective department.

THE GRADUATE SCHOOL

GENERAL INFORMATION

THE Graduate School of the Massachusetts Institute of Technology, including Architecture, Engineering, and Science, was established, upon the recommendation of the Faculty Council, by the Corporation of the Institute in 1932. The School is a natural development of the policy regarding advanced study and research approved by the Corporation as early as 1872. In that year it was announced in the catalogue that "advanced courses have been established by a recent vote of the Corporation and are intended to afford Bachelors of Science of this Institute — and others of equal attainment — the means of continuing their studies. For proficiency in these courses the degree of Doctor of Science has been authorized." The minimum term of residence for this degree was fixed at two years.

The registration of students working for higher degrees in the Graduate School for 1939–1940 was 680 students, approximately one-fifth of the total registration of the Institute. Of these, 279 were pursuing courses leading to the Doctorate, 381 to the degree of Master of Science, and 20 to the degree of Master in Architecture and in City Planning. In addition, 29 college graduates were engaged with special programs, and 12 were taking courses leading to the Certificate in Public Health.

The cosmopolitan character of the School is indicated by the fact that the students were graduates from 214 universities, technical schools, or institutions of higher learning, distributed among 46 states, the District of Columbia, one territory, and 22 foreign countries.

The advanced courses open to graduate students together with brief descriptions of some of the special laboratories and equipment provided for research will be found described in the following pages under the respective departments in which the work is given. Particular attention is called to the facilities provided in the following laboratories which are devoted primarily or exclusively to research:

The George Eastman Research Laboratories opened in 1932, completely equipped for research in modern Physics, Physical Chemistry, Organic Chemistry, and Inorganic Chemistry; the Spectroscopic Laboratory housed in a separate vibration-proof, constant temperature building; the Nuclear Research Laboratories; the Daniel Guggenheim Aeronautical Laboratory and Wright Memorial Wind Tunnel; and the research laboratories in Industrial Physics, Applied Chemistry, Electrical Engineering, and Hydraulics. Facilities for investigation are also amply provided in the extensive laboratories of the other scientific and engineering departments.

Administration. The work of the Graduate School is administered as follows: The Dean of the Graduate School is executive officer and chairman ex-officio of the Faculty Committee on the Graduate School, elected annually by the Faculty and responsible to it. This Committee consists of a representative of each department offering graduate work leading to a higher degree and such other members as the Faculty may elect. Sub-committees appointed by the Dean consider and report to the main Committee on such business as educational policy, admissions, graduate courses, scholarships, etc. The Committee acts with power on all matters delegated to it by the Faculty. The Faculty recommends all degrees.

Degrees Awarded. At the present time the Institute awards the following higher degrees:

To students in the Departments of Science, Engineering, and Economics, the degree of Master of Science, with designation of the field of study, or without such designation, depending upon the character of the course pursued; in the Department of Biology and Public Health, the degree of Master in Public Health; in the Department of Architecture, the degrees of Master in Architecture and Master in City Planning. In the Departments of Science, namely, Biology, Chemistry, Geology, Mathematics, and Physics, the degrees of Doctor of Philosophy and Doctor of Science; in the fields of Applied Science and Engineering, namely, Aeronautical Engineering, Ceramics, Chemical Engineering, Civil Engineering, Electrical Engineering, Marine Engineering, Mechanical Engineering, Metallurgy, Meteorology, Naval Architecture, Sanitary Engineering, the degree of Doctor of Science; in the Department of Biology and Public Health, the degree of Doctor of Public Health.

Scholarships and Fellowships. Fellowship and Graduate Scholarship funds totalling over $100,000 are available for the year 1940–41. For a detailed list of these funds and the regulations governing their award see page 231.

REQUIREMENTS FOR ADMISSION

To be admitted to the Graduate School the applicant must, except in cases of unusual attainments, have received his Bachelor's degree in a four year course of a college, university or technical school of recognized standing, and his academic record and other credentials must be such as to indicate that he has the ability to meet satisfactorily the require-

ments of his proposed program of graduate study and research.

Application Procedure

(1) An application form and three endorsement forms, which may be obtained from the Director of Admissions, should be filed as soon as possible after November 1 preceding date of expected entrance. Preliminary selection of applicants for admission to the Graduate School who are proceeding toward a Bachelor's degree elsewhere is based on the record of the preceding three years. Early application is advisable because enrollment in certain departments is limited. Applications received after March 1 will be considered, but it may be necessary to place them on a waiting list. (2) The applicant (if not in residence at the Institute) must send or have sent to the Director of Admissions a certified transcript of his college record and a statement of his rank in class. (3) As soon as an application for admission has been acted upon, the applicant will be notified of his status.

Undergraduate Prerequisites

An applicant for admission to the Graduate School is expected to meet requirements in the following undergraduate subjects common to all curricula (except Architecture*):

Language. The equivalent of Intermediate French or Intermediate German or Elementary French and Elementary German is desirable and in any case either Elementary French or Elementary German is required in addition to some language other than English. In place of this requirement, the applicant may satisfy the Department in which he wishes to take advanced work leading to the Master's degree that he has a good reading knowledge of scientific French or German.* For language requirements for the Doctor's degree see page 87.

In exceptional cases Spanish may be accepted as meeting the language requirement. This will be allowed, however, only by special permission of the Committee on Graduate Students of the Department in which the student is registered and the approval of the Committee on the Graduate School. In each case the student must satisfy the Department of Modern Languages of his proficiency in Spanish.

Mathematics. The equivalent of the Institute subjects in Mathematics in the first and second years, namely: calculus, M11, M12, M21, and differential equations M22, except as specific exception may be made in the statement of further requirements peculiar to each field of science or engineering.

Chemistry. One or more years of college chemistry, passed with such grades that it may be accepted as meeting the requirements of first-year chemistry, 5·01, 5·02.

Physics. Two or more years of college physics, passed with such grades that it may be accepted as meeting the requirements of first and second-year physics, 8·01, 8·02, 8·03, 8·04.

Cultural Subjects and Economics. It is expected that the applicant shall have a knowledge of English, history, economics and general studies, similar to those included in the undergraduate curricula at the Institute. If the applicant is unusually deficient in meeting this requirement, he may be required to take subjects in these fields.

Professional Subjects. The applicant must, in addition, have completed such professional subjects as may be required by the Department in which he desires to take his Master's degree. Such subjects will be found listed under each Department respectively. Deficiencies in required undergraduate subjects must be removed before proceeding with dependent graduate work.

In exceptional cases the Committee on the Graduate School will give due consideration to a proposal for modification of certain specified requirements initiated by a Department Committee in behalf of an applicant desiring to work toward an advanced degree in a specialized field within a Department.

Co-operation with Harvard University and Radcliffe College. Graduate students are given the opportunity of taking at Harvard University a limited number of subjects under a coöperative agreement between Harvard University and the Massachusetts Institute of Technology, which provides that "Advanced courses other than courses prescribed in undergraduate programs or courses in research, may, with the consent of the Instructor and the Dean or the Head of the Department in which the student wishes to work, be taken in either institution by students of the other without payment of fees." A similar arrangement has been made between Radcliffe College and the Institute.

A graduate student at the Institute desiring to take advantage of this privilege must present to the Dean of the Graduate School, from the chairman of his Department Committee, a request for admission to the desired subject, stating the catalogue number and title, together with the name of the instructor giving it. It should also be stated whether the subject is to be taken for credit or audited. The Dean will give the student a letter of recommendation, to be presented to the Dean of that School in Harvard University in which he desires to register.

THE MASTER'S DEGREE

The degree of Master of Science is awarded upon the satisfactory completion of a course of advanced study and research approved by the Faculty and extending over not less than one year in residence.

* For requirements in the School of Architecture see page 97.

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ments of his proposed program of graduate study and research.

Application Procedure

(1) An application form and three endorsement forms, which may be obtained from the Director of Admissions, should be filed as soon as possible after November 1 preceding date of expected entrance. Preliminary selection of applicants for admission to the Graduate School who are proceeding toward a Bachelor's degree elsewhere is based on the record of the preceding three years. Early application is advisable because enrollment in certain departments is limited. Applications received after March 1 will be considered, but it may be necessary to place them on a waiting list. (2) The applicant (if not in residence at the Institute) must send or have sent to the Director of Admissions a certified transcript of his college record and a statement of his rank in class. (3) As soon as an application for admission has been acted upon, the applicant will be notified of his status.

Undergraduate Prerequisites

An applicant for admission to the Graduate School is expected to meet requirements in the following undergraduate subjects common to all curricula (except Architecture*):

Language. The equivalent of Intermediate French or Intermediate German or Elementary French and Elementary German is desirable and in any case either Elementary French or Elementary German is required in addition to some language other than English. In place of this requirement, the applicant may satisfy the Department in which he wishes to take advanced work leading to the Master's degree that he has a good reading knowledge of scientific French or German.* For language requirements for the Doctor's degree see page 87.

In exceptional cases Spanish may be accepted as meeting the language requirement. This will be allowed, however, only by special permission of the Committee on Graduate Students of the Department in which the student is registered and the approval of the Committee on the Graduate School. In each case the student must satisfy the Department of Modern Languages of his proficiency in Spanish.

Mathematics. The equivalent of the Institute subjects in Mathematics in the first and second years, namely: calculus, M11, M12, M21, and differential equations M22, except as specific exception may be made in the statement of further requirements peculiar to each field of science or engineering.

Chemistry. One or more years of college chemistry, passed with such grades that it may be accepted as meeting the requirements of first-year chemistry, 5·01, 5·02.

* For requirements in the School of Architecture see page 97.

Physics. Two or more years of college physics, passed with such grades that it may be accepted as meeting the requirements of first and second-year physics, 8·01, 8·02, 8·03, 8·04.

Cultural Subjects and Economics. It is expected that the applicant shall have a knowledge of English, history, economics and general studies, similar to those included in the undergraduate curricula at the Institute. If the applicant is unusually deficient in meeting this requirement, he may be required to take subjects in these fields.

Professional Subjects. The applicant must, in addition, have completed such professional subjects as may be required by the Department in which he desires to take his Master's degree. Such subjects will be found listed under each Department respectively. Deficiencies in required undergraduate subjects must be removed before proceeding with dependent graduate work.

In exceptional cases the Committee on the Graduate School will give due consideration to a proposal for modification of certain specified requirements initiated by a Department Committee in behalf of an applicant desiring to work toward an advanced degree in a specialized field within a Department.

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A graduate student at the Institute desiring to take advantage of this privilege must present to the Dean of the Graduate School, from the chairman of his Department Committee, a request for admission to the desired subject, stating the catalogue number and title, together with the name of the instructor giving it. It should also be stated whether the subject is to be taken for credit or audited. The Dean will give the student a letter of recommendation, to be presented to the Dean of that School in Harvard University in which he desires to register.

THE MASTER'S DEGREE

The degree of Master of Science is awarded upon the satisfactory completion of a course of advanced study and research approved by the Faculty and extending over not less than one year in residence.

The degree of Master in Public Health is awarded to students completing the requirements for this degree. (See Department of Biology and Public Health.) The degree of Master in Architecture or Master in City Planning is awarded to students completing the requirements for these degrees in the Department of Architecture. (See under School of Architecture.)

Minimum residence requirement for the Master's degree is one year at the Institute devoted to advanced study and research which must include a full schedule of work at the Institute for one regular term. The Master's degree is not conferred on Summer Session work only. Graduate work satisfactorily completed in the summer may be credited towards the Master's degree but the above residence requirement must be satisfied before the degree will be awarded.

Students who complete the requirements for the Bachelor's degree at the Institute in June, together with substantial advanced credits in graduate subjects, may at that time apply for admission to the Graduate School and will be allowed to complete requirements for the Master's degree during that summer, and become candidates for the degree in October.

Graduates of the Institute, or of other institutions which award the Bachelor's degree on the basis of a four years' course essentially equivalent in breadth and training to that offered by the Institute, may obtain the Master's degree in from one to two years, depending upon preparation. Graduates of colleges or technical schools offering less extensive preparation in science or engineering will in general require two or more years to fulfill the requirements for the degree.

College students intending to enter the Institute for a course of study leading to the Master's degree will find it advantageous to make their selection of college electives correspond as nearly as possible to the undergraduate work of the Institute. If in doubt in regard to any subjects, they should write to the Dean of the Graduate School or to the chairman of the Committee on Graduate Students of the Department they wish to enter.

Graduate Requirements

The degree of Master of Science is awarded upon the satisfactory completion of an approved program of 96 units* of advanced study and research, three-quarters of which, or 72 units including thesis, are chosen from "A" subjects primarily for graduates, and the remaining 24 units are chosen from "A" subjects, or from "B" subjects open to graduates and undergraduates. The number of units credited to thesis shall not be less than 20 or more than 40, except for the prescribed Courses in Naval Engineering and in Naval Construction, for officers of the United States Navy, in which case the minimum thesis allotment shall be 15 units. If 64 units of the required "A" subjects, including thesis, are chosen from subjects in a single field of science or engineering, the degree will be recommended with designation of the field in which the student has thus specialized, otherwise the degree will be awarded without specification of field. All theses must be carried out under the supervision of a member of the Institute Staff.

* A unit represents 15 hours work.

To be recommended for the Master's degree, a student must not only have completed the program of graduate study and research approved by his Department Committee, *but his scholastic standing must be of a distinctly high grade.* His academic rating will be based on records received in all "A" and "B" subjects taken while registered as a graduate student, or credited to him by the committee in charge of his course.

Choice of Program. The choice of subjects for a program of studies leading to a Master's degree either with or without designation of field, must be made in consultation with and must be approved by the Committee on Graduate Students of the Department in which the student is registered or by its duly authorized representative.

Graduate subjects are arranged on the following pages under the Department in which they are given. The number of "units" of exercise and preparation are indicated. They are divided into two groups:

"A" Subjects Primarily for Graduates. These are advanced in character and presented primarily for graduate students.

"B" Subjects Open to Graduates and Undergraduates. These are chosen from elective and professional subjects of the fourth or senior year and, to a very limited extent, from certain subjects given in the third year. Not over twenty-five per cent of the work for the Master's degree may be chosen from subjects in this group.

A description of all "A" and "B" subjects will be found under the Description of Subjects on pages 124–188. The units assigned to each subject, the instructor in charge of the subject, and the required preparatory subjects will be found under the Tabulation of Subjects, pages 189–218.

Students in doubt as to their preparation for any graduate course should correspond with the chairman of their respective Department Committee. Many of the subjects which are prerequisites are offered in the Summer Session. Subjects listed under "B" in one department shall not be counted as "A" subjects in another department.

The number of units allotted to each subject of instruction is shown in the schedules; for instance, on page 91 under the subject of 1·141 Geodesy, two units are devoted to classroom work and four

units are assigned for outside preparation. The subject would therefore count for six units in making up the 96 units required for the degree. Where no division of time between exercise and preparation is indicated, the total number of units devoted to the subject is given.

In arranging a program of studies leading to the Master's degree the choice of subjects is not necessarily restricted to those given in one department, but subjects in other departments may be included provided an integrated and well-balanced program of study results. It is expected that graduate students will concentrate their attention on a few important subjects, together with their research work, rather than attempt to cover a wide range in a less thorough manner.

Each student should decide when beginning his graduate work whether he wishes to become a candidate for a degree in a specified field or for a degree without designation of field, as his program of study will depend upon this decision.

The Degree List. Each graduate student who expects to have met all requirements for the Master's or Doctor's degree in June, October, December, or February, and who desires recommendation for such degree at one of these times, must file with the Registrar, not later than the Wednesday following the Spring Recess, or the first Wednesday of October, December, or January, on a blank furnished therefor by the Registrar, a request to be considered at a designated time for recommendation for the degree. The names of applicants, when approved by departments concerned, will be placed by the Registrar upon a *Degree List*, and such names may not be withdrawn except by petition granted by the Committee on Petitions. All names upon a Degree List, and *only such names*, will be acted upon and reported to the Faculty by the Committee on the Graduate School at its meetings in May, October, December, or February. Each applicant will be notified promptly by the Registrar in case department approval is withheld from his application.

Masters' theses are due not later than one week before the first day of the regular term examination periods.

Prescribed Curricula. In addition to the elective graduate courses leading to the degree of Master of Science the Institute awards the degree for the satisfactory completion of prescribed curricula in the following fields:

A three-year course (XIII-A) in Naval Architecture leading to the degree of Master of Science in Naval Construction open to officers of the United States Navy who prepare for service as Naval Constructors.

No students other than those now enrolled will be admitted to this course, because it is to be superseded by a three-year course in Naval Construction and Engineering. This latter course leads also to the degree of Master of Science. The first students in the new course will enter the Institute at the beginning of the academic year 1940–41. The new course is open only to graduates of the Naval Academy assigned to that duty by the Navy Department.

A one-year course in Naval Engineering, for officers of the United States Navy, leading to the degree of Master of Science in Marine Engineering.

A one-year course in Aeronautical Engineering for officers of the United States Navy, leading to the degree of Master of Science.

A one-year course in Meteorology for officers of the United States Navy leading to the degree of Master of Science in Meteorology.

A two-year course in Torpedo Engineering open to officers of the United States Navy and leading to the degree of Master of Science in Mechanical Engineering.

A course of one year and one summer leading to the degree of Master of Science in Civil Engineering arranged for army officers of the United States Engineer Corps designated by the War Department.

A course of one year and one summer in Army Ordnance leading to the degree of Master of Science arranged for officers designated by the War Department.

A course of two years' duration leading to the degree of Master of Science, for Chemical Warfare officers detailed to the Institute by the United States Army.

A course of one and one-half years' duration in Chemical Engineering Practice (X-A) leading to the degree of Master of Science in Chemical Engineering Practice.

A five-year coöperative course leading to the degrees of Bachelor of Science and Master of Science in Electrical Engineering (VI-A) and also one in Mechanical Engineering (II-A).

A six-year course (IV-C, Option 1), in the Department of Architecture, leading to the degrees of Bachelor of Architecture in City Planning, and Master in City Planning.

A six-year course in Civil Engineering and City Planning Practice (IV-C, Option 2), leading to the degrees of Bachelor of Science in Civil Engineering, and Master in City Planning.

Five-year courses for honor students in Mechanical Engineering and in Aeronautical Engineering leading to the degrees of Bachelor of Science and Master of Science in their respective fields.

A five-year course (VII-A), in the Department of Biology, leading to the degrees of Bachelor of Science in Biophysics, and Master of Science in Biological Engineering.

A five-year course in Economics and Engineering or Natural Science leading to the degrees of Bachelor

of Science in the professional course, and Master of Science in Economics and Engineering or Master of Science in Economics and Natural Science, depending upon whether the professional course pursued is Engineering or Science. (See Department of Economics and Social Science.)

Program of Studies for Teaching Fellows and Assistants. Members of the teaching staff may work towards a Master's or a Doctor's degree by following a program of study and research approved by the Committee on Graduate Students of their respective departments. The length of time necessary to complete the requirements will depend upon the amount of academic work the student can carry with his staff assignments.

THE DEGREE OF DOCTOR OF SCIENCE, DOCTOR OF PHILOSOPHY OR DOCTOR OF PUBLIC HEALTH*

The study and research leading to the Doctor's degree are especially valuable to those who wish to engage in original investigation or to teach at higher institutions of learning. Moreover, the increasing demand in the industries for men who have had extended scientific training and have also the attitude of mind impelling them to attack new problems, opens special advantages to those who have obtained a Doctor's degree.

The degree of Doctor of Science or Doctor of Philosophy certifies to the creditable completion of a program of advanced studies, and to the performance of an investigation of high grade. The degree of Doctor of Science may be taken when the course of study is in a department of either science or engineering; the degree of Doctor of Philosophy may be taken only in a department of pure science or mathematics. The requirements for both degrees are essentially the same. Degrees will be conferred only upon candidates who have not only breadth of scientific attainment, but also the power of dealing with new problems in an independent and original manner.

Admission. The general requirements for admission to the Graduate School will be found on page 83. In addition, an applicant for admission to a course of graduate study leading to the Doctor's degree must include on his application blank a general statement of his proposed course of study and field of research, and indicate the choice of Major and Minor fields in which he desires to specialize. If not a graduate of the Institute of Technology, his application must contain a full statement of his preparation for undertaking work leading to the doctorate.

The approval of a student's application for admission to a course of study and research leading to the Doctor's degree is provisional. If his work in residence is of such a character as to indicate that he does not possess those abilities which warrant his continuance toward the doctorate, he will be required to limit his graduate study to the attainment of the Master's degree or to discontinue graduate work.

Period of Residence. The Doctor's degree is not conferred after any definite period of study, but only when the candidate has given evidence of ability to conduct original research by the presentation of a satisfactory thesis embodying a contribution to knowledge in the field of pure or applied science.

A rule of the Faculty, however, requires that not less than two years must be devoted to advanced study and research for the Doctor's degree. Ordinarily, at least three years will be found necessary to meet the requirements, but students pursuing their researches during the summer may be able to complete the work for the degree in less than this time. Credit will be given for graduate work of high grade carried out at another institution before coming to the Institute in determining the requirements for the degree, but in every case *at least one academic year must be spent in residence, and the thesis submitted must be carried out under the direction of a member of the Institute Faculty. The Doctor's degree is not conferred for research done in absentia.*

It is sometimes advisable for a candidate to qualify for the Master's degree before proceeding towards the Doctorate. The advice of his Departmental Committee should be followed in these cases, but a student may not register for both degrees at the same time.

The four basic requirements for a doctorate are proficiency in languages, completion of a Minor, completion of a Major, and preparation of a thesis.

Language. All candidates for the degree of Doctor of Philosophy and Doctor of Science must be able to read scientific literature in English, German, and one other language, the third to be a modern language approved by the Departmental Committee on Graduate Students in charge of the student's major work. The requirement of the third language may be waived upon the recommendation of that Committee in the case of a student working for the degree of Doctor of Science in a field of engineering in which the scientific literature of a third language is unimportant. Proficiency in reading a foreign language must in all cases be certified by the Department of Modern Languages.

Reading examinations to meet language requirements will be held at three stated times during the year, namely, the week following the opening of each term and during the second week in May. Students wishing to present themselves for examination at any of these times must notify the Head of the Department of Modern Languages in writing two weeks before the examination period, stating the language

* The specific requirements for the degree of Doctor of Public Health are given on page 107.

in which they wish to be examined and their major field of study. The time and place of examinations will be announced in the General Bulletin issued at the beginning of each term, and on departmental bulletin boards. *Language examinations should be passed as early as possible, and must be passed not less than seven months before the award of the degree.*

Major and Minor. While the work for the degree consists mainly of scientific research, this must be supplemented by systematic studies of an advanced character in some branch of science or engineering, which is termed the Major. Thus, chemistry, physics, geology, biology, mathematics, or some branch of engineering may be chosen as the Major field. In exceptional cases in which the desired program of graduate study does not fit in with the above definition of a Major, the student may present and defend his program before the Committee on the Graduate School, and if it be approved, may proceed with this program under the supervision of a special committee of the Faculty appointed by the Dean of the Graduate School.

In addition to the Major, a Minor must be completed in at least one other branch of science or engineering or in mathematics. In general, only one Minor is required, consisting of at least twenty-five units of work, more advanced in character than required in the undergraduate curriculum of the department in which the student is majoring. Subjects should be chosen from the A or B groups. The program for the Minor requirement must be submitted to and approved by the Committee on Graduate Students of the department in which the Minor is taken, soon after the student has registered for the Doctorate. In approving a schedule of studies for a Minor in a given field of science or engineering, a Department Committee may include subjects offered in other departments provided these subjects lie within the field of the Minor and form, with other subjects, a logical program.

Examinations. The requirements for a Minor may be met by passing with grades satisfactory to the Committee in charge of the Minor all subjects in the previously approved Minor program. The Committee may, however, require an oral or written comprehensive examination on the field of the Minor if it so elects. Students who request full credit for a Minor based upon work done at another institution may be required to pass such an examination. *Minor requirements must be passed at least seven months before the completion of the work for the degree* in order that the latter part of the student's period of study may be devoted exclusively to his research.

As soon as a student has completed all subjects required for his Minor he must so notify the Registrar in writing. The Registrar will then submit his complete record to the Committee in charge of the Minor, which will report its decision as to the manner in which the requirements have been met. No final record will be reported on a Minor until the student has initiated a request for this record through the Registrar's office.

General examinations for the Doctor's degree on the field of the Major will be held in October or early November for those who anticipate completing requirements for the degree the following June, and at such other times as Departmental Committees may approve. Application for an examination must be made by the student to the Committee on Graduate Students of the department in which he is majoring and the approval of this Committee must be obtained before the examination will be given. The general examination shall be both written and oral. It must be passed at least seven months before the student may come up for a degree.

Candidacy for the Doctorate. Applicants for the Doctorate must be enrolled on the *list of Candidates*, in general, at least seven months prior to the award of the degree. The status of Candidate may be attained only by favorable vote of the Committee on the Graduate School in confirmation of departmental endorsement of a request, *initiated by the student himself*, that he be so enrolled. This request must be made in writing to the Registrar who will transmit the applicant's complete graduate record to the Chairman of his Departmental Committee. Favorable action on such a request may be expected if there be a record of completion of Minor requirements and of having passed the prescribed Language requirement and the General Major Examination, and if the student has demonstrated his ability to carry on research.

Degree List. When a candidate expects to complete his thesis and to come up for his degree he must apply to the Registrar to have his name placed on the *Degree List* as explained under Degree List on page 86. No candidate will be considered for a degree until his name has been placed on this list.

Thesis. Each candidate for the Doctor's degree must deposit with the Chairman of the Committee on Graduate Students of his department one original and one carbon copy of his thesis; also an abstract of approximately one thousand words, suitable for publication, summarizing in readable form the main results and conclusions of the research. Theses and abstracts must be typewritten and conform to the Regulations of the Graduate School

A short biographical sketch of the candidate's academic career and activities subsequent to the award of the Bachelor's degree must accompany each copy of the thesis. Theses must be submitted in final form at least *two weeks* before the first annual examination, if the candidate expects to receive his degree at Commencement.

Final Examination and Degree. The final examination is oral and held after the completed thesis has been handed in. It is limited to the thesis and the special field of science or engineering in which it lies and to such other phases of the Major field as the Department Committee may require. When the thesis has been accepted and the final examination passed, the candidate, upon recommendation of his Departmental Committee and of the Committee on the Graduate School, will be recommended to the Faculty for the degree.

In conferring the Doctor's degree, the Doctor's hood is presented by the Institute to each candidate who receives his degree in person at Commencement. Candidates recommended for the degree in October or December do not receive hoods at the following June Commencement.

CIVIL AND SANITARY ENGINEERING

ADVANCED work in the Department of Civil and Sanitary Engineering may be pursued to advantage in the fields of Structural Engineering (including Foundation Engineering), Hydraulic Engineering, Railway and Highway Transportation, Sanitary Engineering, Geodetic Surveying and Seismology.

In Structural Engineering a number of advanced subjects are offered in which modern methods of investigating stresses in complicated structures, both of steel and reinforced concrete, are presented in detail and applied to structures of various types, such as arches, suspension bridges, continuous bridges, frameworks of high buildings and high masonry arched dams. Experimental research has been carried on in the past, and is now being conducted with the object of verifying mathematical investigations and formulas pertaining to such structures, and further research may be profitably made in this field by interested students. The facilities of the laboratory of Structural Analysis are available for experimental research and thesis work in this field as well as for courses in the technique of model studies of structures. Other research work consists of the design and investigation of the economy and suitability of various types of construction for particular structures and investigations of properties of soils which may be of interest in engineering construction. The number of separate graduate subjects offered in Structural Engineering is considerable, and the student wishing to specialize in this subject has a wide field open to him. Students seeking admission to these graduate courses should have a thorough training in the fundamental principles of structures, equivalent to that covered by subjects 1·40, 1·41, 1·42, 1·58.

In the field of Foundation Engineering, unusual opportunities for research are possible in the laboratory of Soil Mechanics, which is well equipped with apparatus of various types for determining the properties of soils, and in the retaining wall laboratory.

In Water Power Engineering, students investigate existing water power plants and make detailed studies and designs for a water power project. Studies are also made of the comparative economy and the valuation of various water power developments. Experimental investigations may be carried on in the Hydraulic Laboratory, and the cordial relations between water power companies in New England and the Institute have made it possible for students to conduct certain investigations at existing commercial plants. The graduate subjects are dependent upon the undergraduate subjects of Hydrology and Water Power Engineering and Flood Control (1·70, 1·71) and students wishing to take the graduate work should have had the full equivalent of these.

In the field of Theoretical Hydraulics, advanced work is given, in which the whole subject of hydraulic flow is reviewed and the relation between fundamental formulas and experimental results discussed. Subject matter, not ordinarily included in elementary courses in hydraulics, includes a discussion of open channel flow with special reference to the alternate and critical stages and to the occurrence of the hydraulic jump and its utilization as an absorber of energy; the flow of water at velocities below the critical and the determination of the value of the critical velocity; recent developments in the art of measuring the flow of water in closed conduits; and the dynamic action of streams upon immersed surfaces and solids.

Research has been conducted in recent years to develop a method for reducing or preventing silting under a floating dry dock in New York Harbor; to calibrate sewer nozzles for the Metropolitan District Water Supply Commission; to determine the shape of a mooring basin for the Cape Cod Canal which will give minimum eddy motion; and to determine the high and low water profiles of the enlarged canal. These last two studies were for the Corps of Engineers, United States Army. Other subjects investigated include the character of aprons best fitted to resist erosion for certain proposed dams and the fundamental laws governing the transportation of the bed load of rivers.

In the field of cement and concrete, opportunity is offered for original research. Special equipment and control rooms are available for studying important properties of concrete, such as volume changes, elastic and plastic properties, and hardening characteristics.

Advanced courses in Railway and Highway Transportation, such as experimental work in the Highway

Civil and Sanitary Engineering Continued

Testing Laboratory, investigations of highway traffic control, design and operation studies for improvements of existing railway terminals and other special problems have in the past been done as advanced work, and the department is prepared to offer similar opportunities if sufficient demand exists. Students taking these subjects should have had the full equivalent of the undergraduate subjects in Transportation Engineering (1·271, 1·272).

Advanced subjects in the theory of Geodesy are offered in Cambridge during the regular school year, and field practice in geodetic work is given at Camp Technology during the summer. Subjects in Seismology, with particular emphasis upon seismological instruments and vibration problems are also available for graduate students interested in this field.

Graduate work in Sanitary Engineering may be carried on in connection with the treatment of water and the treatment and disposal of sewage, industrial wastes and garbage. Courses in Advanced Sanitary Design are given in connection with the study of the theoretical principles involved in the foregoing fields, and designs are worked out for typical problems.

Opportunities are available to students for inspecting typical plants for the purification of water supplies; the special treatment of water for certain industrial uses; the disposal of sewage; and the treatment of wastes from tanneries, woolen mills, cotton mills, paper mills and other industrial plants.

Research in the hydraulic, chemical and biological processes relating to Sanitary Engineering may be carried on in the Hydraulic, Sanitary Engineering, Chemical and Bacteriological Laboratories of the Institute.

Undergraduate Prerequisites for Civil Engineering

In addition to the general requirements for all graduate students, candidates for the degree of Master of Science in Civil Engineering must present evidence of training in certain professional studies considered essential for all Civil Engineers and corresponding approximately to the following Institute subjects:

1·00, 1·01, 1·05	Surveying
1·20, 1·21	Railway and Highway Engineering
2·04	Applied Mechanics
1·62	Hydraulics
12·321	Applied Engineering Geology
1·40, 1·41, 1·421	Structures
1·501	Bridge Design

He must also present evidence of having had, in addition, sufficient undergraduate training to prepare him for the advanced subjects he wishes to take. The amount of such training should be approximately equivalent to that included in the following Institute subjects:

For
- (*a*) Structural Engineering
  - 1·42T or 1·421 Structures
  - 1·502T Structural Design
  - 1·58 Design of Reinforced Concrete Structures
- (*b*) Transportation Engineering
  - 1·271, 1·272 Transportation Engineering
- (*c*) Water Power and Flood Control
  - 6·40 Elements of Electrical Engineering
  - 1·70 Hydrology
  - 1·71 Water Power Engineering and Flood Control
- (*d*) Water Works and Sewerage
  - 1·75 Hydraulic and Sanitary Engineering
  - 1·76 Sanitary Engineering

If a student has not had, before entering the Institute, the special training in his chosen field of study listed under (*a*), (*b*), (*c*), or (*d*), such training may be acquired during attendance at the Institute and all subjects in these lists except the third year subjects, Elements of Electrical Engineering, 6·40, and Design of Reinforced Concrete Structures, 1·58, may be taken as B subjects and (up to a total of 24 units) counted for credit toward the Master's degree.

Undergraduate Prerequisites for Sanitary Engineering

In addition to the general requirements for all graduate students, candidates for the degree of Master of Science in Sanitary Engineering must present evidence of having had training in certain professional studies considered essential for all Sanitary Engineers, the field covered corresponding approximately to that covered by the following courses at the Institute:

1·041	Surveying
7·29	Bacteriology
7·41	Chemistry of Water
1·40, (1·41), (1·421)	Structures
1·62	Hydraulics
2·04	Applied Mechanics
(1·75), (1·76), (1·79)	Sanitary Engineering

If the student has not had, before entering the Institute, all the subjects in the foregoing list, such subjects may be taken during attendance at the Institute and those subjects shown in parentheses may be taken as B subjects and (up to a total of 24 units) counted for credit toward the Master's degree.

United States Engineer Corps

Graduate course leading to the degree of Master of Science in Civil Engineering, especially arranged for officers in the United States Army. The course is open only to officers designated by the War Department.

Civil and Sanitary Engineering Continued

First Term	1·402	Structures	4–8
	1·491	Soil Mechanics	3–6
	1·493	Soil Mechanics Lab.	3–3
	1·681	Theory of Models	2–4
	1·70	Hydrology	7–4
	2·689	Mechanical Eng. Equipment	6–3
			25–28
Second Term	1·22	Quantity Surveying	2–2
	1·273	Transportation Eng.	4–5
	1·411	Structures	3–6
	1·47	Cement and Concrete	3–2
	1·492	Soil Mechanics	3–6
	1·682	River Hydraulic Lab.	9–0
	12·79	Applied Eng. Geology	3–3
		Thesis	2
			53
Summer Term	1·25	Engineering Construction	4–1
	1·51	Structural Theory, Adv.	3–6
	1·541	Reinforced Concrete Des.	6–2
		Thesis	18
			40

GRADUATE SUBJECTS IN CIVIL AND SANITARY ENGINEERING

"A" Subjects. Primarily for Graduates

First Term	1·141	Geodesy, Adv.	2–4
	1·301	Railway Transportation, Adv.	2–4
	1·32	Design of Harbor Works	4–3
	1·371	Highway Transportation, Adv.	2–4
	1·491	Soil Mechanics	3–6
	1·493	Soil Mechanics Lab.	3–3
	1·495	Soil Mechanics	5–10
	1·521	Structural Laboratory	Time arr.
	1·541	Reinf. Concrete Design, Adv.	6–2
	1·551	Structural Design, Adv.	6–0
	1·561	Structural Theory, Adv.	4–8
	1·571	Statically Indeter. Structures	3–6
	1·59	Concrete Research	Time arr.
	1·66	Hydraulics Advanced	2–6
	1·681	Theory of Models	2–4
	1·731	Water Power Eng., Adv.	3–6
	1·811	Sanitary Eng., Adv.	3–6
	1·821	Sanitary Engineering Lab.	4–2
	1·851	Water Power Design, Adv.	8–0
	1·881	Sanitary Design, Adv.	6–0
Second Term	1·136	Vibration Problems	3–6
	1·142	Geodesy, Adv.	3–6
	1·302	Railway Transportation, Adv.	2–4
	1·372	Highway Transportation, Adv.	2–4
	1·492	Soil Mechanics	3–6
	1·496	Soil Mechanics	5–10
	1·522	Structural Laboratory	Time arr.
	1·542	Reinf. Concrete Design, Adv.	6–0
	1·552	Structural Design, Adv.	6–0
	1·562	Structural Theory, Adv.	2–6
	1·572	Statically Indeter. Structures	3–6
	1·59	Concrete Research	Time arr.
	1·682	River Hydraulic Lab.	9–0
	1·69	River Engineering	2–4
	1·732	Water Power Eng., Adv.	3–6
	1·812	Sanitary Eng., Adv.	3–6
	1·822	Sanitary Engineering Lab.	4–2
	1·852	Water Power Design, Adv.	8–0
	1·882	Sanitary Design, Adv.	6–0

"B" Subjects. Open to Graduates and Undergraduates

First Term	1·135	Intr. to Vibration Theory	3–2
	1·138	Seismological Lab.	Time arr.
	1·25	Engineering Construction	4–1
	1·271	Transportation Eng.	6–5
	1·34	Municipal Engineering	3–4
	1·41	Structures	3–6
	1·48	Foundations	3–4
	1·501	Bridge Design	8–0
	1·70	Hydrology	7–4
	1·701	Hydrology	3–4
	1·75	Hydraulic & Sanitary Eng.	4–6
	1·801	Hydraulic & Sanitary Design	3–0
Second Term	1·138	Seismological Lab.	Time arr.
	1·16	Aerial Surveying	2–2
	1·26	Railway Signaling	2–3
	1·272	Transportation Eng.	5–4
	1·273	Transportation Eng.	4–5
	1·28	Railway Design	5–0
	1·38	Highway Design	5–0
	1·411	Structures	3–6
	1·42T	Structures	3–6
	1·421	Structures	2–4
	1·502T	Structural Design	8–0
	1·52	Structural Design	3–0
	1·71	Water Power Eng. & Flood Control	7–3
	1·711	Water Power Eng. & Flood Control	3–3
	1·76	Sanitary Engineering	2–3
	1·78	Sanitary Engineering	3–4
	1·79	Sanitary Design	2–0
	1·802	Sanitary Design	5–0

"A" and "B" Subjects offered during Summer

1·07	Geodetic Surveying (B)	13–0
1·25	Engineering Construction (B)	4–1
1·51	Structural Theory, Adv. (A)	3–6
1·541	Reinforced Concrete Des., Adv. (A)	6–2
1·681	Theory of Models (A)	2–4
1·682	River Hydraulic Lab. (A)	9–0

MECHANICAL ENGINEERING

The Department of Mechanical Engineering offers many opportunities for graduate work leading to the degrees of Master of Science and Doctor of Science in Mechanical Engineering. Advanced study and research may be pursued in one or more of the following fields: applied mechanics, theory of elasticity, vibration, properties of materials, plasticity, photoelasticity, rigid dynamics, fluid mechanics, machine design, automatic machinery, physical metallurgy and heat treatment of metals and alloys, metal processing, theoretical thermodynamics, refrigeration, heat transmission, air conditioning, design of power plants and prime movers, automotive engineering and design, textile engineering, and metrology and engineering standards.

Graduate studies in the fields of mathematics, aerodynamics, hydraulic engineering, and business and engineering administration may be included in the candidate's program.

Requirements for Advanced Degrees

In addition to the general requirements for the Master of Science and Doctor of Science degrees, candidates for the degree of Doctor of Science in the major field of Mechanical Engineering will be required to pass satisfactorily scientific reading tests in two modern languages, one of which must be French or German. There must be included in the major field, graduate studies in mathematics, mechanics and thermodynamics; except that a student wishing to specialize in the field of engineering mechanics may limit his major field of study to graduate subjects in mathematics and mechanics. In general, not less than three years of graduate study are necessary for the Doctor's degree.

Laboratory Equipment

For research there is available the extensive equipment of the Mechanical Engineering Laboratories which include:

A Steam Laboratory, with a variety of engines, turbines, condensers and other equipment.

A Compressed Air Laboratory, with compressors of various capacities.

A Refrigeration Laboratory, with several machines of different types, a number of refrigerator units with considerable auxiliary equipment and a constant-temperature room.

An Air Conditioning Laboratory containing winter, summer, and year-round air conditioning units with considerable auxiliary equipment. A special insulated room for study of lower temperature air conditioning problems.

A Hydraulic Laboratory, with high and low pressure pumps, measuring tanks, flumes, wheel pit and other extensive equipment.

An Internal Combustion Engine Laboratory, housed in a specially designed building and equipped with a variety of internal combustion engines, eleven dynamometers ranging from 10 to 300 horsepower in capacity, a small high-speed wind tunnel, a dark room, and a machine and instrument shop.

A Heat Measurements Laboratory specially equipped for research in pyrometry, thermal conductivity and expansion, specific heat, heat of combustion, and refractories. In addition to furnaces and kilns, the laboratory contains a refrigerating unit and an insulated room which can be cooled to − 30° C.

A Power Measurements Laboratory, with a number of dynamometers ranging up to a capacity of 100 horsepower, dynamic balancing machines, and gear testing machines specially arranged for testing power plant transmission devices.

The Engineering Metals Laboratories. (1) The Foundry Laboratory equipped with sand control apparatus, molding equipment, gas and oil fired furnaces and cupolas; (2) the Metal Working Laboratory equipped with forges, drop hammer, forging hammer, rolling mill, punch presses, controlled temperature heating furnaces, and metallographic and physical testing equipment for control tests; (3) the Welding Laboratory equipped with A.C. and D.C. arc welding machines, gas welding and cutting apparatus, and resistance welding machines.

A Testing Materials Laboratory, fully equipped with testing machines ranging from 10,000 lbs. to 1,000,000 lbs. capacity, impact testing machines, hardness testing machines, and extensive equipment for testing cement, concrete and road materials, including special storage rooms which can be maintained under constant temperatures ranging from − 15° F. to 80° F., and constant humidity ranging from zero to 100 per cent. The laboratory also contains completely equipped photoelastic apparatus, extensometers and special strain measuring devices.

A Textile Laboratory, with a full equipment of textile testing machines capable of varying rates of load application and supplied with autographic recording apparatus; machines for measuring wear, resilience and moisture effects. The laboratory is under full moisture control, with automatic humidification apparatus; also a fully equipped microscopic laboratory for the examination of the structure of textiles and textile fibers.

A Machine Tool Laboratory equipped with a large variety of modern machine tools is available for machine work in connection with research, as well as a machine shop, manned by expert machinists.

In addition to the foregoing laboratories, there are available, for research work in physical metallurgy and heat treatment, the extensive laboratories of the Metallurgy Department fully equipped for heat treatment, metallography and X-ray analysis.

GRADUATE SUBJECTS IN MECHANICAL ENGINEERING

"A" Subjects. Primarily for Graduates

First Term	2·125	Research in Photoelasticity	Time arr.
	2·131	Dynamics of Engines	2–4
	2·201	Adv. Mech. & Th. of Elast.	3–9
	2·211	Adv. Mech. Engineering Problems	3–9
	2·221	Plasticity	3–6
	2·223	Plasticity Research	Time arr.
	2·271	Hydromechanics	3–6
	‡2·273	Adv. Hydromech. Prob.	Time arr.
	2·391	Dynamic Strength of Metals	Time arr.
	2·44	Eng. Thermodyn. of Mixtures	3–6
	2·451	Adv. Prob. in Eng. Thermodynamics	Time arr.
	2·461	Refrigeration, Adv.	3–9
	2·53	Heat Measurements	Time arr.
	2·57	Power Plants, Adv.	3–6
	2·63	Storage & Trans. of Foodstuffs	3–6
	2·671	Air Conditioning, Adv.	3–6
	2·751	Machine Design, Adv.	8–2

‡Not offered in 1940–41.

Mechanical Engineering Continued

	2·801	Automotive Engine Prob., Adv.	Time arr
	2·88	Met. & Dimens. Eng. Stand.	3–6
	2·905	Textile Technical Analysis	3–5
	2·907	Textile Microscopy	5–2
	2·911	Textile Research Lab. Research	6–0
Second	2·125	Research in Photoelasticity	Time arr.
Term	2·202	Adv. Mech. & Th. of Elast.	3–9
	2·212	Adv. Mechanical Eng. Problems	3–9
	2·222	Adv. Plasticity Problems	3–6
	2·223	Plasticity Research	Time arr.
	‡2·272	App. Hydromechanics	3–6
	‡2·273	Adv. Hydromech. Prob.	Time arr.
	2·34	Properties of Metals under Stress	3–3
	2·392	Dynamic Strength of Metals	Time arr.
	2·45	Eng. Thermodynamics, Adv.	3–9
	2·451	Adv. Prob. in Eng. Thermodynamics	Time arr.
	2·462	Heat Transmission, Adv.	3–9
	2·64	Refrigeration Eng.	3–6
	2·672	Heating & Vent. Design	4–4
	2·692	Refrig. & Air Cond. Lab.	6–6
	2·752	Machine Design, Adv.	8–2
	2·802	Automotive Engine Prob., Adv.	Time arr.
	2·906	Textile Technical Analysis	3–5
	2·908	Textile Microscopy	5–2
	2·912	Textile Research Lab. Research	6–0
Summer	2·361	Adv. Strength of Materials	5–4

A number of Group A subjects listed in other Courses may be taken for credit in the field of Mechanical Engineering. For example:

First	1·59	Concrete Research	Time arr.
Term	3·34	Physical Metallurgy, Adv.	Time arr.
	13·73	Mechanical Vibration	3–6
	16·41	Instrumentation	3–9
	M351	Adv. Calculus for Engineers	3–6
	M36	Calculus, Adv.	3–6
Second	1·59	Concrete Research	Time arr.
Term	3·35	Physical Metallurgy, Adv.	Time arr.
	13·74	Mechanical Vibration	3–6
	16·46	Vibration Measurements	5–6
	M352	Adv. Calculus for Engineers	3–6
	M37	Calculus, Adv.	3–6

"B" Subjects. Open to Graduates and Undergraduates

First	2·081	Applied Mechanics	3–5
Term	2·10	Ordnance Engineering	3–3
	2·121	Applied Photoelasticity	3–2
	2·35	Adv. Metals and Testing	4–4
	2·43	Heat Engineering	3–5
	2·51	Heat Measurements	3–3
	2·55	Power Plant Engineering	3–3
	2·621	Refrigeration Engineering	3–3
	2·66	Heat., Vent. & Air Cond.	3–5
	2·682	Engineering Lab.	3–3
	2·732	Machine Design	4–2
	2·791	Automotive Engines	4–4
	2·793	Automotive Engine Design	4–0
	2·795	Automotive Vehicles	2–3
	2·797	Automotive Engines	2–2
	2·871	Manufacturing Eng.	2–4
	2·872	Preparation for Manufacturing	2–4
	2·901	Prin. of Fabric Structure	3–6
	2·903	Elem. of Textile Manufacturing	3–6
Second	2·082	Applied Mechanics	3–5
Term	2·11	Industrial Plant Eng.	3–3
	2·121	Applied Photoelasticity	3–2
	2·33	Adv. Engineering Metals	3–2
	2·332	Welding Eng., Adv.	4–2
	2·56	Power Plant Engineering	3–3
	2·58	Heat Eng. in Industrial Plants	3–5
	2·622	Refrigeration Eng.	3–5
	2·69	Refrig. & Air Cond. Lab.	6–6
	2·691	Refrigeration Lab.	3–3
	2·79	Automotive Dynamics	2–2
	2·792	Automotive Engines	4–4
	2·794	Automotive Engine Design	4–0
	2·796	Automotive Vehicles	3–5
	2·798	Automotive Engines	2–2
	2·82	Diesel Engine Design	6–0
	2·83	Steam Turbine Eng.	4–2
	2·871	Manufacturing Eng.	2–4
	2·872	Preparation for Manufacturing	2–4
	2·902	Prin. of Fabric Structure	3–6
	2·904	Prin. of Textile Manufacturing	3–6

‡ Not offered in 1940–41.

Automotive Engineering. Students desiring to specialize in Automotive Engineering for a year of graduate study, leading to the degree of Master of Science in Mechanical Engineering, should register for Subjects 2·801, 2·802, 2·131, 2·871, 2·872, 10·79 and such other subjects as may be approved by the Department Committee on Graduate Students.

Heating and Ventilating Engineering. Students desiring to specialize in Heating and Ventilation and Air Conditioning for a year of graduate study leading to the degree of Master of Science in Mechanical Engineering, should register for Subjects 2·53, 2·671, 2·672, 2·692, 7·53 and such other subjects as may be approved by the Department Committee on Graduate Students.

Refrigeration Engineering. Students desiring to specialize in Refrigeration Engineering for a year of graduate study leading to the degree of Master of Science in Mechanical Engineering, should register for Subjects 2·461, 2·462, 2·63, 2·64, 2·692 and such other subjects as may be approved by the Department Committee on Graduate Students.

Naval Engineering. A graduate course which has been planned in coöperation with the Bureau of Engineering of the United States Navy Department, primarily for Annapolis Graduates, is open to a limited number of civilian graduates in Mechanical Engineering who are American citizens. The schedule of studies is given under Marine Engineering. The course leads to the degree of Master of Science in Marine Engineering.

Torpedo Engineering. A graduate course in Torpedo Engineering, leading to the degree of Master of Science in Mechanical Engineering, has been arranged for officers in the United States Navy. This course is open only to officers designated by the Navy Department.

Torpedo Engineering, United States Navy

First Year

First	2·151	Dynamics	2–4
Term	2·271	Hydromechanics	3–6
	2·59	Torpedoes	2–4
	2·761	Machine Design	6–2
	3·38	Physical Metallurgy, Adv.	4–4
	3·43	Heat Treatment	3–2
	13·73	Mechanical Vibration	3–6
			23–28

Mechanical Engineering Continued

Second	2·152	Dynamics	2–4
Term	2·272	App. Hydromechanics	3–6
	2·45	Adv. Engineering Thermodynamics	3–9
	2·762	Machine Design	3–2
	3·39	Physical Metallurgy, Adv.	6–2
	10·50	Heat Transmission	2–4
	13·74	Mechanical Vibration	3–6
			22–33

Second Year

First	16·41	Instrumentation	3–9
Term	16·43	Instrumentation Laboratory	3–6
		Research and Thesis	30
			51
Second	16·46	Vibration Measurements	5–6
Term		Research and Thesis	35
			46

Army Ordnance. A graduate course leading to the degree of Master of Science, especially arranged for officers in the United States Army. The course is open only to officers designated by the War Department.

Army Ordnance, United States Army

Summer	2·05	Applied Mechanics	4–6
Term	2·203	Theory of Elasticity	2–4
	5·04	Chemistry	4–5
	5·412	Organic Chemistry and Lab.	6–4
	M75	Mathematics	5–7
			21–26
First	2·71	Theory and Appl. of Mech.	6–8
Term	3·11	Production Metallurgy	3–5
	3·36	Physical Metallurgy	4–6
	5·413	Organic Chem. and Lab.	6–0
	6·42	Electrical Eng., Elem.	5–5
	10·38	Explosives Plant Engineering	5–3
			29–27
Second	3·37	Physical Metallurgy, Adv.	4–6
Term	6·88	Electrical Eng. Lab.	3–6
	10·39	Theory of Interior Ballistics	4–6
		Thesis	25
			54

Textile Technology

The Institute offers opportunity for advanced study and research in the field of textiles. A Textile Laboratory has been fully equipped with modern humidification and dehumidification and with excellent facilities for work leading to the degree of 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 four years' 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 and a summer course to fulfill the requirements for the degree.

In general, students desiring to specialize in Textile Technology for a year of graduate study should register for subjects approved by the Department Committee on Graduate Students and which may be selected from the following list, including subjects offered in other departments which relate directly to Textile Technology.

"A" Subjects. Primarily for Graduates

First	2·221	Plasticity	3–6
Term	2·905	Textile Technical Analysis	3–5
	2·907	Textile Microscopy	5–2
	2·911	Textile Research Laboratory	6–0
Second	2·222	Advanced Plasticity Problems	3–6
Term	2·906	Textile Technical Analysis	3–5
	2·908	Textile Microscopy	5–2
	2·912	Textile Research Laboratory	6–0
	Ec38	Engineering and Indust. Statistics	3–6

"B" Subjects. Open to Graduates and Undergraduates

First	2·901	Principles of Fabric Structure	3–6
Term	2·903	Elements of Textile Manufacturing	3–6
	8·27	X-Rays and Crystal Physics	4–5
	M331	Mathematical Theory of Statistics	3–6
Second	2·902	Principles of Fabric Structure	3–6
Term	2·904	Principles of Textile Manufacturing	3–6
	8·173	Color Measurements	3–2
	M332	Mathematical Theory of Statistics	3–6

Other subjects may be elected with the approval of the Department Committee on Graduate Students.

METALLURGY

(Including Mineral Dressing and Ceramics)

Graduate work leading to the degrees of Master of Science and Doctor of Science in the fields of Metallurgy or Ceramics 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

Metallurgy Continued

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 electro-metallurgical 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 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 processes, 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 well equipped with testing apparatus as well as with machines and kilns for carrying out the regular plant processes.

GRADUATE SUBJECTS IN METALLURGY

"A" Subjects. Primarily for Graduates

First Term	3·06	Non-Fer. Metallurgy, Adv.	2–6
	3·15	Metallurgy: Iron & Steel, Adv.	Time arr.
	3·17	Metal. Plant Design	13–0
	3.23T	Fire Assaying, Adv.	Time arr.
	3·34	Physical Metallurgy, Adv.	Time arr.
	3·52	Physics of Metals, Adv.	Time arr.
	‡3·60	Ferromagnetism	2–4
	3·61	Atomic Arrangements in Alloys	2–4
	3·62	Sp. Prob. in the Physics of Metals	Time arr.
	3·73	Fund. Ceramic Processes	7–4
	3·75	Special Problems in Ceramics	Time arr.
	3·89	Mineral Dressing Design	Time arr.
	3·90	Mineral Dressing, Adv.	2–4
	3·91	Mineral Dressing Seminar	1–2
Second Term	3·08	Gen. Metallurgy, Adv.	2–6
	3·09	Metallurgical Calc., Adv.	2–6
	3·16	Metallurgy: Iron & Steel, Adv.	Time arr.
	3·18	Metal. Plant Design	13–0
	3·24	Fire Assaying, Adv.	Time arr.
	3·35	Physical Metallurgy, Adv.	Time arr.
	3·52	Physics of Metals, Adv.	Time arr.
	3·62	Sp. Prob. in the Physics of Metals	Time arr.
	3·74	Phys. Prop. of Ceramic Products	5–4
	3·76	Spec. Problems in Ceramics	Time arr.
	3·89	Mineral Dressing Design	Time arr.
	3·90	Mineral Dressing, Adv.	2–4
	3·91	Mineral Dressing Seminar	1–2

"B" Subjects. Open to Graduates and Undergraduates

First Term	3·031	Metallurgy of Copper & Lead	5–4
	3·041	Electric Furnaces	3–2
	3·19	Metallurgical Plants	3–3
	3·20T	Metallurgical Thermodynamics	4–5
	3·33	App. of Metallography	3–2
	3·40	Corrosion & Heat Resisting Alloys	2–4
	3·42	Powder Metallurgy	2–4
	3·50	X-Ray Metallography	3–3
	3·71	Optical Ceramics	6–2
	3·83	Mineral Dressing Plant	3–2
	3·85T	Flotation	3–3
	3·87	Quantitative Mineragraphy	4–0
Second Term	3·05	Metallurgy, General	3–3
	3·19	Metallurgical Plants	3–3
	3·21T	Principles of Steel Making	2–4
	3·33	App. of Metallography	3–2
	3·41	Light Alloys	2–4
	3·422	Powder Metallurgy Laboratory	4–2
	3·50	X-Ray Metallography	3–3
	3·51	Physics of Metals	2–4
	3·84	Mineral Dressing Practice	2–2
	3·86T	Comminution	2–3
	3·88	Ore Testing	6–2

Ceramics

"A" Subjects. Primarily for Graduates

First Term	3·73	Fund. Ceramic Processes	7–4
	3·75	Sp. Problems in Ceramics. Research	Time arr.
Second Term	3·74	Physical Prop. of Ceramic Products	5–4
	3·76	Sp. Problems in Ceramics. Research	Time arr.

‡ Not offered 1940–41.

Metallurgy Continued

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

First Term	2·53	Heat Measurement	Time arr.
	10·70	Principles of Combustion	4–6
Second Term	‡8·28	X-Ray Diffraction	2–4
	‡8·29	Quantum Theory of the Solid State	3–6
	10·74	Furnace Design	3–6

"B" Subjects. Open to Graduates and Undergraduates

First Term	3·71	Optical Ceramics	6–2

‡ Not offered in 1940–41.

SCHOOL OF ARCHITECTURE

Architecture

The graduate work leading to a Master's degree is so arranged as to give the student who has mastered during the previous five years the multiple requirements of an undergraduate curriculum an uninterrupted opportunity to devote himself to the main essentials of his professional work. The time is divided between Architectural design, freehand drawing, and history, so that the best possible opportunity is offered in long periods of consecutive hours for concentration on these fundamental subjects.

The advantage of a graduate year for the student who has taken his undergraduate work directly after leaving high school lies further in the fact that the intervening years have resulted in an appreciation of the significance and value of an architectural training of which he is only just becoming conscious on graduation, and for the application of which this added year provides a precious opportunity.

The graduate year is of particular value in offering to students of Architecture intending to become teachers the chance to acquire experience in problems of Architecture of a far broader nature than can possibly characterize undergraduate instruction.

The School Library is well equipped with books, photographs, plates and slides, and is a true research laboratory for the ambitious student.

Only those students will be accepted as applicants for the Master's degree in Architecture whose previous performance in the required work, whether at Technology or elsewhere, has been better than a passing grade, and has shown evidence of unusual ability.

The degree of Master in Architecture is awarded upon the satisfactory completion of a program of 96 units of advanced study approved by the School of Architecture, followed by the preparation of a thesis. This thesis is to be prepared during the following summer and completed in sufficient time for the candidate to file his application to be placed on the October degree list.

Graduates from other colleges who desire to obtain the Master's degree in Architecture must present evidence that they have had the essential equivalent of the following undergraduate subjects as prerequisites for graduate work. Deficiencies in these subjects may be removed by taking the subjects at the Institute.

2·031	Structural Mechanics, Elementary
2·032	Structural Mechanics
2·033	Structural Mechanics
4·06	Graphics
4·071	Modeling
4·072	Modeling
4·11	Shades and Shadows
4·12	Perspective
4·421	Architectural History
4·422	Architectural History
4·811	Construction
4·812	Construction
M111	Calculus

While the following subjects in the fields of Architecture, Composition, History and Thesis Research are listed as required for the degree of Master in Architecture, it should be understood that work of equal amounts and of the same quality in related fields will be accepted if approved by the Deans of the Graduate School and of the School of Architecture. In other words, any one of these subjects, with the exception of Architectural Design and Thesis Research may be regarded as an elective.

GRADUATE SUBJECTS IN ARCHITECTURE

"A" Subjects. Primarily for Graduates

First Term	4·053	Freehand Drawing (Composition)	6–0
	4·491	Europ. Civ. & Art (History Research)	2–4
	4·761	Architectural Design VI	36–0
Second Term	4·054	Freehand Drawing (Composition)	6–0
	4·492	Europ. Civ. & Art (History Research)	2–4
	4·762	Architectural Design VI	30–0
		Thesis Research	6–0
Summer		Graduate Thesis	20 to 40

"B" Subjects. Open to Graduates and Undergraduates

First Term	4·051	Freehand Drawing	6–0
	4·091	Color, Comp., Theory and App.	1–4
	4·481	European Civilization and Art	2–3
	4·53	Professional Relations	1–2
	4·751	Architectural Design V	29–0
Second Term	4·052	Freehand Drawing	6–0
	4·092	Color, Comp., Theory and App.	1–4
	4·482	European Civilization and Art	2–3
	4·752	Architectural Design V	14–0

Subject to the approval of the Dean of the School of Architecture certain fourth-year subjects given in other departments, and optional subjects in Architecture and in exceptional instances third-year subjects which form with the advanced work a logical general program may be elected.

Architecture Continued

Foreign Language: The applicant should satisfy the School that he has a good reading knowledge of architectural prose in French or some modern language.

Cultural Subjects and Economics: It is expected that the applicant shall have a knowledge of English, history, economics and general studies similar to that included in the undergraduate Courses at the Institute. In case the applicant is unusually deficient in meeting this requirement, he may be required to take these subjects.

The following undergraduate subjects in Architecture are also required, but as these are open to both graduate and undergraduate students they may be elected in part as "B" subjects leading to the Master's degree.

4·051	Freehand Drawing.
4·052	Freehand Drawing
4·091	Color, Composition, Theory and Application
4·092	Color, Composition, Theory and Application
4·481	European Civilization and Art
4·482	European Civilization and Art
4·53	Professional Relations
4·751	Architectural Design V
4·752	Architectural Design V

City Planning

The School of Architecture offers advanced work in city planning, and opportunities for research in this field to graduate students. Conspicuous ability is rewarded by a Traveling Scholarship. The degree of Master in City Planning is awarded upon the satisfactory completion of a program of 96 units of advanced study approved by the School of Architecture, followed by the preparation of a thesis. This thesis is to be presented in sufficient time for the candidate to file his application to be placed on the February degree list immediately following his completion of all other requirements for the Master's degree. The degree is open to:

1. Students graduating with the Institute degree of Bachelor of Architecture in City Planning, who may expect to complete the requirements in one year followed by the preparation of a thesis.

2. Students graduating from the Institute or other accepted college with the degree of Bachelor in Architecture who may expect to complete the requirements in two years followed by the preparation of a thesis.

3. Students graduating from the Institute or other accepted college with the S.B. or A.B. degree and with such academic records and background that the Committee on Graduate Students of the School of Architecture recommends their admission to the Graduate School. To meet the requirements of the degree of Master in City Planning such students will require a minimum period of study of two years followed by the preparation of a thesis, or if their college preparation in engineering subjects has not been sufficient to meet the prerequisites, a longer period of study will be necessary. The undergraduate prerequisite subjects will be determined in each case by the Committee in charge of the applicant's course of study.

Graduates of other colleges who desire to obtain the Master's degree in City Planning must present evidence that they have had the essential equivalent of the following undergraduate subjects as prerequisites for graduate work. Deficiencies in these subjects may be removed by taking the subjects at the Institute.

1·02	Surveying
4·021	Freehand Drawing
4·031	Freehand Drawing
4·081	Color, Composition, Theory and Application
4·082	Color, Composition, Theory and Application
4·62	Site Planning and Construction
4·641	Principles of City Planning

The following undergraduate subjects in City Planning are also required, but as these are open to both graduate and undergraduate students they may be elected in part as "B" subjects leading to the Master's degree.

1·34	Municipal Engineering
4·651	Theory and Practice of City Planning
4·652	Theory and Practice of City Planning
4·681	City Planning Design
4·682	City Planning Design
Ec83	Urban Sociology
Ec84	Social and Economic Factors in City Planning

GRADUATE SUBJECTS IN CITY PLANNING

"A" Subjects. Primarily for Graduates

First Term	4·541	Housing Seminar	2–4
	4·60	Planning and Housing Legislation	2–4
	4·661	City Planning Research	2–4
	4·691	City Planning Design, Adv.	30–0
		Thesis Research	6–0
Second Term	4·542	Housing Seminar	2–4
	4·63	City Planning Administration	2–4
	4·662	City Planning Research	2–4
	4·692	City Planning Design, Adv.	30–0
	4·694	City Planning Design, Adv.	6–0
		Thesis Research	6–0
Summer	4·52	Office Practice	30–0
		Graduate Thesis	20 to 40

"B" Subjects. Open to Graduates and Undergraduates

First Term	1·34	Municipal Engineering	3–4
	4·651	Theory and Prac. City Planning	3–3
	4·681	City Planning Design	24–0
	4·683	City Planning Design	30–0

Architecture Continued

Second Term	4·51	Office Practice	30–0
	4·642	Theory of Site Planning	2–3
	4·652	Theory and Prac. City Planning	3–3
	4·672	City Planning Design	18–0
	4·682	City Planning Design	12–0

Subject to the approval of the Dean of the School of Architecture certain fourth-year subjects given in other departments, and optional subjects in Architecture and in exceptional instances third-year subjects which form with the advanced work a logical general program may be elected.

CHEMISTRY

The recent rise of chemistry in the United States has made it almost necessary for one who looks forward to a life work in the study or application of the science to give more than four years to preparation. For those whose time is limited, a program of work has been arranged which leads to the degree of Master of Science. The requirements are designed to make it possible for the candidate to specialize in any field of particular interest. The program of studies may be chosen with the approval of the Department of Chemistry from the list of senior and graduate studies offered in the Department. About one-third of a year is devoted to research for the S.M. degree. The degree of Doctor of Philosophy, on the other hand, is awarded to the candidate who has a broad scientific education in the fundamental branches of chemistry, and who has given evidence of the ability to carry on independent research by presenting a thesis which is a definite contribution to scientific knowledge.

Special Requirements for the Degree of Master of Science with Specification of Field

In addition to the general requirements for graduate work, candidates must present equivalents for the following subjects in Course V.

5·10	Qualitative Analysis
5·12	Quantitative Analysis
5·13	Quantitative Analysis
5·41	Organic Chemistry I
5·42	Organic Chemistry I
5·414	Organic Preparations
5·424	Identification of Organic Compounds
5·61	Physical Chemistry I
5·62	Physical Chemistry II
L11, L12	Elementary German
L51, L52	Elementary French

(Differential Equations M22 is not required of students specializing in Inorganic or Organic Chemistry.)

Special Requirements for the Degree of Doctor of Philosophy

Candidates must pass written examinations in French and German, complete a minor equivalent to at least 25 units, to be taken outside the Department of Chemistry, and complete with creditable records certain subjects as specified by the Committee on Graduate Students of the Department of Chemistry. A special folder giving in detail requirements for the advanced degree in Physical Chemistry, Organic Chemistry, or Inorganic Chemistry is available on application to the Chairman of the Graduate Committee of the Department. The examination in the branch of Chemistry in which the candidate is carrying out his research is both written and oral, and must be taken prior to October of the last year of residence in order that the final year may be devoted to research. The final examination on the research is oral and is devoted to the investigation and that part of the science which is closely related to the candidate's experimental work. Research, under direction, may be carried out in the summer months.

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, or in such other capacity as may be advisable, on a part time regular schedule throughout the scholastic year. The appointment is subject to renewal for one year. It is recommended that the candidate finance the last year of graduate work from personal sources, from a graduate scholarship, or from a loan under the Technology Loan Fund so that his entire time may be devoted to research and the completion of his graduate study.

The Research Laboratory of 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.

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. In consequence of the benefits already derived from systematic investigation, many industrial research laboratories have been and are being organized. It is universally agreed that

Chemistry Continued

graduate work is an essential preparation for positions in connection with these divisions. Since the work involved is of a widely varying nature, a student considering the possibilities in this field of activity should endeavor to pursue an educational course which will give him a broad lasting foundation and a wide scientific perspective. In respect to the latter, physical chemistry with its outlook on two or more fundamental sciences is particularly useful.

EQUIPMENT. The work in progress in the Laboratory of Physical Chemistry can be roughly divided into five parts, including investigations (a) on the physical properties of pure substances and mixtures of pure substances under wide variations of temperature and pressure for the purpose of broadening the present thermodynamic interpretation of chemical reactions, (b) on chemical equilibria under extremes of pressure and temperature to obtain special data for extending the theoretical treatment of equilibria, and on heats of reaction in solution, (c) on liquid solutions and liquid mixtures, (d) on the absorption of radiation by gases and the chemical reactivity induced as related to atomic structure, and (e) cryogenic research at liquid hydrogen and liquid helium temperatures.

RESEARCHES IN PROGRESS. A comprehensive study of the pressure-volume-temperature relations of substances, involving wide temperature and pressure ranges, is being carried out for both gaseous and liquid systems. The investigations are being conducted in the light of modern concepts regarding the kinetic theory and the electronic structure of atoms and molecules. Connected with these studies are investigations concerning the absolute temperature scale. Measurements are also being carried out on other thermodynamic properties of substances, such as latent and specific heats at low temperatures.

Researches on the properties of liquid solutions which have been carried on since the founding of the laboratory, consist, at present, of investigations of the electromotive force of concentration cells, the freezing points of aqueous solutions and the vapor pressures of solutions. Extensive new equipment has been added in recent years which is being used to secure very precise data for use in consolidating and extending the theory of solutions.

The structure of compounds and their reactivity are studied with the aid of spectroscopic and photochemical data. New primary and secondary standards of high sensitivity and reproducibility for measurement of radiation are being developed.

Using a new method, a systematic program is in progress having for its object the highly precise direct experimental determination of the effects of molecular forces for pure substances and mixtures from the lowest temperatures to four hundred degrees. The data are of immediate use for the correlation of physico-chemical equilibrium data but the more fundamental objective will be the development of the means of transforming the experimental data into intermolecular potential-distance relationships.

Ample facilities for measurements to 2° K are now available and a high field magnet is available whereby electro-magnetic research may be carried on and sub-helium temperatures realized. At the moment calorimetric measurements on salts are in progress and also determinations of various physical properties. Cryogenic research is being extended as rapidly as facilities can be acquired.

THE DOCTOR'S DEGREE WITH MAJOR IN PHYSICAL CHEMISTRY

Candidates for the Doctor's Degree with Major in Physical Chemistry will take courses 5·76, 5·77, 5·79, 5·741, 5·742, 5·931, and 5·932, and will take their Minor in Mathematics or in Physics. A suggested arrangement of these courses is shown below.

In addition to the subjects here scheduled, as much as possible of the required 25 units of Minor and the written examinations in modern languages, should be passed during the first year. The Minor may be completed and optional subjects taken during the second year.

First Year

5·76	Thermodynamics and Chemistry	3–6
5·77	Thermodynamics and Chemistry	2–4
5·79	Theory of Solutions	2–4
5·98	Research	

Second Year

5·741	Adv. Radiation Chemistry	2–4
5·742	Statistical Mechanics	2–4
5·98	Research	

Third Year

5·98	Research	

Attendance at subjects 5·931 Journal Meeting in Physical Chemistry, 1–1, and 5·943 Research Conference in Physical Chemistry, 1–1, is required in the first term of each year.

Attendance at subjects 5·932 Journal Meeting in Physical Chemistry, 1–1, and 5·944 Research Conference in Physical Chemistry, 1–1, is required in the second term of each year.

Students whose preparation in physical chemistry is not equivalent to courses 5·61, 5·62, 5·63 will take 5·71, 5·72 and postpone 5·76, 5·77, and 5·79 until the second year.

THE RESEARCH LABORATORY OF ORGANIC CHEMISTRY

Organic chemistry has always provided an ever increasing field for industrial and scientific developments. The great interest stimulated in earlier times in the coal tar chemicals and pharmaceuticals has in more recent years not only been maintained but

Chemistry Continued

also extended to petroleum, cellulose, solvents, plastics, and other branches. So great has been this progress that there is an important need for adequately informed and competently trained men. The graduate work therefore emphasizes both courses and research.

SUBJECTS. Lecture subjects are designed to cover first the fundamental reactions, theories, and structures in organic chemistry. This material is followed by a complete course in which the many special fields such as proteins, dyes, carbohydrates, natural products, resins, and the like are discussed. The aim is to provide a well-rounded study with a good grasp of the essentials in every field touched by the science. Further stimulation is provided by staff participation in presenting important current developments. The students coöperate in presenting their own literature study in Journal Meetings.

Laboratory instruction follows two general lines. One deals with identifying and testing organic compounds, a particularly complete and thorough training in the essentials of characterization being provided; the other stresses laboratory manipulation in which the present day demands on the organic chemist for fine fractionation columns, high vacuum work, skill in micro manipulation, ability to work on a large scale, full understanding of the principles of purification, separation, crystallization, etc. are met. The Massachusetts Institute of Technology was a pioneer in both types of instruction and every effort is being made to insure that this training is maintained at a high level.

RESEARCH. A large staff insures a maximum of individual attention to the students' needs. For a long time a lively interest in the effect of factors which influence reactivity of atoms and groups in organic compounds has existed in the laboratory. The problem of bond strength has been studied from many angles, particularly from a physical chemical standpoint.

Rare natural and synthetic carbohydrates are being studied, with the purpose of making these substances available for biological study. Fundamental reaction mechanisms are being investigated to show relationships between configuration and physical properties.

Detailed investigation of the chemistry of cellulose and related substances is under way. Attention is paid to the preparation and properties of various partly substituted derivatives, together with efforts to determine the exact orientation of substituents in the carbohydrate chain.

In the vitamin and hormone field a new industrial method for artificial production of vitamin D has been developed and valuable water-soluble derivatives of fat-soluble vitamins are in progress of study. Intensive work on synthesis in these fields is under way with the ultimate object of studying the effect of chemical constitution on physiological action.

Occurrence of organosodium compounds in the Wurtz and other syntheses are being examined. New preparative methods for malonic acids, tertiary carbinols, olefins, organometallic compounds and other related substances have been developed together with valuable information obtained on reaction mechanism.

Invaluable contributions on identification of organic compounds have been made for many years. The work is being actively continued for the purpose of further developing the system and keeping it abreast of the rapid advances in synthetic and analytical chemistry.

For many years the chemistry of nitrogen compounds, such as guanidines and urea have been carefully investigated. The mode of combination and subsequent breaking apart of these molecules, with physical chemical methods to determine mechanism and structure, has been extensively studied.

The interesting field of cycloparaffins is being investigated in order to discover new methods of preparation as well as to examine the properties of such compounds.

The following subjects, in addition to those noted above, are being investigated:

Oxidation of meta-diphenols.
Complex metal-pyridine compounds.
Identification of hydrocarbons.
Action of ultra-violet radiation on organic reactions.
Diphenic acid and its derivatives.
Catalysis in homogeneous systems.
Auto-oxidation reactions in organic chemistry.
Mechanism of the Friedel-Crafts reaction.
Fluorenone and its derivatives.
Chemiluminescence.
Structure of the guanidonium ion.
Steric hindrance.
Carbonium salts.
Analogues of carbonyls.
Organic peroxides.
Effect of electric discharges on organic compounds.
Preparation and derivatives of tetroses.
Synthesis of lactoflavin analogues.
Action of triphenylchloromethane on carbohydrates.
Oxidation of carbohydrate derivatives with lead tetraacetate.
Hydroxylation of unsaturated substances.
Catalytic oxidation of lignin.
Asymmetric synthesis.
Quinones.

The laboratory is fully equipped with a wide variety of special apparatus and instruments for facilitating research in the above fields.

Candidates for the Doctor's degree who major in Organic Chemistry are required to pass 5·642, Radiation Chemistry; 5·66, Surface and Colloid Chemistry; 5·71 and 5·72, Physical Chemistry; 5·061 and 5·062, Inorganic Chemistry with credit, or show equivalent preparation. A reading knowledge of scientific French

Chemistry Continued

and German is required. A Minor of at least twenty-five units must be chosen in any field outside of Chemistry. While 5·581 and 5·582, Advanced Organic Laboratory, are the only required courses in Organic Chemistry, it is expected that students will take full advantage of the opportunity to acquire complete instruction in their chosen field. The comprehensive oral and written examinations in Organic Chemistry must be taken at least seven months before the degree is granted.

The Research Laboratory of Inorganic Chemistry
(Including Analytical Chemistry)

Although inorganic chemistry was the first of the various branches of the science to attain a high degree of development with an attendant wealth of experimental detail, it is nevertheless true that this field is very far from exhausted; a practically unlimited opportunity for further investigation remains, not only in the chemistry of the less common and the rare elements, but also in the elaboration of the chemistry of the commoner elements. Furthermore, much of the data accumulated in the past century is in need of revision; for example, in much of the earlier work, the necessity for the rigid exclusion of air and of moisture was often overlooked in the study of various reactions, resulting in erroneous conclusions concerning their nature. The availability of modern research tools and the application of precision methods to numerous problems hitherto studied only in a superficial manner, are constantly exposing serious inaccuracies both in the observation and the interpretation of various inorganic phenomena.

The desirability of devising new methods of analysis, as well as of improving existing methods, has given rise to a number of analytical investigations, among which may be mentioned the determination of zirconium in ores and steels, the determination of small quantities of selenium in sulfur and in alloy steels, electrometric methods of analysis, and methods of analysis and purification of gas mixtures.

Some of the other subjects which are being investigated in the Laboratory at present are as follows:

Artificial radioactivity.

Radioactive determination of the relative abundance of K^{40} from various sources.

Radiometric methods of measurement of low solubilities and low vapor pressures.

Preparation and properties of various halides of silicon and silico-organic compounds.

Preparation and properties of the hydrides and halides of boron.

Preparation of metal carbonyls and nitrosyl-carbonyls at ordinary temperature and atmospheric pressure.

Influence of sonic and supersonic vibrations upon chemical reactions.

Preparation of pure rare earth metals and their compounds.

Improved methods of separation of the rare earth elements.

Methods of separation of zirconium and hafnium and the study of hafnium compounds.

Elaboration of the chemistry of scandium.

Conditions for the formation of polymorphic modifications of inorganic compounds.

The decomposition of inorganic perchlorates and its application to analytical methods.

The Laboratory is equipped to carry on a wide variety of inorganic research, including high vacuum technique, operations at high temperatures and at low temperatures, and electrolytic oxidations and reductions. Apparatus for precise determination of melting points at low temperatures is available as an aid in the determination of the purity of volatile substances. X-ray apparatus for the taking of Debye-Scherrer photographs is also available.

Research in nuclear chemistry is facilitated by the possession of a powerful source of neutrons as well as alpha and beta counters. In these studies the Laboratory has coöperated with the research laboratories of the Department of Physics.

The Doctor's Degree with Major in Inorganic Chemistry

Candidates for the Doctor's degree with Major in Inorganic Chemistry take the following subjects: 5·061, 5·062, 5·071, 5·072, 5·08, 5·911, 5·912 in the field of advanced Inorganic Chemistry; they are also required to take one or more subjects in Organic Chemistry, Physical Chemistry, Physics, Metallography, or Crystallography (totalling from 11 to 18 units).† The Minor may be taken in any department other than that of Chemistry. It is intended hereby to provide a well-rounded training in the different branches of Chemistry by avoiding over-specialization in a single, restricted field.

As many as possible of the subjects listed above should be taken during the first year, and by the end of the second year the Minor and all course requirements, as well as the written examinations in German and French should be completed, leaving the third year free for research (5·98).

Attendance at the research conferences in Inorganic Chemistry (5·945 and 5·946) is also expected.

GRADUATE SUBJECTS IN CHEMISTRY

"A" Subjects. Primarily for Graduates

First	5·071	Seminar Inorganic Chemistry	2–3
Term	5·08	Inorganic Laboratory, Adv.	6–0
	5·51T	Functional Groups in Org. Chem.	3–6
	5·53T	Sp. Topics in Organic Chem.	3–6
	5·55	Identification of Org. Compounds	10–0
	5·581	Organic Laboratory, Adv.	6–1
	5·71	Physical Chemistry	3–5
	5·741	Radiation Chemistry, Adv.	2–4
	5·76	Thermodynamics & Chemistry	3–6
	5·911	Journal Meet. Inorganic Chem.	1–1
	5·98	Research	Time arr.

† Graduates of Course X and graduates of other institutions take Physical Chemistry 5·71 and 5·72 in addition to the requirements above specified.

Chemistry Continued

Second	5·072	Seminar Inorganic Chemistry	2–3
Term	5·08	Inorganic Laboratory, Adv.	6–0
	5·52T	Mechanism, Structure & Reactivity in Organic Chem.	3–6
	5·54T	Sp. Topics in Organic Chem.	3–6
	5·56T	Structure in Organic Chem.	2–4
	5·582	Organic Laboratory, Adv.	5–1
	5·642	Radiation Chemistry	2–4
	5·72	Physical Chemistry	3–5
	5·742	Statistical Mechanics	2–4
	5·77	Thermodynamics & Chemistry	2–4
	5·79	Theory of Solutions	2–4
	5·912	Journal Meet. Inorganic Chem.	1–1
	5·98	Research	Time arr.

"B" Subjects. Open to Graduates and Undergraduates

First	5·061	Inorganic Chemistry	2–3
Term	5·63	Int. to Thermodynamics	3–5
	5·83	History of Chemistry	2–2
Second	5·062	Inorganic Chemistry	2–3
Term	5·43	Powder, Explosives & War Agents	2–2
	5·64	Introduction to Radiation Chem.	2–3
	5·66	Surface and Colloid Chem.	2–3

Units in the following subjects are not accepted as credits for the Master's degree.

First	5·591	Recent Advances in Organic Chemistry	1–1
Term	5·921	Journal Meeting in Organic Chemistry	1–1
	5·931	Journal Meeting in Physical Chemistry	1–1
	5·941	Research Conf. in Organic Chemistry	1–1
	5·943	Research Conf. in Physical Chemistry	1–1
	5·945	Research Conf. in Inorganic Chemistry	1–1
Second	5·592	Recent Advances in Organic Chemistry	1–1
Term	5·922	Journal Meeting in Organic Chemistry	1–1
	5·932	Journal Meeting in Physical Chemistry	1–1
	5·942	Research Conf. in Organic Chemistry	1–1
	5·944	Research Conf. in Physical Chemistry	1–1
	5·946	Research Conf. in Inorganic Chemistry	1–1

ELECTRICAL ENGINEERING

The Department of Electrical Engineering offers advanced work leading to the degrees of Doctor of Science and Master of Science. The general rules governing the granting of these degrees are set forth on pages 84–89, while such special rules as apply to the Department of Electrical Engineering are given below.

In order to be accepted without deficiencies for graduate study in the Department of Electrical Engineering, an applicant must have completed with evidence of more than average capacity, the five fundamental requirements common to all courses, stated on page 84, and in addition must have covered substantially the equivalent of the undergraduate professional subjects as offered in Course VI (page 52), in the Illuminating Engineering Option, VI-B (page 53) or the Communications Option, VI-C (page 54). If a student is deficient in any one of these respects, the Department Committee on Graduate Study will insist that he remove his indicated deficiencies by special study ordinarily while in residence. Credit is not usually allowed for preparatory subjects in which the applicant's grades are low, and it is particularly important that the work in mathematics and physics be of high grade.

Where a choice can be made between French and German in the student's preparation for graduate work, German is to be preferred, since the German literature is more extensive in Electrical Engineering.

Entering students who are deficient in preparation, especially in mathematical and professional electrical-engineering subjects, are urged to make up this deficiency before entrance by attendance at Summer Session. Furthermore, graduate study in certain subjects, and also graduate research, may be carried on during the summer. The Summer Session Issue of the general catalogue should be consulted on these matters.

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.

All graduate students in the Department who have not had equivalent experience in the preparation and oral presentation of technical papers are required to register for Seminar 6·501, 6·502. In the seminar meetings, papers on the historical aspects of electrical engineering are presented and discussed. Entering students should select seminar subjects early. Regulations concerning the seminar are available in the Department, and should be followed in making selections. The seminar and thesis subjects of a student should be so related that the former lays the foundation for the latter.

Simultaneously with the lecture subjects the student carries on research, thus beginning his training as an independent investigator. He selects his own research subject, which should be one in which he is vitally interested. After suitable preliminary study he must submit an outline of the proposed investigation to the Department Committee on Graduate Study. This outline is critically examined with regard to the scientific and educational value of the subject and the possibility of accomplishing the investigation in a reasonable time and with the facilities available. The outline must be approved before further independent work is commenced.

In thesis work graduate students are expected to rely on their own resourcefulness, the professor in

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charge of the particular research exercising only a general supervision. It is usual for the student to construct any special apparatus needed for his research, but in cases where it is likely to form a permanent addition to the laboratory equipment he may be assisted by a laboratory mechanician. A student shop is available to those who are required to construct apparatus. Graduate study in the Department is considered to include much more than class exercises and assignments pursued in a routine manner. It is expected that each student will conceive of his program as a coördinated whole, having as its end enhancement of professional preparation, and including, therefore, a substantial amount of independent and correlative study in current literature and in the laboratories. Such independent study and investigation are essential parts of the seminar and thesis requirements, both of which are expected to demonstrate the ability for sound constructive reasoning, and to embody a contribution to the advancement of the art.

Only students who have demonstrated outstanding ability in work of a creative nature are encouraged to go on 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 in order to demonstrate this ability. The thesis research for the doctorate is expected to make a substantial and noteworthy contribution in Electrical Engineering or a related field.

FACILITIES FOR RESEARCH

The first of the Graduate Laboratories of Electrical Engineering was established in 1913 as an educational agency to stimulate students and staff by bringing them into contact with problems on the frontier of their profession and to train students in methods of research. The original laboratory has expanded to a group of research centers whose facilities are used by most of the graduate students and a number of undergraduates. The research of the Department is directed by many members of the instructing staff who are actively interested in the general progress of this phase of the Department's activities, and particularly in those researches which lie within their own special fields of endeavor. The available laboratory equipment is extensive, permitting effective work toward the solution of fundamental problems in all of the more important branches of Electrical Engineering.

Though the Graduate Laboratories were established as a purely educational agency, noteworthy contributions to knowledge have come from them, and to date some two hundred papers describing the researches have been published.

Each year a limited number of appointments to assistantships are available to men especially qualified by training and natural endowment for research. Each of these assistants is expected to devote about one-third of his time to study toward an advanced degree, and may utilize appropriate portions of the work covered by his research as a basis for his thesis. The problems assigned to research assistants as well as those elected by students working toward the doctorate are such as require for their solution a high degree of scientific skill. The major research problems which have received and are receiving the attention of the staff are described in the following paragraphs.

Applications of high-frequency currents to communications and other problems are advancing rapidly and the Department of Electrical Engineering has for many years had an important place in this advance. Today its activities in this field include an extensive program covering measurements in the meter-centimeter region, the generation, propagation and radiation of centimeter waves and the behavior of systems at these wavelengths where circuit conceptions become less and less real and the field conception more and more apparent. Specific expressions of these broad ideas are the transmission of centimeter waves down the inside of conducting tubes, their directive radiation from electromagnetic horns, the investigation of the factors affecting the propagation of these waves through space and their generation by various means including triodes, magnetrons and velocity-modulation devices of the klystron type, as well as research to improve these devices. Other important studies have to do with the nature and behavior of elements resonant to these waves, for instance, cavities with conducting walls, and the nature of the behavior of dielectric materials to their rapidly alternating fields. For some years the Institute has been active in the search for solutions to the fog-navigation problem. Recently it has been successful in applying the results of its high-frequency research to the instrument landing of airplanes. These various activities have supported individual laboratory facilities peculiar to their needs. Recently, in addition, a general ultrahigh-frequency laboratory for undergraduate and graduate student use has been set up.

Facilities include triode, magnetron, and klystron generators making energy of wavelengths down to a few centimeters available; frequency and voltage measuring equipment; evacuating systems for ultra-high-frequency tube experimentation; and in general, a complement of equipment to support highly advanced work in this region of the electromagnetic spectrum. In carrying out many of these projects we have worked in close coöperation with the industry, which in some instances has been the sponsor

Electrical Engineering Continued

Out of this has come an atmosphere that is at once scholarly, natural, and redolent of the kind of thing that is ahead of the student who will enter this highly refined and promising branch of the industry.

An important problem, various phases of which have occupied the attention of the staff, is the study of the fundamental properties of insulation. One research program in this field is directed primarily toward a comprehensive study in terms of atomic physics of the fundamental electrical properties of solid, liquid, and gaseous dielectrics, and in particular dielectric strength, and is approached through the study of the basic electronic and atomic processes taking place in materials under electric stress. Equipment is available for the production of high alternating, direct, and surge voltages; for the measurement of these voltages, as well as currents of all magnitudes; for handling gases at high and low pressures; and for studies over a wide range of temperatures.

Another program utilizes electrical measurements of properties of insulating materials, such as conductivity, dielectric constant, and power factor, in studying the structure of the materials, the mechanism of dielectric loss, and the nature of the deterioration characteristics. Facilities are available for making precise measurements of these characteristics over extended ranges of the parameters involved and for studying the inherent characteristics of the measuring circuits.

Flash photography, utilizing light sources which furnish illumination of great intensity and extremely brief duration, has been developed to a state permitting technical application in engineering and other fields. There are available controlled sources designed for single — or multiple — flash photography or for stroboscopic or high-speed motion-picture studies, and the necessary cameras and other auxiliary equipment.

Many problems in engineering and physics are of such complexity that satisfactory progress in their solution is dependent upon the use of non-formal methods. The Differential Analyzer, which was originally developed here, was designed to perform mechanically the necessary operations required in the solution of differential equations. With the aid of this machine many problems have been solved. Typical of these are the determination of the transient behavior of transmission lines, power systems, and electrical machinery, the determination of the operating characteristics of non-linear circuits, the design of structures, the investigation of field distributions in acoustics, and studies in wave mechanics leading to further knowledge of atomic and molecular structure. A larger, faster, and more precise Differential Analyzer is nearing completion.

A laboratory for the scientific and systematic study of the fundamental properties of automatic control systems is a recent addition to the facilities for research. Considerable attention is being given to the problem of developing means for stabilizing automatic control systems, reducing the transient and steady-state errors of such control systems, and the development of high-power fast-response output drives. The equipment of the laboratory includes servomechanisms comprising electric motors operated from gaseous-discharge tubes, selsyns, a dynamo-electric amplifier, mechanical and hydraulic torque amplifiers, an hydraulic gear having a continuously adjustable ratio, an aircraft automatic pilot servomechanism, and recording potentiometers.

A program for the development of X-ray equipment employing potential differences of one and more megavolts, including the associated direct-current generators, has been under way for several years. Incidental to these developments, studies have been made of the design of insulating structures for maximum dielectric strength, and of the dielectric strengths of gases and vapors as functions of pressure.

In the illumination laboratories of the Department, investigations have been made among which are studies of the visual effect of light from sodium lamps, the visibility of objects on highways when various lighting conditions obtain, the elimination of glare by use of polarized light, the reflection characteristics of road surfaces, and the design of reflectors. A variety of visual and photoelectric photometers for measuring candlepower, illumination, brightness, and luminous flux are available for such investigations, as well as a spectroradiometer, a goniophotometer, a photoelectric densitometer, etc.

Another machine, the Cinema Integraph, utilizing illumination in its operation, is available for solving integral equations having under the integral sign the product of two functions, one of which has a variable parameter.

One large and two small sound-isolated rooms are available for acoustic measurements in the general field of communications. Provision is made to adapt the properties of the rooms to various requirements by the use of absorbing material mounted on portable frames. These rooms are used in sound field measurements, loudspeaker response measurements, determination of acoustic absorption coefficients, sound studio work, and the like.

Researches on the fundamental properties of sound have shown that precise mesaurements of acoustic impedance and attenuation can be made to yield valuable information on the characteristics of sound generators, transmitting or absorbing media, and receivers. The equipment necessary for these measurements has been developed and is available.

Extensive investigations made to demonstrate the

Electrical Engineering Continued

feasibility of representing entire power systems in miniature resulted in the construction of the M. I. T. Network Analyzer. This device is adequate for the single-phase representation, on a 60-cycle, 200-volt, 1-ampere basis, of systems embodying as many as sixteen generating stations with their loads and interconnecting circuits. The Network Analyzer, with its fast and accurate measuring equipment, provides an exceptional facility for the study of steady-state problems such as voltage regulation, system expansion and interconnection, and the transient problems of symmetrical and unsymmetrical short circuits with the accompanying questions of system stability. In addition to its use in research and in connection with class instruction, the Network Analyzer is available for the solution of commercial power-system problems. It was built with the coöperation of the General Electric Company.

The transients, both electrical and mechanical, occurring in electrical machines as a result of short circuit, of sudden terminal voltage changes, or of sudden or periodic load changes, may in part be predicted analytically, but experimental checks are often desirable or necessary. To facilitate such studies, a special machine-transients laboratory has been established, equipped with motor-generator sets and necessary accessories, such as static condensers, reactors, circuit breakers, and measuring equipment. In the alternating-current machines, provision is made for the use of solid cylindrical, squirrel-cage, slip-ring induction, and salient-pole rotors.

The increasing interest in electronics led to the establishment of an engineering electronics laboratory for the construction and study of various types of vacuum or gas-filled electronic devices. Facilities are provided for spot welding of electrodes, fabrication of glassware, and sealing and exhausting of tubes.

The shop facilities of the Department are adequate to care for the maintenance of the existing equipment and the construction of such new equipment as is necessary for carrying on the research of the Department. A student shop, available to both graduate and undergraduate students, is equipped with all the machine tools necessary for ordinary wood and metal working, with a competent mechanician in charge. The research shop, employing at present nine mechanicians, is equipped to build the special and unusual devices required for the various experimental researches.

For rapid and intelligent progress in an advancing art such as Electrical Engineering, it is essential that the theoretical as well as the experimental aspects receive due consideration. Many members of the staff devote their energies primarily to the correlation and organization of the experimental facts of Electrical Engineering and its basic sciences in order that the whole may be simplified and clarified. The theoretical work of the Department is particularly strong in the fields of circuit theory, transmission-line theory and traveling waves, electromagnetic wave propagation in both free and confined space, transient behavior of electrical circuits and mechanical systems, vibrations, acoustics, and electrical machinery.

THE VAIL LIBRARY

The need for a special library of electrical literature, which is a necessary adjunct to all research, is satisfied by the Vail Library. The original Vail Collection, comprising 30,000 volumes, was presented to the Department in 1912 through the interest of the late Theodore N. Vail, and is one of the three great electrical libraries in the world. Merged with the other works on electrical subjects in the Central Library, but distinguished by a special binding stamp and a special bookplate, the Vail Collection is the basis upon which the Vail Library as an administrative unit has been developed. The Vail Library now comprises over 40,000 volumes. In the library are the works of all scientists and engineers who have made significant contributions to electrical science from the time of William Gilbert (1600) to the present. Among the rarities are the 1558 edition of Peregrinus, a large number of first editions including Gilbert's De Magnete, and a notable autographed collection of original papers.

Modern authorities are even more fully represented. The leading electrical periodicals, in foreign languages as well as English, are kept on file, together with the publications of the principal electrical societies of all countries. These are for the most part in complete sets, and are supplemented by the standard periodical indexes. A selection of books for reference is available in the main reading room, and all graduate students have access to the stacks.

In order that the resources of the Vail Library may be understood and fully utilized, a reference librarian is provided for exclusive service to the Department. This librarian gives instruction in the use of the library by group talks and individually, and offers assistance in the gathering of references and the preparation of bibliographies. The library is kept up to date by the addition of all important publications in the field, and books not in the Institute Library are obtained through the Interlibrary Loan Service.

Colloquia and Special Lectures

Through the courtesy and coöperation of the industries associated with the electrical-engineering field, the Department has been able to arrange a series of colloquia conducted by men of distinguished

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accomplishment in the practice of electrical engineering. The purpose of the colloquia is to secure the injection into the curriculum of matters showing the relation of science to engineering practice, the Institute instruction itself being concerned chiefly with basic scientific considerations. The colloquia also give graduate and senior students the opportunity to meet prominent engineers and to discuss with each of them that branch of the electrical art in which he is a particular authority.

The Department provides a number of such colloquia each year, treating the economic as well as the technical aspects of such subjects as communications, the design and production of electrical machinery, the design, construction and operation of power-transmission lines, the operation of plant such as public-utility p'ant or manufacturing plant, electrical measurements, illumination, electronics, and railroad electrification as it affects the electrical engineer.

The colloquia of 1939–40 are listed below:

"Recent Developments in Distribution Transformers," by Mr. W. H. Cooney, of the General Electric Company.

"Recent Developments in Fluorescent Lighting," by Mr. G. E. Inman of the General Electric Company.

"Physical and Inductive Coördination of Power and Telephone Systems," by Mr. H. R. Huntley of the American Telephone and Telegraph Company, Mr. J. O'R. Coleman, '23, of the Edison Electric Institute, and Mr. P. W. Blye, '19, of the Bell Telephone Laboratories, Inc.

"Electric Load Forecasting," by Mr. Atherton Thomas, '23, and Mr. W. J. Hayden, Jr. of the Consolidated Edison Company of New York, Inc.

"Technical Problems of the Motor Industry," by Mr. T. C. Lloyd of Robbins & Myers, Inc.

"Use and Limitation of Indicating Instruments," by Messrs. H. L. Olesen and F. X. Lamb of the Weston Electrical Instrument Corp.

"Acoustical Problems Involved in Sound Recording and Reproduction and Their Relation to General Auditorium Acoustics," Mr. J. P. Maxfield, '10, of Electrical Research Products, Inc.

"Ignitron Rectifiers," by Mr. J. H. Cox, '23, of the Westinghouse Electric and Manufacturing Co.

GRADUATE SUBJECTS IN ELECTRICAL ENGINEERING

"A" Subjects. Primarily for Graduates

First Term	6·501	Electrical Eng. Seminar	2–10
	6·511	Electric Power Circuits	3–7
	6·513	Power System Stability	4–6
	6·515	Power Systems Laboratory	Time arr.
	6·521	Alt. Current Machinery Adv.	3–7
	6·531	Power System Economics	3–7
	6·541	Electric Power Generation	3–6
	6·551	Railroad Electric Traction	3–6
	6·561	Adv. Network Theory	5–5
	6·571	Illuminating Eng., Prin.	5–4
	6·58	Transients in Linear Systems	3–7
	6·59	Communications Lab.	Time arr.
	6·60	Math. Anal. by Mech. Methods	2–4
	6·605	Dyn. Anal. of Automatic Control Systems	3–6
	6·621	Radio Lines, Antennas, & Propagation	3–6
	6·627	Patents & Their Relation to Science & Eng.	2–4
	6·631	Engineering Electronics	3–7
	6·651	Electric Power Distribution	3–6
	6·661	Electric Machine Dev. Prin.	4–6
	6·671	Vibrations	4–6
	6·68	Sp. Problems in Electrical Eng.	Time arr.
	6·73	Electrical Meas. Lab., Adv.	Time arr.
	6·74	Electrical Eng. Lab., Adv. Research	Time arr.
Second Term	6·502	Electrical Eng. Seminar	2–2
	6·512	Electric Power Circuits	3–7
	6·514	Power System Stability	4–6
	6·515	Power Systems Laboratory	Time arr.
	6·522	Alt. Current Machinery Adv.	3–7
	6·532	Power System Economics	3–7
	6·542	Electric Power Generation	3–6
	6·552	Railroad Elec. Traction	3–6
	6·562	Adv. Network Theory	3–7
	6·572	Illuminating Eng., Prin.	5–4
	6·58	*Transients in Linear Systems	3–7
	6·586	Eng. Applications of Static Field Th.	3–6
	6·59	Communications Lab.	Time arr.
	6·606	Dyn. Anal. of Automatic Control Systems	5–7
	6·61	Gen. & Util. of Super Voltages	3–6
	6·62	Electrical Communications Prin.	5–5
	6·622	Radio Lines, Antennas & Propagation	3–6
	6·628	Patent Background of Elec. Com. in U. S.	2–4
	6·632	Engineering Electronics	5–5
	6·64	App. of Atomic Physics in Elec. Eng.	3–6
	6·652	Electric Power Distribution	3–6
	6·662	Electric Machine Dev. Prin.	4–6
	6·672	Vibrations	4–6
	6·68	Sp. Problems in Electrical Eng.	Time arr.
	6·69	Sound in Elec. Communications	5–5
	6·73	Electrical Meas. Lab., Adv.	Time arr.
	6·74	Electrical Eng. Lab., Adv. Research	Time arr.

"B" Subjects. Open to Graduates and Undergraduates

First Term	6·211	App. of Electricity in Industry	3–6
	6·221	Electric Power Generation	3–6
	6·241	Electric Railways	3–6
	6·251	Electric Machinery Design	3–6
	6·26	Electric Insulation	3–6
	6·271	Illuminating Eng., Prin.	5–4
	6·281	Prin. Wire Communications	3–6
	‡6·31	Electrical Communications, Prin.	3–5
	6·34	Electrical Communications Lab.	Time arr.
	6·80	Electrical Eng. Lab.	Time arr.
Second Term	†6·04	Electrical Eng. Prin.	6–9
	6·212	App. of Electricity in Industry	3–6
	6·222	Electric Power Generation	3–6
	6·242	Electric Railways	3–6
	6·252	Electric Machinery Design	3–6
	6·272	Illuminating Eng., Prin.	5–4
	6·282	Prin. Radio Communications	3–6
	‡6·32	Electrical Communications, Prin.	4–8
	6·34	Electrical Communications Lab.	Time arr.
	6·80	Electrical Eng. Lab.	Time arr.

* Usually repeated in second term.
† Only for students specializing in Communications.
‡ Only for students specializing in Power.

BIOLOGY AND PUBLIC HEALTH

Graduate work in this department may be selected in one of the fields listed below:

Fields of Study

Bacteriology
Basic Biological Science
Biochemistry

Biology and Public Health Continued

Biophysics
Food Technology
Health Education
Industrial Biology
Industrial Hygiene
Microbiology
Public Health Admin. and Practice
Public Health Engineering
Sanitary Biology

Degrees Awarded

Master of Science
Master in Public Health
Doctor of Science
Doctor of Philosophy
Doctor of Public Health
A Certificate in Public Health is also awarded.

Acceptance of Applicants for Advanced Degrees

Only students with superior credentials, offering a substantial equivalent to the professional subjects in the undergraduate curricula of Courses VII, VII-A or VII-B can be accepted as applicants for advanced degrees in the department. Satisfactory record of courses in introductory subjects, such as general biology, zoölogy, anatomy, and physiology must also be presented. In case of minor deficiencies in preparatory subjects, petition for advanced standing examinations in the subjects of deficiency may be granted.

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.

The number of graduate students in any one year is limited by spatial and other considerations.

A student desiring to enter the department as a graduate student must comply with the regulations as set forth on page 84, concerning filing of application with credentials.

Requirements for the Degree of Doctor of Philosophy or Doctor of Science

In addition to the general requirements set forth on pages 87–89, attention is directed to the essential requirement of satisfactory completion of the Oral Examination within the department, with the demonstration of scientific competence and breadth of understanding of various phases of biology. The general examinations are held in four divisions, covering approximately fifteen subjects, three divisions being common to all programs and the fourth varying according to the field of specialization.

Requirements for the Degree of Doctor of Public Health

Of a similar standard to that for the degrees of Sc.D. and Ph.D., the requirements for the Dr.P.H. will generally require three years for those entering upon this program directly from college work. Holders of the degree of M.D. from a class "A" medical school, with at least two years of previous college training, may expect to satisfy the requirements for the degree of Doctor of Public Health in two years. For this degree, the regular Minor requirement and the undergraduate requirement in Calculus, M21 may be waived. Medical Officers of the United States Army who are graduates of accepted medical schools and of the Basic Course in Public Health at the Army Medical School, the special course required for Sanitary Officers, and with five years of public health practice in the army may be accepted as one-year candidates, but must pass a general examination in the field of public health at least six months before the degree may be awarded.

Requirements for the Degree of Master of Science

Generally only graduates in the upper two-thirds of a college class may expect to be admitted to the graduate school for work leading to the degree of Master of Science. Substantial equivalent of the Course VII, Course VII-A or VII-B undergraduate curriculum is prerequisite to admission to full standing as a graduate student in this group. The general requirements as listed on page 84 should be consulted.

Biological Engineering

To be accepted as a graduate student working toward the degree of Master of Science in Biological Engineering, a record of acceptable preparation in subjects substantially equivalent to those prescribed for the first four years of the curriculum of VII-A (see page 60) is required.

Public Health Engineering

Prerequisites for acceptance of an applicant for the degree, Master of Science in Public Health Engineering, comprise training substantially equivalent to that required for the degree of Bachelor of Science in Public Health Engineering at the Massachusetts Institute of Technology. Graduates in engineering from a school of recognized standing, who have had one year's experience with a city, county, or state department of health, or with the United States Public Health Service or other recognized health agency, and have demonstrated outstanding professional promise may be admitted.

Biology and Public Health Continued

The course is designed to provide qualified engineers with the professional training necessary to protect and promote the health of the individual and the community through the control of the environment. To this end the subject matter will include not only such customary subjects of instruction as water supplies, water purification, sewerage and sewage disposal, trade waste disposal and stream purification; but also such items as the collection and disposal of refuse; the sanitation of swimming pools; camp sanitation; rural sanitation; the sanitation of shellfish; milk sanitation; pasteurization; sanitation of food supplies, food stores and restaurants; the relationship of insects and rodents to disease; the atmosphere in relation to health and comfort; housing in relation to health; school sanitation; industrial hygiene and sanitation; the collection, analysis, and interpretation of vital statistics; epidemiological methods; the organization and activities of health departments; the value and conduct of public health surveys; and the uses of various standard health appraisal forms.

Requirements for the Degree of Master in Public Health

The degree of Master in Public Health is awarded upon the satisfactory completion of an approved course of advanced study designed to equip the student for a career in the field of public health. Applicants for this course of study will be admitted from two groups, (a) graduates of approved medical schools, (b) graduates in arts or science from colleges, universities or technical schools of recognized standing. In order to be admitted, applicants must present credentials showing high scholastic records attained in adequate courses in physics, chemistry, biology, anatomy, histology, and physiology. With the exception of those who hold the M.D. degree, candidates must also meet the general Institute requirements for the degree of Master of Science with respect to language, cultural subjects, and economics.

An approved course of study must include 96 units of advanced courses and research, of which 72 units, including a thesis of not less than 15 units nor more than 40 units, are selected from "A" subjects (primarily for graduates) and the remaining 24 units either from "A" subjects or from "B" subjects (open to graduates and undergraduates). The thesis may take the form of a Public Health Survey. The program arranged by the Department of Biology and Public Health for each student will be adapted to his individual requirements and aims, but all programs will comprise professional training in public health administration, public health engineering, public health bacteriology, vital statistics, and personal hygiene.

A minimum of one academic year in residence is required. Physicians and graduates in Public Health from the Department of Biology and Public Health at the Massachusetts Institute of Technology may expect to complete the program in one year; graduates in arts or science from other colleges will usually find that a longer period of study is required unless they are able to present adequate professional public health experience or unusual breadth of training in prerequisite subjects.

Requirements for the Certificate in Public Health

A candidate for the Certificate in Public Health in a special field (such as Health Education or Public Health Laboratory Methods) must hold (1) a bachelor's degree from a recognized institution or, (2) a medical degree from a Class A medical school or (3) have had professional training equivalent thereto. He must have stood in the upper two-thirds of his class at the time of receiving his medical or bachelor's degree, or have demonstrated by professional work the probability that he can profitably undertake advanced academic study. In any case the student must maintain the cumulative rating required of all students in the graduate school if he is to be continued as a candidate for the certificate. In addition, students who have not passed courses of satisfactory grade in anatomy and physiology or other prerequisite subjects will be required to take these subjects before receiving the Certificate.

The work scheduled for the Certificate in Public Health requires: (1) At least one full academic year in residence with the satisfactory completion of 96 units of "A" or "B" subjects, including thesis, of which the following are minimum essentials:

		Units
7·22	Personal Hygiene and Nutrition	4
7·302	Bacteriology	9
7·50	Communicable Diseases	6
7·541	Public Health Administration	5
7·542	Public Health Administration	5
7·551	Public Health Lab. Methods	11
7·552	Immunological Methods	7
7·57	Municipal Sanitation	7
7·58	Vital Statistics	5

(2) The completion of an approved survey, or a research on some phase of public health, of at least 10 units. (3) The creditable passing of an examination covering the general field. (4) At least one month of field work which has the approval of the registration officer.

Students taking the Certificate in Public Health in the field of Health Education may substitute for

Biology and Public Health Continued

laboratory work in the field of sanitary and diagnostic bacteriology an equal number of units in the field of health education and school health. Courses in the Harvard Graduate School of Education and in the School of Education of Boston University are available as electives.

Graduates of Class A medical schools and graduates of the Public Health option of the department may reasonably expect to secure the Certificate in one year.

The Biological Research Laboratories

The Biological Laboratories offer facilities for advanced work in bacteriology, biochemistry, food technology, zymology, industrial hygiene, and municipal sanitation. Special opportunities for training for the profession of Public Health and for investigation of methods of public health education and administration are available.

Research under leadership of staff members in a variety of subjects constitutes a continuing program with which advanced graduate students may hope to become affiliated. Among the problems being investigated at the present time are the following:

A varied program of studies on rickets and the vitamin D, including monochromatic ultraviolet activation of its precursors, methods for increasing the D content of milk of the human and other animals, the antirachitic properties of certain proteins.

Mechanisms in production of commercial solvents by fungi and fusaria are a part of the program in microbiological biochemistry.

In nutritional biochemistry there is a program in metal metabolism which will be extended by the use of artificially radioactive atoms. The nutritional availability of iron in molasses is being measured by chemical, biological, and clinical procedures.

In the field of enzymes there is a continuing study of the kinetics of enzyme action, temperature activation of crystalline urease and of purine and aldehyde oxidases of milk. Enzyme functions at low temperatures in the liquid and solid state are being measured; this has application in the matter of frozen foods.

In the domain of bacteriology varied studies include the development of sound statistical methods for evaluating results of bacterial studies, the physiology of recently discovered species, algae for growth of viruses, the mechanism of bacterial death on human skin, a photoelectric turbidimeter for determination of numbers in cultures, a study of the reaction, epidemiology, and practical control of minor respiratory diseases; physico-chemical factors affecting laboratory culture of bacteria.

Health surveys of various municipalities enable students to observe actual procedures in such cases. Likewise, studies in growth and health in children in selected secondary schools permits the practical application of professional techniques and actual practice in health education methods. From such practice schools then evolve a theoretical consideration of administrative possibilities and procedures in coördination of health education among health departments, school departments, and volunteer health agencies.

In the field of biological engineering, an investigation of lethal effects of X-rays of low, high, and super-voltage excitation upon living cells employs the unique facilities of our Physics Department for million-volt X-rays. A study of radium poisoning involves coöperation between Biology and Physics. Instrumentation for precise objective measurements of electrical changes in physiological processes is being constantly extended. The precise evaluation of the lethal effects of radiant energy, supersonics, cathode rays, high-frequency fields, and other forms of applied energy in a program in biological engineering.

Graduate work in food technology offers opportunity for advanced study and experimental work in the biological, chemical, and engineering aspects of food production and control, leading either to the Master's or Doctor's degree.

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.

This year, for the first time, an extension of this program has been made possible through the generous coöperation of the Dewey & Almy Chemical Company, who have made available for joint use their conveniently located, modern and complete food-freezing laboratory, where research students may conduct semi-plant scale freezing experiments and research. Graduate work in food technology may be combined with courses in business administration, chemical engineering or other fields of interest.

The following problems are a part of the present research program in food technology: the investigation of latex containers for the packaging of frozen and refrigerated foods, especially directed to their utilization in the prevention of deleterious chemical and biological storage changes in foods; the development of new apparatus and mechanisms for the more accurate evaluation of tenderness in meats and other foods; the study of biological, chemical, physical, and color changes which take place in the aging of meats; a broad survey of the bacterial flora of frozen foods and the health significance thereof; the development

Biology and Public Health Continued

of new techniques for the mycological examination of foods; the development of a new method for freezing human milk for hospital use; the application of unit-process methods in food manufacture; the relation of oxidation-reduction potentials and the development of toxins by food poisoning bacteria; the spectroscopic analysis for metallic elements in foods; sterilization of food materials by gas treatment; the use of resazurin as a chemical means of quality control in food manufacturing operations.

GRADUATE SUBJECTS IN BIOLOGY

"A" Subjects. Primarily for Graduates

First	7·18	Tech. Aspects of Entomology	2–3
Term	7·24	Advanced Nutrition	7–2
	7·321	Bacteriology, Adv.	3–4
	7·35	Planktonology	2–3
	7·371	Industrial Microbiology, Adv.	5–4
	7·411	Sanitary Biology	9–4
	7·543	Health Department Practice	4–6
	7·591	Public Health Engineering	11–7
	7·601	Health Education	3–4
	7·63	Public Health Field Work	2–4
	7·66	Epidemiology	2–6
	7·67	Functional Pathology	3–4
	7·721	Food Technology, Adv.	4–2
	7·81	Zymology	6–3
	7·831	Microbiological Chemistry Laboratory	5–1
	7·91	Biological Engineering I	6–3
	7·941	Research Problems	Time arr.
Second	7·09	Parasitology, Adv.	4–4
Term	7·132	Histology, Adv.	4–2
	7·201	Physiology, Adv.	7–3
	7·23	Applied Nutrition	3–4
	7·322	Bacteriology, Adv.	5–2
	7·372	Industrial Microbiology, Adv.	4–4
	7·38	Germicides and Antiseptics	4–4
	7·39	Bacteriology of Foods	4–2
	7·592	Public Health Engineering	8–4
	7·602	Health Education	3–4
	7·603	Public Health Education	2–4
	7·604	School Health Adm.	2–4
	7·64	Public Health Problems	2–4
	7·65	Health Haz. in Spec. Industries	2–5
	7·68	Pathology	6–2
	7·722	Food Technology, Adv.	4–2
	7·82	Biochemistry, Adv.	6–3
	7·832	Microbiological Chemistry Laboratory	5–1
	7·92	Biological Engineering II	4–2
	7·942	Research Problems	Time arr.

"B" Subjects. Open to Graduates and Undergraduates

First	7·131	Histology, Adv.	4–2
Term	7·22	Personal Hyg. & Nutrition	2–2
	7·50	Communicable Diseases	3–3
	7·53	Air Examination	2–2
	7·541	Public Health Admin.	2–3
	7·551	Public Health Lab. Meth.	8–3
	7·58	Vital Statistics	2–3
	7·59	Sanitation	5–3
	7·711	Tech. of Food Products	6–4
	7·80	Biochemistry	8–5
Second	7·03	Theoretical Biology	2–3
Term	7·08	Parasitology	2–4
	7·302	Bacteriology	6–3
	7·362	Industrial Microbiology	4–4
	7·52	Industrial Hygiene	5–3
	7·542	Public Health Admin.	2–3
	7·552	Immunological Methods	6–1
	7·56	Principles of Sanitation	2–5
	7·57	Municipal Sanitation	4–3
	7·712	Tech. of Food Products	5–4
	7·802	Quant. Biochemistry	5–1
	7·84	Biophysics	6–3

PHYSICS

The Department of Physics offers work for the degrees of Master of Science, Doctor of Philosophy and Doctor of Science. 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

The courses in the field of pure physics are intended primarily for students intending to go into teaching and fundamental research. As preparation, in addition to a thorough knowledge of mathematics and chemistry, the student is expected to become well trained in both experimental and theoretical physics. Most of the fields of research of active importance in physics at present are well represented at the Institute, and excellent facilities for them are found in the George Eastman Research Laboratories, and the adjoining Spectroscopy Laboratory, and the new laboratories housing the high voltage equipment and the cyclotron.

One of the most active fields of research in physics at present is nuclear physics, and the Institute is well equipped for this type of research. The high voltage electrostatic generator, now widely used in nuclear investigations, was originally developed at the Institute, and the generator formerly located at Round Hill has been entirely reconstructed and installed in Cambridge in connection with a well-equipped laboratory, providing a reliable and flexible direct current source and discharge tube, operating at something over two million volts and large current. In addition, a cyclotron of large size, located in a building specially designed for it, is available for physical and biophysical investigations. The Institute has very highly developed facilities for the detection and measurement of nuclear radiation of all sorts, particularly of weak radioactive sources, and is uniquely equipped for determining the age of minerals by radioactive methods, as well as for the application of artificial radioactivity to biological problems.

Physics Continued

The Spectroscopy Laboratory provides unique equipment. Communicating with the basement by a corridor, but entirely independent of the main building, and located in a court, this building has been designed particularly to provide constant temperature and freedom from vibration. Included in it are complete Paschen circles for both 35-foot and 21-foot gratings, entered from a common source room; several other grating mountings; and separate rooms for vacuum spectrographs and other pieces of apparatus. These include among other things a 21-foot vacuum spectrograph, microphotometers, and various interferometers for work requiring high resolving power.

The new magnet, used for the production of Zeeman effects, and operating at magnetic fields up to 100,000 Gauss, increases greatly the usefulness of the laboratory. The principal researches in progress are investigations of the line spectra of the elements. Developments of automatic methods of measuring and analyzing spectra, in conjunction with unusually fine diffraction gratings, have made possible new standards of precision in wavelength measurement, and analyses of spectra which were not previously attempted.

Experimental problems in electronic phenomena include studies of thermionic and photoelectric emission from metals, and the mechanism of discharge in gases. The X-ray Laboratory is principally concerned with the structure of crystals, as determined by X-ray diffraction. Recently a large part of the research has been concerned with the structure of glasses, other amorphous solids, and liquids. Other work in the structure of solids includes a research program in the properties of dielectrics, including optical, electrical and mechanical behavior, and research in the production of large single crystals. Theoretical research has recently included work in classical physics, as in diffraction problems of sound and light, the architectural acoustics of auditoriums and hydrodynamics and aerodynamics; the theory of gas discharges, and the scattering of atoms and electrons; the theory of metals and the solid state; and the theory of the motion of high speed particles, as in cosmic rays and nuclear processes.

The Eastman Laboratories contain, in addition to the equipment already mentioned, facilities shared jointly by the departments of Physics and Chemistry, including a lecture room, where frequent colloquia and advanced lectures are held; classrooms for graduate subjects; a social room; and a well-equipped research library of physics, chemistry, and mathematics, containing reading room, stack space for thirty thousand volumes, and cubicles for study in the stacks. The Physics department also maintains well-equipped shops, including machine shop, instrument maker's shop, pattern shop, and a staff shop; a research stock room; a glass blower's room; and an optical shop.

Graduate Study and Research in Applied Physics

The course in the field of applied physics is intended primarily for students intending to go into industrial research in physics or engineering. For such a career, a broad training not only in the more classical and experimental parts of physics, but also in engineering, chemistry, and other subjects is essential. For this reason, a student of applied physics will be expected to do a considerable part of his work in other departments. Some of the more important branches of applied physics, with the type of training available and the research opportunities, are enumerated below. The field of physical properties of matter is one of great commercial importance. The student in this field should have thorough grounding in physics, particularly in X-ray crystal structure and thermodynamics, and in chemistry, especially physical and organic. He should also receive training in some of the following fields (in each case the particular subjects which should be emphasized in other departments are given in parentheses): physical metallurgy; geology (crystallography); mechanical engineering (elasticity, plasticity, strength of materials); civil engineering (soil mechanics). Students in acoustics should study physics (mechanics); electrical engineering (oscillating circuits and vacuum tube devices); the mathematics of vibrations and boundary value problems; and should do advanced work and research in acoustics, conducted jointly by the departments of Physics and Electrical Engineering. In several other fields of the application of mechanics and heat, joint work with other departments can easily be arranged. These include heat measurements, in mechanical engineering; ceramics, in metallurgy; and study of heat engines, hydrodynamics, and aerodynamics, in mechanical engineering and aeronautics. In electricity, particularly in electronics, and in the study of dielectrics, joint programs of study and research with the Electrical Engineering Department can be worked out. The work in applied optics is largely in the Physics Department, including study and research in color measurements, design of optical instruments, and related fields, but the student entering this field, as for research on color problems, should study the chemistry and chemical engineering of dyes, and textile research, while if he expects to enter the motion picture field, he should study physics and electrical engineering as related to oscillating circuits and vacuum tubes, acoustics, and illumination. Geophysics, the application of physical methods to geology, and particularly to prospecting for

Physics Continued

ores, demands a good foundation in physics, especially electrical measurements; in mathematical physics, particularly elasticity, wave motion, electromagnetic theory; and in geology. Biophysics can be undertaken jointly with the Biology Department, with particular attention to radiation and X-rays in physics, and to biological subjects.

In all of these branches of applied physics, considerable work in other departments is required, and it is very desirable to start the fundamental subjects in these departments as undergraduates. Undergraduates planning to enter applied physics should choose their electives with this in mind.

Requirements for the Doctor's Degree

The following special requirements must be met, in addition to the general requirements:

Undergraduate subjects, which may be taken at the Institute or elsewhere, but may not be counted for an advanced degree:

8·161 Optics
8·201 Electronics
8·311 Atomic Structure
8·511 Thermodynamics and Statistical Mechanics or
5·61 Physical Chemistry I

Undergraduate subjects which may be counted as "B" subjects toward an advanced degree:

8·11, 8·12 Experimental Physics
8·461, 8·462 Introduction to Theoretical Physics

The further requirements for the doctor's degree are: reading examinations in French and German; a minor of at least 25 units in some other department; a general examination; a thesis; and an examination on the thesis. The student is expected to take graduate subjects to prepare himself for the general examination, but there are no stated required subjects. The general examination consists of a written examination, followed by an oral one. The written portion is given in three parts, of three hours each, over a period of two weeks. If his work in the written part is satisfactory, the student will be allowed to take the oral portion of the examination. A student may try the written part as many times as he wishes as long as he does not choose to finish the examination by taking the oral. If he takes the whole examination, written and oral once, and fails, then he will be allowed only one additional trial. These examinations are given twice a year, during October and during the latter part of April. The oral examination, minor, and language requirements must be passed off before the student is admitted to candidacy for the degree, which must be at least seven months before taking the degree.

The requirements for a doctor's degree in the field of pure physics, tested by the general examination, include a general knowledge of physics of the grade required for a bachelor's degree in Course VIII, Option 1; and a more advanced knowledge of several fields of experimental or theoretical physics.

The requirements for a doctor's degree in the field of applied physics include a general knowledge of physics of the grade required for a bachelor's degree in Course VIII, Option 2; a knowledge of certain fields of science or engineering outside the Physics department, as chemistry, metallurgy, electrical engineering, geology, which have particular bearing on applications of physics; and more advanced knowledge of certain fields of physics or engineering.

GRADUATE SUBJECTS IN PHYSICS

"A" Subjects. Primarily for Graduates

First Term	8·051	Sp. Problems in Acoustics	Time arr.
	8·181	Optics Seminar	2–2
	8·183	Sp. Problems in Optics	Time arr.
	8·21	Electronic Phenomena	2–4
	8·212	Experimental Electronics	4–3
	‡8·213	Advanced Electronics	3–9
	8·215	Sp. Problems in Electronics	Time arr
	8·26	Molecular Structure	3–6
	8·341	Spectroscopy Seminar	1–1
	8·343	Sp. Problems in Spectroscopy	Time arr.
	8·441	Sp. Problems in Nuclear Res.	Time arr.
	8·463	Int. to Theoret. Phys. III	4–8
	‡8·481	Advanced Mechanics I	3–9
	8·491	Meth. of Theoretical Physics	3–9
	8·56	Electromagnetic Wave Theory	3–9
	‡8·57	Cosmic Rays and High Energy Phenomena	2–6
	8·591	Theoretical Seminar	1–1
	8·60	Sp. Problems in Theoret. Physics	Time arr.
Second Term	8·051	Sp. Problems in Acoustics	Time arr.
	8·182	Optics Seminar	2–2
	8·183	Sp. Problems in Optics	Time arr.
	‡8·194	Advanced Physical Optics	3–2
	‡8·214	Advanced Electronics	3–9
	8·215	Sp. Problems in Electronics	Time arr.
	8·271	Advanced Physics of X-Rays	2–4
	‡8·28	X-Ray Diffraction	2–4
	‡8·281	Crystal Chemistry	2–4
	‡8·29	Quantum Theory of the Solid State	3–6
	8·30	Sp. Problems in Crystal Physics	Time arr.
	8·32	Line Spectra	3–6
	8·342	Spectroscopy Seminar	1–1
	8·343	Sp. Problems in Spectroscopy	Time arr.
	8·42	Seminar in Nuclear Physics	1–2
	‡8·43	Theory of Nuclear Structures	2–6
	8·442	Sp. Problems in Nuclear Research	Time arr.
	‡8·482	Advanced Mechanics II	3–9
	8·512	Statistical Mechanics	3–9
	8·521	Quantum Mechanics	3–9
	8·58	Theory of Relativity	3–9
	8·592	Theoretical Seminar	1–1
	8·60	Sp. Problems in Theoret. Physics	Time arr.

‡ Not offered in 1940–41.

Physics Continued

"B" Subjects. Open to Graduates and Undergraduates

First Term	8·05	Vibrations and Sound	?–6
	8·11	Experimental Physics	8–4
	8·174	Motion Picture Photog.	1–3
	8·27	X-Rays & Crystal Physics	4–5
	8·411	Nuclear Physics	5–4
	8·461	Int. to Theoret. Physics I	4–8
	8·471	Historical Develop. of Physics	3–6
Second Term	8·12	Experimental Physics	2–4
	8·13	Undergrad. Colloquium	2–2
	8·14	Production and Measurement of High Vacuum	3–3
	8·173	Color Measurements	3–2
	8·412	Nuclear Physics	5–4
	8·462	Int. to Theoret. Physics II	4–8
	8·54	Electromagnetic Theory	3–6
Summer	8·344	Practical Spectroscopy	3–3
	8·345	Applied Spectroscopy	9–0
	8·346	Quantitative Spectroscopic Analysis	1–1

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 carefully 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 field of Chemical Engineering has been divided into a series of unit operations which are studied quantitatively and in detail in the Practice School. 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, from early in July until Christmas, 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 Design (10·53) between the close of the Christmas vacation and the end of the examination period of the first term. The work of the second term, including thesis, is elective, though subject to the approval of the department registration officer of graduate students.

A group of about twelve students may take the Practice School program, followed by the Design Course (10·53), in the period from the end of January to the middle of August.

For graduates in Chemical Engineering from other institutions the usual program of study for the Master's degree involves one school year at the Institute, followed by the seven months in field station work in the Practice School and in the Design Course, 10·53. Graduates in chemistry from other institutions usually require an additional half year. A preliminary program in the Summer Session is frequently desirable for new men. Students are usually not permitted to enter the Practice School until they have spent at least one term at the Institute. The student's program is so dependent on previous training and experience that individuals interested are requested to communicate directly with the Department.

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.

Chemical Engineering Continued

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 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.

Requirements for Graduate Study

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 preparation required above that common to all courses of the Institute is outlined below:

Mathematics. Differential Equations equivalent to the undergraduate M22.

Chemistry. A training approximately equivalent to that of the undergraduate course, with particular emphasis on physical chemistry.

Engineering. A training which includes preparation in (a) thermodynamics and (b) applied mechanics or elements of electrical engineering.

Graduate students may meet many of these requirements while studying for an advanced degree.

GRADUATE SUBJECTS IN CHEMICAL ENGINEERING

"A" Subjects. Primarily for Graduates

First	10·25	Industrial Chemistry	5–7
Term	‡10·27	Industrial Chemistry Lab.	8–0
	10·33	Anal. Treat. of Chem. Eng. Processes	3–6
	10·40	Chem. Eng. Thermodynamics	3–6
	10·45	Distillation and Absorption	4–8
	10·52	Chemical Engineering II	4–5
	10·53	Chem. Engineering Design	3–9
	10·54	Econ. Balance in Chem. Industry	5–7
	10·661	Int. to Colloid Chemistry	2–4
	10·673	Colloid Chemistry Lab.	3–3
	10·674	Colloid Chemistry Lab.	3–3
	10·68	Corrosion	2–4
	10·69	Plastics and Other High Polymeric Sub.	2–4
	10·70	Principles of Combustion	4–6
	10·74	Furnace Design	3–6
	10·79	Automotive Fuels	2–4
		School of Chemical Engineering Practice	
	10·81	Bangor Station	12
	10·82	Parlin Station	12
	10·83	Buffalo Station	12
	10·90	Exp. Research Prob.	Time arr.
	10·911	Research Conferences	1–2
	10·991	Seminar in Chem. Eng.	2–4

‡ Not offered in 1940-41

Second	10·40	*Chem. Eng. Thermodyn.	3–6
Term	10·41	Distillation	3–5
	10·46	Absorption and Extraction	3–6
	10·50	Heat Transmission	2–4
	10·55	Economic Balance	3–6
	10·61	Industrial Electrochemistry	2–4
	10·62	App. Chem. Thermodyn.	3–6
	10·63	Industrial Chemistry II	3–6
	10·65	*Catalysis & High Pressure Processes	3–6
	10·662	Colloid Chemistry	2–4
	10·663	Int. to Applied Colloid Chemistry	2–4
	10·672	Colloid Seminar	2–4
	10·673	Colloid Chem. Lab.	3–3
	10·674	Colloid Chem. Lab.	3–3
	10·71	Fuel Engineering	3–6
	10·74	Furnace Design	3–6
	10·76	Seminar in Rad. Heat Trans.	2–4
		School of Chemical Engineering Practice	
	10·81	Bangor Station	12
	10·82	Parlin Station	12
	10·83	Buffalo Station	12
	10·90	Exp. Research Prob.	Time arr.
	10·912	Research Conferences	1–2
	10·992	Seminar in Chem. Eng.	2–4

"B" Subjects. Open to Graduates and Undergraduates

First	10·26	Industrial Chem. Lab.	5–1
Term	10·31	Chemical Engineering	4–5
Second	10·21	Industrial Chemistry	2–2
Term	10·29	Chemical Engineering	4–5
	10·32	Chemical Engineering	4–5

* 10·40 and 10·65 may not be taken simultaneously.

FOR CHEMICAL WARFARE OFFICERS

Course Leading to the Degree of Master of Science

The work begins with the Summer Session in June. The first summer and the first school year are devoted to work of a professional nature preparatory to the more advanced program of the second year, and the School of Chemical Engineering Practice. The student starts the work of the Practice School in July of the second summer, and returns to the Institute the following January to take the course in Chemical Engineering Plant Design, and a term of graduate subjects and thesis. The total time to meet the requirements for the degree is normally 24 months. The subjects to be included in the program depend to a considerable extent on the student's training and experience.

GEOLOGY

In Geology many opportunities are given to pursue advanced work leading to the Master's and Doctor's degree. One line of work is in Economic Geology, and the student may specialize in mining geology, petroleum geology, hydrology, or geology applied to engineering or geophysics. Or again, he may elect to devote the greater part of his time to geology, mineralogy, petrography and paleontology in their more theoretical aspects as preparation for teaching and research.

The advanced work is facilitated by laboratories provided with modern appliances for work in the various phases of geology, mineralogy, petrography, geophysics, and paleontology. The collections in economic geology are supplied with material from the mining districts of all parts of the world.

Requirements for the Degree of Master of Science

Candidates for the degree of Master of Science in Geology must present approved equivalents for the subjects of the first and second years in keeping with indicated field of special interest. In the field of Geology they must present a record of attainments satisfactory to the Department Committee on Graduate Work.

Requirements for the Degree of Doctor of Philosophy, or Doctor of Science

The preparation of the candidate for the Doctor's degree must be such as to satisfy the Department Committee on Graduate Work that he is qualified to undertake the course of advanced study and research.

Each candidate upon his entrance in the Department is given a preliminary examination which may be partly oral and partly written. This is designed to survey his training and attainments in the field of geology. This preliminary examination precedes the "major" examination which must be passed at least seven months before the degree is awarded. The "minor" requirement should likewise be passed before the major examination.

A reading knowledge of both French and German is required.

GRADUATE SUBJECTS IN GEOLOGY

"A" Subjects. Primarily for Graduates

First	‡12·05	Mineralogical Seminar	2–4
Term	12·06	Mineralogical Research	Time arr.
	12·16	Chemical Petrology Seminar	2–4
	12·431	Economic Geology Lab., Adv.	4–1
	12·433	Economic Geology Sem., Adv.	2–6
	12·52	Paleontology, Adv.	4–3
	12·54	Micropaleontology	4–2
	12·55	Organic Evolution, Adv.	3–3
	12·63	Physical Geology Seminar	2–5
	12·64	Geology of North America	2–5
	12·671	Problems in Geology Seminar	1–3
	12·851	Theoret. Geophysics, Adv.	3–6
		Research	
Second	12·17	Petrography, Advanced	4–0
Term	‡12·18	Structural Petrology Seminar	2–4
	12·26	Structural Crystallography	Time arr.
	12·432	Economic Geology Lab., Adv.	4–1
	12·434	Economic Geology Sem., Adv.	2–6
	12·52	Paleontology, Adv.	4–3
	12·53	Index Fossils	6–2
	12·55	Organic Evolution, Adv.	3–3
	12·582	Sedimentation	5–2
	‡12·62	Geological Climates Seminar	2–5
	12·672	Problems in Geology Seminar	1–3
	12·71	Structural Geology, Adv.	3–6
	12·81	Geology of Petroleum, Adv.	3–6
	12·852	Theoret. Geophysics, Adv.	3–6
	12·95	Mine Valuation	3–8
	12·96	Mineral Economics Seminar	Time arr.
		Research	

‡Not offered in 1940–41.

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.

"B" Subjects. Open to Graduates and Undergraduates

First	12·38	Geomorphology	3–6
Term	12·41	Economic Geology Lab.	8–0
	12·581	Sedimentation	5–2
	12·66	Research	Time arr.
	12·70	Structural Geology	3–6
	12·87	Intro. Geophys. Prospecting	2–2
	12·91	Elements of Mining	4–4
	12·94	Mineral Economics	2–4
Second	12·03	Mineralogy, Theoretical	5–1
Term	12·42	App. Economic Geology	3–6
	12·44	Economic Geology of Fuels	1–1
	12·60	Glacial Geology	5–6
	12·66	Research	Time arr.
	12·80	Geology of Coal and Petroleum	4–3
	12·86	Seismology, Elem.	2–2
	12·92	Mining Methods and Practice	5–4

XIII. NAVAL ARCHITECTURE

Graduate Study in Field of Ship Design and Construction

Opportunity is offered to graduates of courses in Naval Architecture (a) to work for a Master of Science degree in Naval Architecture, in which case the student's program must include certain subjects in this department, or (b) to undertake a course of advanced study in fields allied to ship design and ship construction which will lead to the degree of

Naval Architecture Continued

Master of Science *without specification*. In the latter case the program can include a much broader range of subjects.

In addition to meeting the general requirements for admission to the Graduate School, candidates must have completed the necessary prerequisites for the graduate subjects they wish to pursue.

MARINE ENGINEERING

The Department of Naval Architecture and Marine Engineering offers opportunities for graduate work in Marine Engineering leading to the degree of Master of Science in Marine Engineering. Advanced study may be pursued in steam engineering; vibrations of ships and their machinery; propeller design and research; and other fields of marine engineering. The Institute's new propeller testing tunnel is available for research work.

In addition to subjects offered in the Department of Naval Architecture and Marine Engineering, the student may elect subjects closely related to marine engineering given in the Department of Mechanical Engineering, or other departments of the Institute, in making up his program of studies such, for example, as: applied mechanics, hydromechanics, thermodynamics, refrigeration, Diesel engineering, steam turbine engineering, heat transmission, air conditioning, advanced machine design, metallurgy, metallography, and advanced mathematics.

The preparation required for graduate work in Marine Engineering is the equivalent of the Institute's undergraduate course in Naval Architecture and Marine Engineering.

In addition to the general requirements for all graduate students, candidates for the degree of Master of Science in Marine Engineering must meet the approximate equivalent of the following undergraduate subjects:

1·62 or	Hydraulics
2·251	Fluid Mechanics
2·01, 2·04, 2·06	Applied Mechanics
2·40, 2·42	Heat Engineering
2·684	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
13·61, 13·62	Marine Engineering Design

However, students taking 13.75 will not be required to offer 13.02, and graduates in Mechanical Engineering who take 13.75 and 13.76 may substitute courses in machine design, power plant engineering and advanced heat engineering for the marine engineering subjects listed above.

If a student has not had training in all the undergraduate prerequisites listed above before entering upon the work for the graduate year, those listed below as "B" subjects may be taken during the graduate year, up to a total of 24 units, and counted as credit towards the Master's degree.

GRADUATE SUBJECTS IN NAVAL ARCHITECTURE AND MARINE ENGINEERING

"A" Subjects. Primarily for Graduates

First	13·03	Naval Architecture & Ship Design	Time arr.
Term	13·73	Mechanical Vibration	3–6
	13·75	Advanced Marine Engineering	7–8
	13·90	Experimental Research	Time arr.
Second	13·04	Naval Architecture & Ship Design	Time arr.
Term	13·74	Mechanical Vibration	3–6
	13·76	Advanced Marine Engineering	7–5
	13·78	Propeller Theory & Exp. Research	2–4
	13·90	Experimental Research	Time arr.

"B" Subjects. Open to Graduates and Undergraduates

First	13·01	Naval Architecture	3–5
Term	13·54	Marine Engineering	2–3
	13·61	Marine Engineering Design	7–1
Second	13·02	Naval Architecture	3–5
Term	13·62	Marine Engineering Design	6–0

Naval Engineering. A graduate course in Naval Engineering, leading to the degree of Master of Science in Marine Engineering, has been arranged for officers of the United States Navy.

Naval Engineering, United States Navy

First	2·211	Adv. Problems in Mech. Eng.	3–9
Term	2·805	Diesel Engines	2–4
	10·311	Heat Transfer	3–3
	13·73	Mechanical Vibrations	3–6
	13·75	Adv. Marine Engineering	7–8
			18–30
Second	2·212	Adv. Problems in Mech. Eng.	3–9
Term	2·806	Diesel Engines	2–4
	13·76	Adv. Marine Engineering	7–5
		Thesis	20
			50

XIII-A. NAVAL CONSTRUCTION

Course for Naval Constructors

The Department of Naval Architecture and Marine Engineering offers to United States Naval Officers a graduate course (XIII-A) of prescribed studies extending over three years, leading to the degree of Master of Science in Naval Construction. The curriculum for senior and graduate years is given below.

A new Course in Naval Construction and Engineering (XIII-A) will replace the present Course in Naval Construction. (See page 117 for the complete schedule, the Junior Year of which will go into effect in 1940–41.)

Naval Construction Continued

SENIOR YEAR (1940–41 only)

First	2·271	Hydromechanics	3–6
Term	13·13	Theory of Warship Design	3–6
	13·23	Warship Design	5–0
	13·58	Marine Engineering	3–4
	Ec15	Principles of Economics	3–5
	M731	Mechanics	3–6
		General Study	2–2
			22–29
Second	2·72	Machine Design	3–6
Term	3·13T	Metallurgy	2–1
	13·14	Theory of Warship Design	3–8
	13·24	Warship Design	5–0
	13·37	Merchant Shipbuilding	2–2
	13·48	Model Making	2–0
	13·64	Marine Engine Design	3–0
	M732	Mechanics	3–6
		Memoirs	0–3
			23–26

REQUIRED DURING SUMMER (1941)

Work arranged by Postgraduate School

GRADUATE YEAR (1940–41, 1941–42)

First	1·451	Structures	3–6
Term	3·30	Metallography	4–1
	13·15	Theory of Warship Design	3–6
	13·25	Warship Design	6–0
	15·61	Law of Contracts	3–6
	16·811	Aeronautics	3–1
	L11	Elementary German	3–5
			25–25
Second	1·452	Structures	3–6
Term	1·46	Structural Design	2–0
	13·16	Theory of Warship Design	3–6
	13·26	Warship Design	6–0
	L12	Elementary German	3–5
		Thesis	15
			49

Elementary French L51 and L52 may be substituted for German L11 and L12.

XIII-A. NAVAL CONSTRUCTION AND ENGINEERING

The Department of Naval Architecture and Marine Engineering offers to United States Naval Officers a graduate Course (XIII-A) of prescribed studies extending over three years, leading to the degree of Master of Science in Naval Construction and Engineering. The complete curriculum is given below.

REQUIRED DURING SUMMER PRECEDING JUNIOR YEAR

(June to August) (Beginning 1940)

M73	Review of Mathematics	20–0
2·851	Machine Tool Laboratory	4–0
2·852	Machine Tool Practice	4–0

JUNIOR YEAR (In effect 1940–41)

First	2·043	Applied Mechanics	3–5
Term	2·402	Heat Engineering	6–7
	3·391	Properties of Metals	3–3
	13·01	Naval Architecture	3–5
	13·21T	Warship Design	5–0
	M36	Advanced Calculus	3–6
			23–26
Second	2·061	Applied Mechanics	3–6
Term	2·422	Heat Engineering	2–3
	3·392	Properties of Metals	3–3
	13·02	Naval Architecture	3–5
	13·12T	Theory of Warship Design	2–5
	13·22T	Warship Design	5–0
	M37	Advanced Calculus	3–6
			21–28

SENIOR YEAR (In effect 1941–42)

First	2·081	Applied Mechanics	3–5
Term	6·43	Electrical Engineering	3–5
	10·311	Heat Transfer	3–3
	13·13T	Theory of Warship Design	4–8
	13·751	Marine Engineering	7–9
			20–30
Second	2·082	Applied Mechanics	3–5
Term	2·72	Machine Design	3–6
	6·83	Electrical Engineering Lab.	3–5
	13·24T	Warship Design	5–0
	13·752	Marine Engineering	6–6
	Ec15	Principles of Economics	3–5
			23–27

GRADUATE YEAR (In effect 1942–43)

First	2.211	Adv. Problems in Mech. Eng.	3–9
Term	2·805	Diesel Engines	2–4
	6·44	Electrical Engineering	3–5
	13·15T	Theory of Warship Design	3–5
	13·25T	Warship Design	7–0
	13·73	Mechanical Vibrations	3–6
			21–29
Second	2·212	Adv. Problems in Mech. Eng.	3–9
Term	6·84	Electrical Engineering Lab.	3–5
	13·16T	Theory of Warship Design	3–6
	13·26T	Warship Design	6–0
		Thesis	15
			50

BUSINESS AND ENGINEERING ADMINISTRATION

Designed to prepare the technical graduate for ultimate executive responsibilities of an important nature, the course leading to the Master's degree in Business and Engineering Administration has for its objective an awareness 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.

Business and Engineering Administration Continued

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 Course 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 as described on page 89.

Prerequisites to Graduate Study

In addition to satisfying undergraduate requirements* for the Master's degree common to all courses, candidates should have taken a substantial number of engineering units similar to those prescribed in the optional groups listed in the undergraduate Course in Business and Engineering Administration. Candidates should also present evidence that they have had the equivalent of the following undergraduate subjects:

15·41	Finance	Ec11, Ec12	Economic Principles
15·50	Accounting	Ec32	Statistics
15·61	Law of Contracts	Ec40	Money and Banking
15·70	Production	Ec61	Labor Relations
15·81	Marketing	E35	Reports
15·92	Industrial Problems		

and the equivalent of *any three* additional subjects to be selected from "B" subjects (other than those in the preceding group) as listed below.

The second or graduate-year program comprises a selection largely of "A" subjects from the following list, and the undertaking of a Master's thesis.

* M22 Differential Equations is not prerequisite for graduate work in this Department.

GRADUATE SUBJECTS IN BUSINESS AND ENGINEERING ADMINISTRATION

"A" Subjects. Primarily for Graduates

First Term	15·25	Industrial Traffic Management	3-6
	15·55	Problems in Accounting Policy	3-6
	15·75	Manufacturing Analysis	3-6
	15·85	Industrial Marketing	3-6
	15·95	Special Problems in Management	Time arr.
	15·98	Special Administrative Seminar	3-6
	Ec17	Economic Theory	3-6
	Ec47	Investment Finance	3-6
	Ec57	Public Utilities	3-6
	Ec59	International Economic Relations	3-6
	Ec67	Labor Relations Seminar	3-6
	Ec91	Economics Seminar	3-6
	Ec95	Social Science Seminar	3-6
Second Term	15·46	Financial Admin. of Industry	3-6
	15·58	Problems in Accounting Control	3-6
	15·86	Marketing of Consumer Goods	3-6
	15·94	Contemporary Problems Seminar	3-6
	15·95	Special Problems in Management	Time arr.
	15·96	Administrative Theory and Practice	3-6
	15·99	Special Administrative Seminar	3-6
	Ec28	Business Cycles	3-6
	Ec38	Engineering and Industrial Statistics	3-6
	Ec48	Investment Analysis	3-6
	Ec68	Personnel Problems & Labor Relations	3-6
	Ec78	Government Control of Industry	3-6
	Ec92	Economics Seminar	3-6
	Ec96	Social Science Seminar	3-6

"B" Subjects. Open to Graduates and Undergraduates

First Term	15·51	Industrial Accounting	5-4
	15·61	Law of Contracts	3-6
	15·71	Production	3-6
	15·83	Marketing Research	3-6
	Ec15	Principles of Economics	3-5
	Ec45	Monetary & Banking Problems	2-4
	Ec61	Labor Relations	2-4
	Ec81	Human Problems in Industry	2-4
	Ec83	Urban Sociology	2-4
Second Term	2·872	Preparation for Manufacturing	2-4
	15·42	Financial Problems	3-6
	15·51	Industrial Accounting	5-4
	15·62	The Law of the Market	3-6
	15·64	Law of Business Organization	3-6
	15·72	Technique of Executive Control	3-6
	15·82	Sales Management	3-6
	15·88	Advertising	2-6
	15·92	Industrial Problems	2-6
	Ec62	Personnel and Labor Problems	2-4
	Ec84	Social & Econ. Factors in City Planning	2-4
	M54	Mathematical Laboratory	3-6

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

Aeronautical Engineering Continued

Engineering rest heavily upon mathematics and mechanics, aptitude in these subjects is very desirable.

Undergraduate Preparation

The preparation required for graduate work in Aeronautical Engineering is equivalent to that possessed by a graduate of the Massachusetts Institute of Technology in the undergraduate Course in Aeronautical Engineering. With this preparation the candidate may reasonably expect to complete the requirements for the Master's degree in Aeronautical Engineering in one year. Graduates of other engineering courses at the Massachusetts Institute of Technology or from non-aeronautical courses in other accredited engineering schools may register as graduate students but will usually find it necessary to devote a considerable portion of their first year of residence to making up their deficiencies in undergraduate aeronautical subjects, with a second year of strictly graduate work.

Students entering either the graduate or undergraduate courses without previous training in Aeronautical Engineering are strongly advised to register in the summer session previous to their first term of residence, as by this means it is usually possible to reduce materially the total period of study required. It is particularly important that this summer program include subjects 16·01, 16·02, 16·10, *and* 16·20 *unless already covered.*

In addition to the general requirements, graduate students who desire to obtain the Master's degree in Aeronautical Engineering must offer the equivalent of the undergraduate subjects which are listed below or must take these subjects in residence. Exceptions may be made in individual cases.

Not Counted as "B" Subjects

2·701	Machine Drawing (S)
2·351	Materials of Engineering (S)
2·42	Heat Engineering (S)
16·10	Aerodynamics of Airplane Design (S)
16·20	Structures
16·71	Airplane Shopwork (S)
16·72	Aircraft Production Methods (S)
	Intermediate French (S) or Spanish
	Intermediate German (S)

Counted as "B" Subjects

16·01	Introduction to Aeronautical Mechanics (S)
16·02	Introduction to Aeronautical Mechanics (S)
16·11	Aerodynamics of Airplane Design
16·17	Airplane Design Practice
16·21	Structures
16·62	Aeronautical Laboratory
16·75	Construction Details of Aircraft

(Subjects marked (S) are usually offered during the Summer Session as well as during the regular academic year.)

Attention is drawn to the two five-year programs leading to simultaneous bachelor's and master's degrees, described on pages 73 and 121. Under either program the student enjoys graduate status for the fifth year which includes the privilege of living in the Graduate House.

Requirements for the Doctor's Degree

Special requirements for the degree of Doctor of Science in Aeronautical Engineering, or in Meteorology, beyond the general requirements of the Graduate School, given on pages 87–89, are the following:

The student is expected to take graduate subjects in preparation for the general examination and thesis research, but no particular subjects are required. The general examination for the doctorate consists of two parts. The first is a written examination, consisting normally of six questions set to require, on the average, one day each to complete and 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, which must be at least seven months before taking the degree.

For United States Naval Officers
course leading to the degree of master of science

The degree of Master of Science will be awarded to United States Naval Officers who have completed satisfactorily Schedules E and E2 listed in the United States Naval Academy catalogue of 1939–40, and the summer instruction at the Naval Aircraft factory, and have completed satisfactorily the following one-year schedule in the Department of Aeronautical Engineering. (The regular three years of German, French, or Spanish taken at Annapolis will be accepted as satisfying the language requirement.)

First Term	2·791	Automotive Engines	4–4
	2·801	Automotive Engine Problems Adv.	5–0
	16·17	Airplane Design Practice	8–0
	16·41	Instrumentation	3–9
	16·43	Instrumentation Laboratory	3–6
	16·60	Aeronautical Problems, Adv.	3–5
			50
Second Term	2·792	Automotive Engines	4–4
	2·802	Automotive Engine Problems, Adv.	3–5
	16·46	Vibration Measurements	5–6
	16·53	Adv. Airplane Engine Design	5–3
		Thesis	15
			50

Aeronautical Engineering Continued

Research Facilities

The principal laboratory is the Wright Brothers Wind Tunnel capable of airspeeds from 40 to 400 miles per hour and permitting a variation of air density from one quarter to four atmospheres. An elliptical test section 7½ feet by 10 feet permits the testing of models up to 7½ foot span.

Other laboratory equipment consists of three smaller wind tunnels for model testing and instruction, varying from 4 feet to 7½ feet in diameter, and from 60 to 90 miles per hour in airspeed, and two research tunnels. One, for boundary layer research, is equipped with hot wire amplifier apparatus for turbulence studies, and the other with multiple stage throats is available for studies requiring low-speed airstreams essentially free of turbulence.

The Instrumentation Laboratory is equipped for instruction in the fundamentals of instrument design and testing, with particular emphasis on the behavior of measuring systems under rapidly changing conditions. Apparatus is available for studying magnetic compasses and gyroscopic aircraft instruments. Electrical and mechanical equipment for recording vibration in automotive power plants and aircraft is available for application to research problems of various kinds.

The laboratories of the Department of Mechanical Engineering are used for the investigation of mechanical and structural problems. Also, the facilities of the Internal Combustion Engine Laboratory (see page 92) are available to students in Aeronautical Engineering. Likewise, the metallurgy, photo-elastic, and other laboratories of the Institute are available.

GRADUATE SUBJECTS IN AERONAUTICAL ENGINEERING

"A" Subjects. Primarily for Graduates

First	2·801	Automotive Engine Prob., Adv.	Time arr.
Term	16·03	Hydrodyn. & App. to Aero.	3–6
	16·07	Adv. Topics in Aeromechan.	3–6
	16·23	Advanced Aircraft Structures	2–4
	16·31	Airship Theory	2–3
	16·41	Instrumentation	3–9
	16·43	Instrumentation Laboratory	3–6
	16·45	Sp. Prob. in Aeronautical and Meteor. Inst.	Time arr.
	16·53	Adv. Airplane Engine Design	5–3
	16·60	Adv. Aeronautical Problems	Time arr.
	16·913	Synoptic Meteorology III	3–6
	16·923	Meteorological Lab. III	12–0
	16·931	Dynamic Meteorology I	5–10
	16·933	Dynamic Meteorology III	3–6
	16·941	Meteorological Seminar	2–2
Second	2·802	Automotive Engine Prob., Adv.	Time arr.
Term	16·04	Hydrodyn. & App. to Aero.	3–6
	16·08	Adv. Topics in Aeromechan.	3–6
	16·18	Airplane Des. Prac., Adv.	6–3
	16·25	Aircraft Structures, Adv.	3–6
	16·36	Airship Structures	2–4
	16·42	Aeronautical Instruments	3–9
	16·46	Vibration Measurements	5–6
	16·52	Aircraft Propeller Design	4–4
	16·54	Adv. Airplane Engine Design	5–3
	16·60	Adv. Aeronautical Problems	Time arr.
	16·68	Aeronautical Seminar	2–2
	16·912	Synoptic Meteorology II	3–6
	16·914	Synoptic Meteorology IV	3–6
	16·932	Dynamic Meteorology II	4–8
	16·934	Dynamic Meteorology IV	3–6
	16·942	Meteorological Seminar	2–2
		Thesis	20–40 hours per week

"B" Subjects. Open to Graduates and Undergraduates

First	2·791	Automotive Engines	4–4
Term	16·01	Int. to Aeronautical Mechanics	6–6
	16·11	Aerodyn. of Airplane Des.	6–4
	16·17	Airplane Design Practice	8–0
	16·21	Structures	3–5
	16·44	Meteorological Instruments	5–5
	16·62	Aeronautical Lab.	4–3
	16·81	Aeronautics	3–1
	16·911	Synoptic Meteorology I	3–4
	16·921	Meteorological Lab. I	12–0
Second	2·792	Automotive Engines	4–4
Term	16·02	Int. to Aeronautical Mechanics	6–4
	16·14	Airplane Design Prob.	6–6
	16·22	Aircraft Structures	3–5
	16·63	Aero. Lab. & Res. Methods	4–2
	16·75	Construction Details of Aircraft	7–2
	16·81	Aeronautics	3–1
	16·922	Meteorological Lab. II	15–0

Students may also elect subjects given in other departments, but bearing a useful relation to their program of aeronautical studies. Those specializing in aircraft design will, in general, be advised to take advanced work in materials and elasticity; those choosing aerodynamics as their field may advantageously take courses in advanced physics, while those chiefly interested in engines should supplement their aeronautical studies by work in physical chemistry and in dynamics. The selection of such subjects is subject to approval of the registration officer.

Meteorology

The Institute maintains also a laboratory for synoptic meteorology with radio receiving equipment for the collection of weather data. A teletype receiver is available for speedy collection of airways weather reports. Two radio operators are permanently employed for this purpose. There is also available equipment for the reproduction of weather maps used in the training of students and for exchange with American and foreign meteorological institutions.

The Meteorological Instrument Laboratory includes considerable equipment for the measurement and recording of local weather data, complete instrumentation for pilot balloon soundings and an assortment of meteorographs for airplane soundings. In addition there is available a set of sounding balloon meteorographs for stratosphere investigations and a microscope for evaluation of sounding balloon

Aeronautical Engineering Continued

records. A limited number of radio meteorographs of several different types are also available for instruction purposes and for high altitude investigations. A calibration chamber suitable for pressure-temperature calibrations at temperatures as low as −76° C. has been constructed and also a humidity calibration chamber.

Close coöperation is maintained with the Blue Hill Observatory of Harvard University, the Mount Washington Observatory, the Woods Hole Oceanographic Institution, and the United States Weather Bureau.

For United States Naval Officers

A graduate course leading to the degree of Master of Science in Meteorology for United States Naval Officers who have completed satisfactorily Schedules EL and E2L listed in the United States Naval Academy catalogue of 1939–40, and the summer instruction at United States Naval Air Station, and have completed satisfactorily the following one-year schedule under the charge of the Department of Aeronautical Engineering. (The regular three years of German, French, or Spanish taken at Annapolis will be accepted as satisfying the language requirement.)

First Term	16·44	Meteorological Instruments	5–5
	16·913	Synoptic Meteorology III	3–6
	16·923	Meteorological Laboratory III	12–0
	16·931	Dynamic Meteorology I	5–10
	16·941	Meteorological Seminar	2–2
			50
Second Term	16·914	Synoptic Meteorology IV	3–6
	16·922	Meteorological Laboratory II	15–0
	16·932	Dynamic Meteorology II	4–8
		Thesis	15
			51

ECONOMICS AND SOCIAL SCIENCE

The Five Year Course

This course 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 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 candidates for the Master's degree apply to this curriculum.

The third and fourth year subjects which provide a foundation for the more advanced work may be chosen from among the following: Introduction to Business Management (15·11, 15·12), Accounting (15·52), Money and Banking (Ec40), Statistics (Ec32), Labor Relations (Ec61), Personnel and Labor Problems (Ec62), Economic Theory (Ec17), Investment Finance (Ec47). The fifth year subjects may be chosen from the "A" subjects listed below and other related subjects offered by other departments.

Various fields of concentration are available for students enrolled in this course. Those interested in statistics may select from Ec32, Ec33, Ec34, Ec38 in Economics, and from M331–2 and M341–2 in Mathematics. For those interested in labor relations there are Ec61, Ec62, Ec81, Ec67, Ec68, as well as subjects in the field of industrial hygiene offered by the Department of Biology and Public Health. Students concentrating in finance might select from Ec40, Ec47, Ec48, Ec54, Ec57 in economics, and from 15·50, 15·41, 15·42, 15·46 in the Department of Business and Engineering Administration. Appropriate groups of subjects are available for students desiring to concentrate in economic theory, government and industry, and other special fields.

This 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, nor 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.

The Department of Economics and Social Science also offers instruction to graduates who are studying for advanced degrees in other departments. Such students may, for example, submit economics as their minor requirements for the doctorate. Provided they have had the necessary elementary groundwork, suitable programs may be arranged from the subjects listed below. The fairly broad range of selection enables the student to choose a group of subjects related to his major interest. Those interested in the economic aspects of particular industries will be given opportunity to devote special attention to such industries.

Economics and Social Science Continued

INSTRUCTION IN THE FIELD OF INDUSTRIAL RELATIONS

Special training for men concerned with industrial relations and personnel problems is provided through the coöperation of three departments of the Institute: Economics and Social Science with its special interests in industrial relations, Business and Engineering Administration, and Biology and Public Health with its special work in the field of industrial hygiene. For this program certain fundamental subjects in social science, business management, biology and public health, and industrial relations are suggested for all students. The remainder of the program may be selected from a broad list.

Admission will be restricted to graduate students of superior qualifications and to men who have had satisfactory experience in industry. The requirements for admission will be graduation from a college, technical school or university with academic ratings comparable to those required for admission to the graduate school of the Institute. Students with suitable prerequisites may become candidates for the degree of master of science, which will be granted upon the completion of 96 units of graduate study, 72 of which, including thesis, are "A" subjects. Others will be registered as special students. Ordinarily, at least a full year, including the summer preceding the academic year, will be required for the work for the master's degree.

GRADUATE SUBJECTS
IN ECONOMICS AND SOCIAL SCIENCE

"A" Subjects. Primarily for Graduates

First	Ec17	Economic Theory	3–6
Term	Ec47	Investment Finance	3–6
	Ec57	Public Utilities	3–6
	Ec59	Internat. Economic Relations	3–6
	Ec67	Labor Relations Seminar	3–6
	Ec91	Economics Seminar	3–6
	Ec95	Social Science Seminar	3–6
Second	Ec28	Business Cycles	3–6
Term	Ec38	Engineering and Industrial Statistics	3–6
	Ec48	Investment Analysis	3–6
	Ec68	Personnel Problems & Labor Relations	3–6
	Ec78	Government Control of Industry	3–6
	Ec92	Economics Seminar	3–6
	Ec96	Social Science Seminar	3–6

"B" Subjects. Open to Graduates and Undergraduates

First	Ec15	Principles of Economics	3–5
Term	Ec33	Design of Experiments	3–6
	Ec45	Monetary and Bank. Problems	2–4
	Ec61	Labor Relations	2–4
	Ec81	Human Problems in Industry	2–4
	Ec83	Urban Sociology	2–4
Second	Ec54	Corporations	3–3
Term	Ec62	Personnel and Labor Problems	2–4
	Ec84	Social & Econ. Factors in City Plan.	2–4

MATHEMATICS

The Department of Mathematics offers courses leading to the degrees of Master of Science, Doctor of Philosophy and Doctor of Science.

The course of each student will be arranged in consultation with the Department from subjects mentioned below. A student who is interested in applied mathematics may also be allowed to select subjects offered in other departments. Before receiving a Graduate Degree in mathematics a student is expected to complete the undergraduate mathematics subjects in Course XVIII, Option 1, or their equivalents.

To obtain the degree of Master of Science the student must elect in each term at least three subjects of advanced mathematics or allied subjects, and fill the remaining time with other electives and thesis.

For the degree of Doctor of Philosophy, the student must fulfill the mathematical requirements for the degree of Bachelor of Science in Course XVIII, Option 1. 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.

GRADUATE SUBJECTS IN MATHEMATICS

"A" Subjects. Primarily for Graduates

First	M351	Adv. Calculus for Engineers	3–6
Term	M36	Adv. Calculus	3–6
	M381	Theory of Functions	3–9
	M451	Fourier Series & Integrals	3–9
	‡M471	Seminar in Analytical Statistics	3–9
	M551	Functions of a Real Variable	3–9
	‡M561	Functions of a Complex Variable	3–9
	M571	Differential Equations	3–9
	‡M581	Continuous Groups	3–9
	M631	Modern Algebraic Theories	3–9
	M641	Differential Geometry, Adv.	3–9
	‡M651	Analytical Mechanics	3–9
	M661	Algebra of Quantum Theory	3–9
	M671	Partial Differential & Integral Equations	3–9
	‡M691	Characteristic Value Problem	3–9
	M791	Theoret. & App. Elasticity	3–9
	M90	Mathematical Reading	Time arr.
Second	M352	Adv. Calculus for Engineers	3–6
Term	M37	Adv. Calculus	3–6
	M382	Theory of Functions	3–9
	M452	Fourier Series & Integrals	3–9
	‡M472	Seminar in Analytical Statistics	3–9
	M552	Functions of a Real Variable	3–9
	‡M562	Functions of a Complex Variable	3–9
	M572	Differential Equations	3–9
	‡M582	Continuous Groups	3–9
	M632	Modern Algebraic Theories	3–9
	M642	Differential Geometry, Adv.	3–9
	‡M652	Analytical Mechanics	3–9

‡ Not offered in 1940–41.

Mathematics Continued

	M662	Algebra of Quantum Theory	3–9
	M672	Partial Differential & Integral Equations	3–9
	‡M682	Calculus of Variations	3–9
	‡M692	Characteristic Value Problem	3–9
	M76	Theory of Probability	3–9
	M792	Theoret. & App. Elasticity	3–9
	M90	Mathematical Reading	Time arr.

"B" Subjects. Open to Graduates and Undergraduates

First Term	M331	Math. Theory of Statistics	3–6
	‡M441	Projective Geometry	3–6
	M731	Mechanics	3–6
	M831	Analysis	3–6
	M841	Analysis	3–6
Second Term	M332	Math. Theory of Statistics	3–6
	M442	Elem. Diff. Geometry	3–6
	M54	Mathematical Lab.	3–6
	M62	Modern Algebra	3–6
	M732	Mechanics	3–6
	M77	Vector Analysis	3–6
	M832	Analysis	3–6
	M842	Analysis	3–6

‡ Not offered in 1940–41.

DESCRIPTION OF SUBJECTS

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. An elementary course in the theory and practice of plane and topographical surveying. Breed and Hosmer's *Principles and Practice of Surveying, Vol. I.*

1·01. TOPOGRAPHICAL DRAWING. A course in making scale drawings, profiles, contour maps, and conventional signs for topography, followed by a study of their application to the solution of engineering problems. Breed and Hosmer's *Principles and Practice of Surveying, Vol. I.*

1·02. SURVEYING. A course in elementary surveying, which includes theory and fieldwork. Breed and Hosmer's *Principles and Practices of Surveying, Vol. I.*

1·041. SURVEYING. At Camp Technology. The fieldwork consists of plane and topographic surveying, in which the transit, tape, level and plane table are used, the astronomical determination of the meridian, the adjustment of instruments and many important problems in surveying. Plans and maps are made from notes taken in the field. (Not accepted in place of 1·05 in Course I.) Breed and Hosmer's *Principles and Practice of Surveying, Vol. I.* This subject satisfies the requirements in surveying for Courses IV-B, IV-C_1, VI, VI-A, IX-B.

1·042. SURVEYING. At Camp Technology. Lectures, fieldwork and drafting. The theory and practice of plane and topographic surveying is supplemented by many problems. Field training is given in the use of surveying instruments. Designed for students in Course XVII. Breed and Hosmer's *Principles and Practice of Surveying, Vol. I.* This subject satisfies the requirements in surveying for Courses IV-B, IV-C_1, VI, VI-A, IX-B.

1·05. SURVEYING. At Camp Technology. An extended subject covering plane, topographic and elementary geodetic surveying. The fieldwork consists of making plane and topographic surveys in which the tape, transit, level, stadia method and plane table are used. Astronomical determination of azimuth, time and latitude. Triangulation. In the drafting room, plans and maps are made from original field notes. In the class room, discussions on the methods of conducting surveys, and a limited number of problems are given. Breed and Hosmer's *Principles and Practice of Surveying, Vols. I and II;* Hosmer's *Practical Astronomy.* This subject satisfies the requirements in surveying for Courses IV-B, IV-C_1, VI, VI-A, IX-B.

1·07. GEODETIC SURVEYING (B). At Camp Technology. Four weeks of field and office work. The fieldwork includes measuring a base line with invar tapes; triangulation with repeating and with direction instruments; precise leveling; astronomical observations. (Elective for students who have had Surveying 1·05 and Geodesy 1·13 or equivalent Given if a sufficient number of students apply.)

1·12. ASTRONOMY AND SPHERICAL TRIGONOMETRY. Supplements 1·00 and 1·01, and is therefore treated from the standpoint of the engineer. Spherical trigonometry covers the principles of the subject sufficiently to serve as a preparation for the work in astronomy. The class work in the latter includes the theory of spherical and practical astronomy. The fieldwork is given at Camp Technology and includes the determination of latitude, longitude, time and azimuth with the engineer's transit. Hosmer's *Practical Astronomy.*

1·13. GEODESY. The methods of conducting a geodetic survey are discussed in detail, including the mathematical treatment of base line measurements, triangulation and precise leveling. Hosmer's *Geodesy.*

1·135. INTRODUCTION TO VIBRATION THEORY (B). Basic theory of free and forced vibrations with and without solid and fluid friction. To meet the needs of practical engineering, special emphasis is placed upon the analysis of various vibration measuring devices, accelerographs, frequency meters, etc. The proper interpretation of the results obtained from such devices is studied in detail and attention is given to the principles of design of instruments and recording systems. Practical problems of mechanical vibration and of vibration prevention are discussed. Some laboratory experiments are included to illustrate the principles involved.

1·136. VIBRATION PROBLEMS (A). Covers the available methods of solving the more complex problems in vibrations — step-by-step integration, the differential analyzer, model study, electrical network solution, Rayleigh and Rayleigh-Ritz methods, Lagrange's equations, and the general solution of n^{th} order vibration equations. Non-harmonic vibrations are included. Analysis of complex mechanical systems under transient and periodic forces and displacements. Particular attention is given to practical problems illustrating the application of the various methods and principles.

1·138. SEISMOLOGICAL LABORATORY (B). Subject will be arranged to meet needs of individual students.

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 observa-

tions; and application of least squares to the adjustment of geodetic surveys.

1·16. Aerial Surveying (B). A study of the various methods of constructing maps from photographs for engineering purposes, and the methods of making topographic maps from vertical and from oblique photographs. A study is also made of the different methods of control of aerial surveys. The work covered is confined to the methods of producing the maps from the photographs, and does not take up the technical work of photography or of piloting.

1·18. Map Reading and Topographical Drawing. A study of the different conventional signs employed in making topographic maps. Each student is required to make a number of plates of conventional signs, and to solve problems relating to contour maps. (Not open to first year students.)

1·20. Railway and Highway Fieldwork. A location survey for a railway or highway project; together with a systematic drill in laying out curves, setting slope stakes for earthwork and staking out masonry structures. A limited amount of class work and drafting is given to supplement the fieldwork. Allen's *Railroad Curves and Earthwork;* Allen's *Field and Office Tables.*

1·21. Railway and Highway Curves. A thorough study of the mathematics of curves with applications to location and property lines of railways, highways and waterways. Simple, compound, reversed, spiral and vertical (parabolic) curves are treated. Allen's *Railroad Curves and Earthwork;* Allen's *Field and Office Tables.*

1·22. Quantity Surveying. Methods of computing quantities for civil engineering work. It includes earthwork volumes, haul and mass diagram; concrete volumes and detailed estimates of quantities of ingredients; preparation of bills of material for reinforcing steel, timber structures, etc. Stress is laid on the ability to read plans and on neatness, accuracy and the use of methods accepted in professional practice.

1·25. Engineering Construction (B). Deals primarily with the construction of civil engineering works, such as railways, highways, water power, water supply and similar projects. The subjects covered are estimates and reports, contracts and specifications, methods of economic comparison, financing of engineering projects, engineering organization and duties, acquisition of land, and construction methods including clearing of the site, earth and rock handling, and construction of structures of concrete, steel and timber. Principles are illustrated by studies of typical projects. Particular attention is given to methods of control of concrete mixtures.

1·26. Railway Signaling (B). Interlocking and block signals; and remote, centralized and automatic train control. Critical attention is given to the development of modern signaling practices with reference to the economics of train operation. The subject is illustrated by inspections of railway signal installations.

1·271, 1·272. Transportation Engineering (B). Transportation by railway and highway with some attention to air and water transportation. Subjects treated include railway maintenance of way, highway location and pavement design and research, railway rolling stock and motor vehicles, economics of location illustrated by typical projects, traffic and transportation surveys, highway traffic control, underlying principles of railway and highway operation, waterways, air transport, public relations and regulation, coördination of the different forms of transportation.

1·273. Transportation Engineering (B). An abridgment of 1·271 and 1·272. (Given primarily for U. S. Army Engineer Officers.)

1·28. Railway Design (B). The design of railroad yards and terminals.

1·301, 1·302. Advanced Railway Transportation (A). A continuation of the undergraduate subjects in transportation engineering 1·271 and 1·272. It pertains to the design and operation of locomotive, freight and passenger terminals; use of motor transport; railway economics; public relations and regulation; and involves individual investigations and reports.

1·32. Design of Harbor Works (A). Includes the 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 will include inspection of Boston Port facilities and waterfront construction.

1·34. Municipal Engineering (B). An elementary subject especially arranged for students in City Planning. It deals with the phases of municipal engineering that must be considered by those responsible for the planning or replanning of towns and cities. Subjects covered include the location, design, construction and maintenance of city streets; a study of urban problems of traffic and transportation; and a brief consideration of municipal systems of drainage, water supply, sewage disposal and other public utilities.

1·35. Roads and Pavements. Principles governing the location, construction and maintenance of roads, and the construction and maintenance of pavements for city streets. Bruce's *Highway Design and Construction.*

1·371, 1·372. Advanced Highway Transportation (A). Study of research results and methods of design, construction, maintenance, operation and economics of highways.

1·38. Highway Design (B). A design for the improvement of an existing highway by substitution of improved alignment, grades and new pavement, and the preparation of an estimate of cost.

1·39. Graphic Statics. Graphic methods of problems dealing with forces and reactions, curves of bending moment and shear and stresses in simple trussed structures. Hudson and Squire's *Elements of Graphic Statics.*

Civil and Sanitary Engineering Continued

1·40. Theory of Structures. An introductory subject covering outer forces, reactions, moments and shears for fixed and moving loads, the use of influence lines, the design of steel and wooden beams and plate girders, and the analysis of continuous beams by the use of the Equation of Three Moments. Spofford's *Theory of Structures.*

1·401. Theory of Structures. An abridgement of 1·40 for students in Courses VII_2, IX-B and XVII. Spofford's *Theory of Structures.*

1·402. Structures. To cover strength of materials, bending moment and shear, distribution of normal and shearing stress, strength of columns, influence lines for bending moment and shear in beams and girders; effect of moving loads; beam and girder design; deflection of beams; composite beams; elementary theory of reinforced concrete.

1·41, 1·42T. Theory of Structures (B). An extended subject, in continuation of 1·40. It deals with the analysis and design of the more common structures of wood, steel and masonry by analytical and graphical methods. First term: roof and bridge trusses of various forms, including simple end-supported trusses, three-hinged arches, cantilevers, portals, viaduct towers and three-dimensional frameworks. Second term: masonry structures, including dams and arches, and the application of the methods of deflection, least work, slope deflection, etc., to the solution of various statically indeterminate structures. Spofford's *Theory of Structures.*

1·411. Structures (B). A continuation of 1·402, dealing particularly with the analysis of trussed structures, three-hinged arches, cantilevers, portals, towers, three-dimensional frames and stability of masonry walls.

1·421. Theory of Structures (B). A continuation of 1·41 for students in Course VII_2. The elementary theory of reinforced concrete, stability of masonry walls, deflection of trusses and the theory of least work. Spofford's *Theory of Structures.*

1·422. Structures. Masonry structures including piers, retaining walls and arches, the deflections of beams and trusses and other structural members, and the analysis of building frames by slope deflection, least work, moment distribution and other methods.

1·451, 1·452. Structures. Arranged for Naval Constructors. It is intended to give some familiarity with problems met by structural engineers and the usual methods employed by them in stress analysis for and design of structures. The subject matter includes the use of influence lines and the analysis of simple trusses, portals, rigid frames, trusses with redundant members, space framework, continuous beams, the computation of deflections and the analysis of statically indeterminate structures, Spofford's *Theory of Structures.*

1·46. Structural Design. Design calculations and drawings for a small steel truss bridge, intended to illustrate and amplify the work of 1·451, 1·452.

1·47. Cement and Concrete. A study of cement and concrete as materials of construction, emphasizing such phases as nature of cement hydration, design of concrete mixes, and various physical and chemical properties of concrete. Includes some laboratory exercises.

1·48. Foundations (B). A brief outline of the basic principles of soil mechanics, followed by the study of foundations for buildings and other structures. Pile foundations, deep foundations, and lateral pressure determinations are included. Jacoby and Davis' *Foundations of Bridges and Buildings.*

1·491. Soil Mechanics (A). A detailed study of those physical and mechanical properties of soil which govern its behavior as an engineering material. Base soil classifications; studies of the laws of permeability, capillarity and seepage; compressibility and consolidation theory followed by settlement analysis of structures which are founded above compressible soil strata; studies of relationships of stresses, strains, and shearing strengths in cohesive and cohesionless soils; critical densities and the quicksand phenomenon in cohesionless soils. *Mimeographed Notes.*

1·492. Soil Mechanics (A). Specific applications of modern soil research are considered on the basis of the physical studies of 1·491. Stability of slopes and retaining walls; earth and masonry dams, with special 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.*

1·493. 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.

1·495, 1·496. Soil Mechanics (A). An extended and more comprehensive study of soil mechanics than 1·491, 1·492.

1·501. Bridge Design (B). Shows the relation of the theory of structures to engineering practice through the preparation of designs and drawings for a riveted plate girder railway bridge, a welded girder bridge and a wooden truss. Emphasis is laid on the development of careful, systematic and practical habits of computation.

1·502T. Structural Design (B). An extension of 1·501 including the design of a riveted steel truss highway bridge, and a reinforced concrete bridge.

1·51. Advanced Structural Theory (A). A study of the basic theorems underlying the analysis of statically indeterminate structures, computation of deflections of trussed structures, method of slope-deflection, moment distribution procedure.

1·52. Structural Design (B). Application of the theory of structures to the design of a steel truss highway bridge.

1·521, 1·522. Structural Laboratory (A). Covers by lectures, conferences, assigned reading and laboratory work, the theory and practice of structural analysis by the use of models. The fundamentals of the entire field are

discussed first, and later work is arranged to cover fields of special interest to individual students. Time will be arranged to suit these individual requirements.

1·541, 1·542. Reinforced Concrete Design, Advanced (A). First term: a more advanced treatment of the subject matter handled in 1·58, designed for graduate students from other colleges who have already had some training in this field. A complete design for an interior bay of a typical factory building, illustrating design of floors of various types, columns, footings, etc. Second term: a 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. Structural Design, Advanced (A). A study of 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. Structural Theory, Advanced (A). A study of the 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 certain types of indeterminate structures such as continuous and suspension bridges, high building frames, arches, arched dams. Spofford's *Theory of Continuous Structures and Arches.*

1·58. Design of Reinforced Concrete Structures. The elementary principles of reinforced concrete with the consideration of methods and rules used in design of concrete structures.

1·59. Concrete Research (A). Gives opportunity for attacking special problems, such as the determination of important properties of concrete under various conditions. It also permits studies aimed toward improving the quality of concrete through determination of the effect of numerous variables upon the important properties. The variables include: character and gradation of aggregates, composition and fineness of cement, exposure conditions, size of mass, addition reagents, method of tamping, and proportions of materials. The important properties include: heat of hydration, volume change, durability, strength, elasticity, permeability, plastic flow, and workability.

1·60. Hydrographic Surveying. At Camp Technology. (a) Stream gaging: The student is instructed in the principles of measuring the flow of water in open channels, the work being carried out on one of the nearby streams. Each student is instructed in the use of various types of current meters and the test data of his gagings assembled and plotted. (b) Soundings: On Gardner Lake the student is instructed in the methods of making soundings, including instruction in the use of the sextant.

1·62. Hydraulics. Includes the fundamental principles of hydrostatics, hydrodynamics, hydraulic turbines and centrifugal pumps. The flow of water through orifices, nozzles, weirs, pipes and open channels is emphasized, as well as the application of basic principles to the flow of other fluids. Russell's *Hydraulics, Fourth Edition.*

1·63. Hydraulics. Comprises the essentials of 1·62 but omits the hydraulic turbines and centrifugal pumps. The treatment of pipe-flow and open channels is also abbreviated. Russell's *Hydraulics, Fourth Edition.*

1·64. Hydraulics. Comprises the essentials of 1·62 but certain portions of the subject matter are abbreviated. Russell's *Hydraulics, Fourth Edition.*

1·66. Hydraulics, Advanced (A). An elaboration of subjects fundamentally treated in 1·62 and, in addition, studies in the advanced field of theory and practice. Subjects included are: general fluid flow in pipes; open channels with special reference to non-uniform flow, alternate stages, critical stage, surface curves, hydraulic jump, transitions and wave formations. Russell's *Hydraulics;* Gibson's *Hydraulics; professional papers.*

1·681. Theory of Models (A). Presents the principle of dimensional analysis and its application to many problems, also the 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 will be cited to illustrate the work covered.

1·682. River Hydraulic Laboratory (A). Instruction in the construction of models for river hydraulic experiments, in the method of making such experiments, and in the interpretation of the results thereof. Registration for the subject is limited in accordance with the number of models available in the laboratory.

1·69. River Engineering (A). A study of the hydraulic factors affecting river flow, the theory of bed load transportation, and means for improving rivers as regards floods and also for navigation.

1·70. Hydrology (B). A study of the basic theory of the occurrence and distribution of water on the surface of the earth. The subject includes: 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 is supplemented by supervised problems of applied hydrology in the drafting room. Barrows' *Water Power Engineering.*

1·701. Hydrology (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 and Flood Control (B). A study of the 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. It includes 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 and flood control, including flood damages and

the selection and planning of reservoirs for flood control. Supplemented by drafting room exercises with reports and problems of design. Barrows' *Water Power Engineering.*

1·711. Water Power Engineering and Flood Control (B). An abridgement of 1·71 including the theory but omitting the practical design work in the drafting room. Barrows' *Water Power Engineering.*

1·731, 1·732. Water Power Engineering, Advanced (A). These subjects are supplemented by subjects 1·851, 1·852 and include the 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 are also considered, with their basic theory and practice. A field trip of several days' duration to examine typical power and storage developments is included. Barrows' *Water Power Engineering.* Creager and Justin's *Hydroelectric Handbook* and Justin and Mervine's *Power Supply Economics.*

1·75. Hydraulic and Sanitary Engineering (B). The first eleven weeks are devoted to a comprehensive study of the principles of water supply engineering, which includes rainfall and run-off, consumption of water, surface and ground water supplies, dams and impounding reservoirs, supply and distribution works, principles of treatment of water and design of treatment works. Opportunities for group inspection of nearby water works construction and water treatment works are included. The last four weeks are devoted to a study of the principles of design of sanitary sewers and storm drains, including methods for estimating the quantity of sewage and storm water run-off

1·76. Sanitary Engineering (B). A continuation of 1·75 covering the principles of design and construction of sewage collecting systems and appurtenances, the principles of sewage treatment and the design and construction of treatment works. Opportunities are offered for group inspection of nearby sewage works.

1·78. Sanitary Engineering (B). A continuation of 1·75, covering in more detail the subject matter of 1·76 and in addition thereto the elements of stream sanitation and of disposal of industrial wastes and municipal refuse and garbage. Opportunities are offered for group inspection of nearby sewage works.

1·79. Sanitary Design (B). The design of a sanitary intercepting sewer for a small community followed by the design of a system of storm drains for a small area.

1·801. Hydraulic and Sanitary Design (B). An investigation for and report on a gravity water supply for a small community.

1·802. Sanitary Design (B). The same as 1·79 followed by the design of a sewage treatment plant for the community.

1·811. Sanitary Engineering, Advanced (A). A comprehensive study of the principles of modern water treatment engineering, including coagulation, sedimentation, filtration, sterilization, softening, corrosion, and removal of tastes and odors. Opportunities are offered for group inspection of nearby treatment works. *Notes prepared by Professor Camp and textbooks and professiona. papers by various authors.*

1·812. Sanitary Engineering, Advanced (A). A comprehensive study of the principles of modern sewage treatment engineering, including screening, removal of grit, 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. Opportunities are offered for group inspection of nearby sewage works. *Notes prepared by Professor Camp and textbooks and professional papers by various authors.*

1·821. Sanitary Engineering Laboratory (A). Laboratory studies of methods of treatment of water for municipal and industrial use. Several samples of water of varying quality whose analyses are known will be studied and treated on a laboratory scale to determine practical methods of treatment of each water for a specific use, to determine treatment plant design factors and to estimate costs of treatment. Turbidity and color removal, corrosion protection, softening, iron and manganese removal, and odor removal will be considered. To be conducted in parallel with 1·811.

1·822. Sanitary Engineering Laboratory (A). A continuation of 1·821 dealing with sewage, wastes and sludges. Samples of sewage or other liquid wastes of known analysis will be treated on a laboratory scale to arrive at practical treatment methods to produce plant effluents of specified quality. Plant design factors will be determined and estimates made of costs of treatment. Settling, aeration and chemical treatment will be considered. Samples of sludge of known analysis will be studied in the laboratory to determine practical methods of drying and disposal, costs of disposal and plant design factors. Anaerobic digestion, gas production, various methods of conditioning and drying, and incineration will be considered. To be conducted in parallel with 1·812.

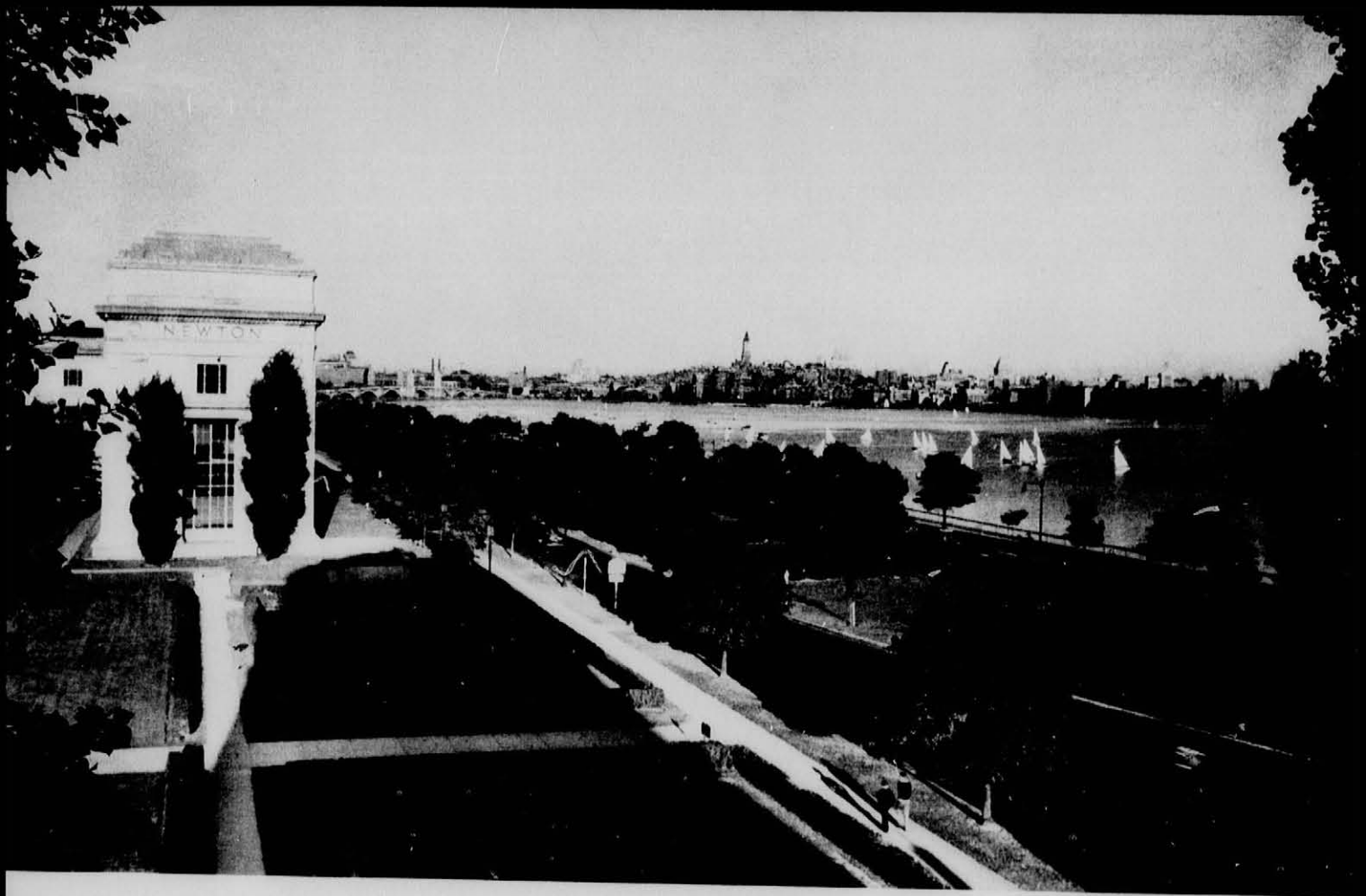
1·851, 1·852. Water Power Design, Advanced (A). (For description see Advanced Water Power Engineering 1·731, 1·732.)

1·881. Sanitary Design, Advanced (A). The design of a modern water treatment plant to effect the proper treatment of a given water for domestic and industrial consumption. Conducted in parallel with 1·811.

1·882. Sanitary Design, Advanced (A). The design of a modern sewage treatment plant to effect the proper treatment of a given raw sewage. Conducted in parallel with 1·812.

The following subject is offered as a General Study. For description see Division of General Studies.

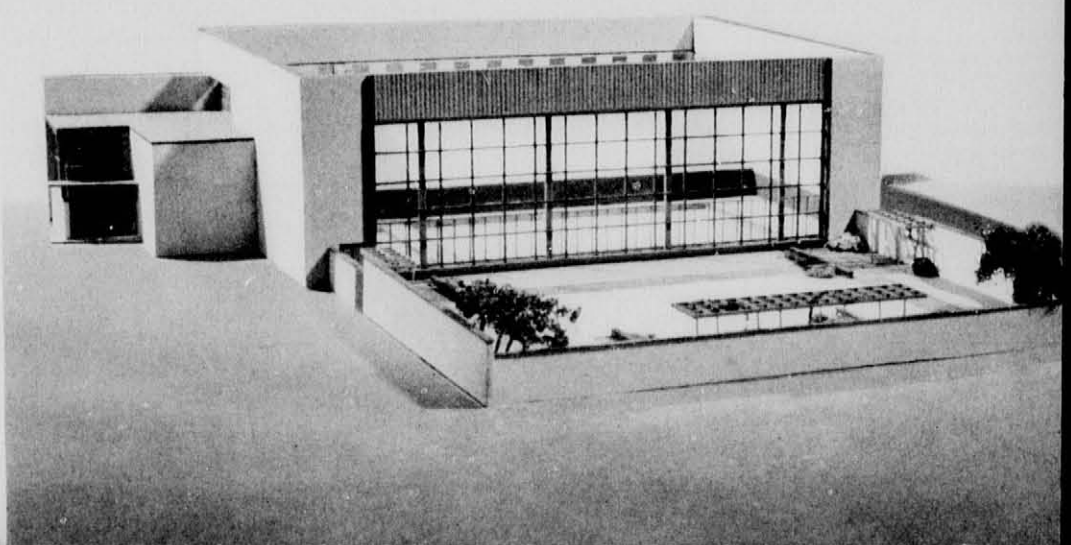
G22. Development of Transportation.


NEWTON


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Above. *The William Barton Rogers Building which houses the School of Architecture as well as laboratories and facilities for other Institute activities*

Below. *Architect's model of the Alumni Swimming Pool completed in the summer of 1949*



2·00, 2·01. APPLIED MECHANICS. *Statics:* Analysis of force systems in two and three dimensions, laws of equilibrium, distributed forces, centers of gravity, moments and products of inertia, application in determination of external forces and internal stresses in simple frames and machine parts. *Kinematics:* The laws of motion applied to rigid bodies and systems of bodies in various types of mechanisms. *Kinetics:* Momentum, energy, work and power. Dynamics of translation and rotation of rigid bodies in plane motion. Fuller and Johnston, *Applied Mechanics, Vol. I.*

2·011. APPLIED MECHANICS. Abridged from 2·00 and 2·01.

2·031. STRUCTURAL MECHANICS, ELEMENTARY. Arranged for students in Courses IV, IV-B and IV-C_1. Includes a study of the fundamental principles of statics, using both analytical and graphical solutions for the determination of the stresses in simple frames and trusses. Formulae are derived for use in figuring the centers of gravity and moments of inertia of plane areas.

2·032, 2·033. STRUCTURAL MECHANICS. An elementary subject in stregnth of materials arranged for students in Courses IV, IV-B and IV-C_1. Deals with the physical properties of materials, simple problems in tension, compression and shear, the common theory of beams, stresses in columns, etc. Also includes a few exercises in the testing materials laboratory.

2·04. APPLIED MECHANICS. *Strength of Materials.* The physical properties of materials; simple stresses, thin cylinders and spheres under fluid pressure, riveted connections; the common theory of bending, including shearing forces and bending moments, the distribution of normal and shearing stresses, the equation of the elastic curve and the determination of slopes and deflections in beams; eccentric loading; stresses due to combinations of axial and transverse loads; theories for determining the strength of columns; the theory of torsion of circular bars; particular emphasis being placed on the application of these theories in the solution of engineering problems. *Applied Mechanics, Vol. II*, Fuller and Johnston.

2·042. APPLIED MECHANICS. Similar to 2·04, arranged for students taking the short preparatory courses.

2·043. APPLIED MECHANICS. A somewhat more comprehensive treatment in the subject of strength of materials than given in 2·04. (For U. S. Naval Officers only.)

2·05. APPLIED MECHANICS. A study of statics, dynamics and strength of materials. (For U. S. Army Officers only.)

2·06. APPLIED MECHANICS. Theory of continuous beams; elementary theory of elasticity applied to cases involving plane stress, with applications to members subjected to combined bending and torsion, helical springs, thick cylinders and plates; theories for determining stresses in non-homogeneous beams and columns, particularly as applied to reinforced concrete; analytical and graphical solutions of some more advanced problems in dynamics. *Applied Mechanics, Vols. I and II*, Fuller and Johnston.

2·061. APPLIED MECHANICS. A more comprehensive treatment of the subject matter of 2·06 with the omission of concrete beams and columns, but including laboratory work in testing materials. (For U. S. Naval Officers only.)

2·07. APPLIED MECHANICS. The study of more advanced problems in engineering mechanics including stresses due to inertia in moving parts of machinery and graphical solutions applied in the field of statics and strength of materials.

2·08. APPLIED MECHANICS. Similar to 2·081. Arranged for students in Course II-A.

2·081. APPLIED MECHANICS (B). A study of dynamical problems in engineering. Harmonic motion. Vibrations of simple systems. Balancing, critical speeds and other problems of high speed rotating machinery. Torsional vibrations. Study of plane motion of rigid bodies about a point with applications to gyroscopes. Miscellaneous problems from modern industry.

2·082. APPLIED MECHANICS (B). A study of problems of mechanical strength in engineering. Failure of metals under stress, plastic flow and creep in their relation to the problem of strength. Applications to cylinders under internal pressure, rotating disks, railroad tracks, transmission lines, steam piping, turbine buckets, and other miscellaneous problems from modern industry.

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. The calculation of stresses in gun carriages, foundations, gear trains, roller bearings, and foundation bolts used in different types of mounts, forms an important part of the subject.

2·11. INDUSTRIAL PLANT ENGINEERING (B). Covers (a) soils and foundations, types of superstructures with some computation of steel and concrete frames; (b) heating and ventilation, air conditioning, and mechanical equipment of buildings; (c) fire protection methods.

2·121. APPLIED PHOTOELASTICITY (B). Instruction and practice in the 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 PHOTOELASTICITY (A). Opportunity is afforded graduate students to apply photoelasticity to the solution of special problems, or to take part in current development of photoelastic theory and technique.

2·131. DYNAMICS OF ENGINES (A). Lectures and drawing-room exercises on the inertia forces and the stresses in the running parts of high-speed gasoline engines. Application is made chiefly to the types of engines used in automobiles.

Mechanical Engineering Continued

2·132. Dynamics of Aircraft Engines (A). An advanced subject given to students having considerable knowledge of engine balancing and practical experience with aircraft engines. (For U. S. Naval Officers only.)

2·151, 2·152. Dynamics. A study of the inertia effects of rigid bodies and systems of bodies in motion other than simple translation or rotation about fixed axes. Begins with general cases of plane motion of extended bodies, and afterwards covers motion in three dimensions, relative motions, and motions about axes whose directions are changing. It deals particularly with the centripetal and gyroscopic couples associated with stabilizing and control devices of interest in torpedo design. (For U. S. Naval Officers only.)

2·201, 2·202. Advanced Mechanics and Theory of Elasticity (A). The fundamentals of the mathematical theory of elasticity in three dimensions developed for application in practical problems in strength of materials and dynamics; including St. Venant's theories of flexure and torsion, stresses in plates, rotating cylinders and shafts, compound cylinders, temperature effects, stresses in curved bars and unsymmetrical bars under flexure, stability of thin rods, plates and cylinders under pressure, vibration, etc.

2·203. Theory of Elasticity. The fundamentals of the mathematical theory of elasticity developed with particular reference to the solution of problems in the field of ordnance engineering. (For U. S. Army Officers only.)

2·211, 2·212. Advanced Mechanical Engineering Problems (A). Analytical treatment of a series of advanced problems in mechanical engineering, which have figured in the industrial developments of recent years. Particular emphasis is given to those aspects which impose limitations on further progress. The course is not devoted to any particular apparatus; its purpose is to develop the scientific approach to various classes of problems in applied mechanics, which appear in many branches of mechanical engineering. A part of the subject is devoted to a general review of those aspects of statics, dynamics, and strength of materials which are necessary for the main subject matter. Representative examples of topics: The problem of mechanical strength in rotating machinery. Problems incidental to the advance of temperature in power plants. Steam piping in power plants. Stresses in railroad tracks. Strength and vibrations of turbine buckets. The problem of vibrations in high speed rotating machinery. Vibration absorbers. The governing of prime movers. Lubrication problems of high speed rotating machinery.

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. The 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. The rolling, drawing, and extrusion of metals. Plastic flow problems in the field of synthetic plastics. Special problems are chosen in consultation with the instructor, and some laboratory work is included.

2·223. Plasticity Research (A). Experimental and theoretical investigations are carried through in the general field of the plasticity of engineering materials.

2·251. Fluid Mechanics. Physical properties of fluids, hydrostatics, aerostatics, continuity, stream lines, Bernoulli's and St. Venant's equations, potential flow, circulation, vortex theory of lift, momentum theorem and principles of hydraulic machinery. Dimensional analysis and theory of models. Boundary layer and skin friction, flow separation.

2·252. Fluid Mechanics. Continuation of 2·251. Laminar and turbulent flow, pipe flow. Convective heat transfer based on fluid mechanics and dimensional theory. Application of laws of viscous flow to lubrication mechanics. Compressibility effects in flow of fluids. Sound intensity, propagation and absorption.

2·253. Fluid Mechanics. The content of 2·251 and 2·252 compressed into one term. (For Course II-A only.)

2·254. Fluid Mechanics. Lectures of 2·251. (Not offered in 1940–41.)

2·255. Fluid Mechanics. Lectures of 2·252. (Not offered in 1940–41.)

2·271. Hydromechanics (A). Mechanics of a continuum, kinematics and dynamics of ideal and viscous fluids, compressible and incompressible fluids, flow in pipe lines, boundary layer, applications to hydraulic machinery.

2·272. Applied Hydromechanics (A). Continuation of 2·271. Potential flow, conformal mapping, flow around a single blade, a series of blades, induced drag, hydraulic machinery, leakage, fluids at high speed, cavitation, experimental methods and results. (Not offered in 1940–41.)

2·273. Advanced Hydromechanics Problems (A). Selected in consultation with the instructor. Theoretical or practical research, design of hydraulic machinery. (Not offered in 1940–41.)

2·30. Engineering Metals. A study of the principles involved in the production of cast metal parts. Lectures cover pig iron, ferrous and non-ferrous alloying, centrifugal casting, die casting, casting design, and inspection methods. Laboratory work consists of demonstration practice and reports on hand and machine molding, core making and testing, sand testing, cupola operation, oil and gas furnace melting of ferrous and non-ferrous metals, permanent mold casting, and the testing of cast metals. *Metal Castings*, Campbell.

Mechanical Engineering Continued

3·31T. Engineering Materials. A study of the manufacture, treatment, properties, and uses of the wrought ferrous and non-ferrous metals, and the more important non-metallic engineering materials, Subjects include the manufacture of wrought iron and steel, wrought non-ferrous metals, hot and cold working processes and equipment, effect of alloys and heat treatment, fatigue, high temperature effects, corrosion, physical properties, metal working calculations; and the properties and uses of timber, cements, concrete, protective coatings, rubber, glass, mechanical fabrics, and plastics. *Engineering Materials*, White.

2·311. Engineering Materials. A consolidation of 2·30, 2·31, and 2·32 particularly adapted to students in Course XIII. *Enigneering Materials*, White.

2·32. Engineering Metals. A study of the fundamentals of the welding processes as applied to manufacturing and construction, and their influence on metals. Processes include manual and automatic A.C. and D.C. arc welding; oxy-acetylene welding; spot, seam, butt, and flash resistance welding; gas cutting, flame machining, and hard surfacing. Emphasis is placed on the general problem of design for welding and on the effect of welding procedure on the properties of welded joints.

2·33. Advanced Engineering Metals (B). A continuation of 2·30, 2·31, and 2·32, involving a detailed study of the more important phases of metal processing.

2·331. Metal Processing. A subject covering problems in the casting, hot and cold working, and welding of metals. Arranged to suit the needs of Naval Constructors. (Open only to students in XIII-A.)

2·332. Advanced Welding Engineering (B). A continuation of 2·32 intended for students who expect to be actively engaged in welding engineering. The subjects covered include metallography of welding, design and strength of welded joints, residual stress effects, welding codes and specifications. *Current Technical Literature.*

2·34. Properties of Metals under Stress (A). An advanced subject on the behavior of metals under tension or compression, with special reference to overstrain and recovery. Methods of interpretation of creep data. The hardness and wear of metals. Effect of combined stresses, both static and dynamic, on the yielding and failure of metals. Photoelastic studies of three-dimensional problems. Laboratory exercises covering these subjects are included.

2·35. Advanced Metals and Testing (B). A study of ductile materials under tension, compression, torsion, and fatigue. Effect of temperature on tensile and fatigue properties. Fatigue under complete and incomplete stress reversals; effect of speed and form. Gerber, Goodman, and Moore empirical laws of fatigue; stress concentration. Basis of choice of working stresses for simple stress and simplified cases of combined stress. Laboratory exercises on points covered by lecture work such as stress concentration, damage effects in fatigue.

2·351. Materials of Engineering. A study of the production and engineering properties of metals, their alloys and the more important non-metallic materials; introduction to tensile and fatigue tests and their relationship to composition; physical metallurgy including alloy diagrams and the effect of hot and cold work and heat treatment. Consideration is given to the suitability and specifications of these materials in design. *Materials of Construction.* Mills.

2·361. Advanced Strength of Materials (A). The subject will embrace more advanced work on the behavior of materials under stress. Experts from outside interests assist the staff members in presenting certain special features. Laboratory exercises are held bearing on the subject matter presented in the lectures. Seminars on related subjects take place at frequent intervals. Two all-day conferences are held, at which representatives from industry present special subjects not covered in the lectures.

2·37. Testing Materials Laboratory. Covers various laboratory methods for determining the physical properties of engineering materials and the interpretation of results of such tests. In addition to the usual study of the behavior of materials under stress, consideration is given to stress analysis by strain determination and by photoelastic methods. A discussion of measuring instruments, X-ray examination, fabrics testing, methods of calibration and special research problems are included in the lecture periods. *Materials Testing.* Cowdrey and Adams.

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. *Materials Testing.* Cowdrey and Adams.

2·373. Testing Materials Laboratory. Covers the material of 2·371, and in addition a three-hour period per week is devoted to the study of cement and concrete. Especially adapted to the Course in Building Engineering and Construction.

2·391, 2·392. Dynamic Strength of Metals (A). A laboratory subject with weekly seminar, devoted to the study and experimental investigation of the strength and life of metals under working conditions. The following subjects will be discussed: fatigue, including influences of surface condition and corrosion; impact; instrumentation for vibration and dynamic stress; inelastic properties and effect on dynamic strength; creep at normal temperatures; wear and corrosion.

2·40. Heat Engineering. The First Law of Thermodynamics and internal energy. The properties of liquids, vapors, and gases. The 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. *Notes on Thermodynamics*, Keenan; *Steam Tables*, Keenan and Keyes.

2·402. Heat Engineering. First and second laws of Thermodynamics, with applications to the properties of

gases, vapors and mixtures. The laws governing the flow of gases and vapors, with applications to boilers, nozzles, orifices, throttle valves, calorimeters, steam engines, steam turbines, gas engines and gas turbines. The laws of heat flow by radiation, conduction and convection, with applications to condensers, evaporators and other heat exchangers. The pressure-volume, temperature-entropy and other planes will be used to simplify the applications of the thermodynamic principles to the solution of heat engineering problems. (For U. S. Naval Officers only.)

2·41. Heat Engineering. A brief study of the fundamental laws and conceptions of engineering thermodynamics; the physical properties of gases, saturated and superheated vapors and their use in thermodynamic problems including the use of steam tables and charts; the laws governing the flow of gases and vapors and their application to heat engineering; elementary steam turbine theory and practice. In discussing the application of the various principles a brief description will be given of the apparatus and machines involved. *Elementary Engineering Thermodynamics*, Taft; *Steam Tables*, Keenan and Keyes.

2·411. Heat Engineering. An abridgment of 2·41.

2·42. Heat Engineering. Discussion of steam nozzles and turbine blading. Steam power plant cycles, including Rankine, reheat, regenerative, and multi-fluid cycles. Study of heat losses in real engines and methods of minimizing these losses. Hot air and internal combustion engine cycles. Humidity, air conditioning, and cooling tower problems. *A Standard Textbook on Thermodynamics; Steam Tables*, Keenan and Keyes.

2·421. Heat Engineering. A study of theoretical vapor cycles; the reciprocating steam engine; theoretical gas cycles and the internal combustion engine; air compressor theory and practice; steam boilers, accessories and combustion. A brief discussion of the principles of refrigeration, heat transmission and humidity problems. Descriptive work as in 2·41. *Elementary Engineering Thermodynamics*,Taft; *Steam Tables*, Keenan and Keyes.

2·422. Heat Engineering. The application of the laws governing the flow of gases, vapors and mixtures in air conditioning, air compressors and refrigerating compressors. Comparison of the freon, carbon dioxide, water and air compression refrigeration cycles. Refrigeration at more than one level. Low temperature refrigeration. Elementary discussion of absorption refrigeration systems. Comparison of insulating materials. Application of refrigeration to food storage. Laboratory classes will supplement lectures whenever practicable. (For U. S. Naval Officers only.)

2·43. Heat Engineering (B). Power absorbing processes. Air compressors, single and multi stage. Heat pumps. Refrigeration processes. Comparison of ammonia, carbon dioxide, water and air compression refrigeration cycles. Refrigeration at more than one level. Voorhees multiple effect compressor. Elementary discussion of the manufacture of solid carbon dioxide.

2·44. Engineering Thermodynamics of Mixtures (A). Study of the thermodynamics of mixtures of ideal gases, of gases and vapors, and of liquids and vapors. Applications are made to internal combustion engines, to the effects of water vapor in air during various processes, and to the problems of separation, distillation, rectification, etc., for different types of mixtures. Pressure-temperature-concentration, enthalpy-concentration, and similar charts are used in connection with problem work.

2·45. Engineering Thermodynamics, Advanced (A). The first and second laws of thermodynamics, their application to fixed mass and steady flow processes and to the determination of the properties of fluids. An introduction to the thermodynamics of solutions and chemical reactions and a study of the equilibrium of a pure substance.

2·451. Advanced Problems in Engineering Thermodynamics (A). Selected in consultation with the instructor. Experimental and analytical studies of the thermodynamic phases of various engineering problems, with emphasis on the properties and behavior of elastic fluids.

2·461. Advanced Refrigeration (A). Use of various equations of state, van der Waals, Dieterici, Keyes, reduced forms, etc., with special application to the liquefaction of air. Thermodynamics of mixtures of gases and vapors with applications to the absorption refrigerating systems and to the separation of gaseous mixtures.

2·462. Heat Transmission, Advanced (A). The variations of surface coefficients, conductivities, etc., under varying conditions; laws of heat transmission as illustrated in steam condensers, feed water heaters, brine coolers, radiators, steam boilers, engine cylinders, cooling of castings, freezing of ice, etc. It includes the solution of problems involving fluctuating and transient temperature conditions.

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.

2·51. Heat Measurements (B). A lecture and laboratory subject dealing with the theory and practical application of temperature measurements and the methods of measuring coefficients of heat transfer such as the conductivity, conductance, transmittance, convection, radiation and surface coefficients.

2·53. Heat Measurements (A). Selected experiments with laboratory investigation of problems connected with the industrial application of heat such as thermal conductivity, thermal expansion, specific heat, ceramics, etc.

2·55. Power Plant Engineering (B). The production and use of steam for the generation of power, including a study of fundamental types of steam boilers, fuel burning equipment, prime movers and their allied apparatus.

2·551. Power Plant Engineering. A consolidation of 2·55 and 2·56 for Course II-A.

Mechanical Engineering Continued

2·56. Power Plant Engineering (B). A continuation of 2·55 with application to problems. Includes the fundamentals of the Diesel and hydraulic power plant.

2·57. Power Plants Advanced (A). An advanced subject on 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. The various steam cycles and types of auxiliary drive will be studied to show their effect on station heat balance. Includes discussion of deaërators, evaporators, condensers, heater, etc., including turbine and machinery foundations and layouts. Lectures and problems will be supplemented by trips.

2·58. Heat Engineering in Industrial Plants (B). Deals with the use of steam in such industrial plants as shoe and rubber factories, paper mills, laundries, hospitals, etc. The general characteristics of such plants, the selection of the heat and power supply and the distribution of steam for power and heating are considered. Problems are presented and solved in connection with the various heat machines in the power plant. Questions in connection with the use and economy of steam for process and heating are thoroughly discussed. Students are required to solve problems from actual plant data. Trips to various industrial plants will supplement the classroom work.

2·59. Torpedoes. Deals with the utilization of energy in the power plant of a torpedo. Includes the thermodynamics of gas and vapor mixtures, the laws of combustion of gaseous mixtures, heat losses, and the laws of heat transmission. The principle of the flow of fluids is applied to the calculation of the time required to decrease the pressure in the air tank, to design gas turbine nozzles and to determine the power developed in the turbine. (For U. S. Naval Officers only.)

2·60, 2·601. Food Engineering. A brief survey of the elementary principles of mechanism, mechanics, heat engineering, heat transfer and refrigeration precedes a discussion of the methods, processes, materials and equipment used in the preparation and handling of foodstuffs, including canning machinery, packaging machines, bottling equipment, conveying systems, temperature and humidity control, bakery installations, etc.

2·621. Refrigeration Engineering (B). Deals with the 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 the important foods; the microbiology of foodstuffs, the nature of their ripening and spoilage, the impurities in the atmosphere.

2·622. Refrigeration Engineering (B). A study of the operation of various types of compressor, evaporators, condensers, and automatic controls used in commercial refrigerating systems. Heat flow problems in condensers and evaporators. Theory and calculation of size of cooling towers. Low temperature refrigeration. The application of refrigeration in the manufacture of water ice, eutectic ice and dry ice. Students present a paper on the application of refrigeration to an industry.

2·63. Storage and Transportation of Foodstuffs (A). A continuation of 2·621 with a study of the refrigeration load and necessary equipment. Trips to near-by plants will be made, where it is possible, to supplement classroom study.

2·64. Refrigeration Engineering (A). A study of thermal, physical, and toxic properties of the chief refrigerants. A discussion of the time required to freeze ice. Application of refrigeration to skating rinks, shaft sinking, petroleum, breweries, and the manufacture of ice cream. Students present a paper on the application of refrigeration to an industry not covered in the lectures.

2·65. Mechanical Equipment of Buildings, Heating and Ventilation. Principles and practice of heating and ventilation; discussion of the various other mechanical equipment of a building, such as elevators, dust collecting systems, etc. Fifteen hours are given over to trips.

2·651. Mechanical Equipment of Buildings. Abridgment of 2·65.

2·66 Heating, Ventilation and 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.

2·671. Air Conditioning, Advanced (A). A study of the 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.

2·672. Heating and Ventilation Design (A). The choice of type of heating and ventilating system for a particular building, layout of piping and duct system together with complete calculations and estimation of cost. An investigation and study of existing plants will be made with trips to these plants, whenever possible, to bring out the practical problems involved in design.

2·680. Engineering Laboratory. The use and calibration of instruments used in mechanical engineering; the practice of heat measurements including heat by combustion and heat transfer; experimental studies involving the 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). A continuation of 2·680 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, heat measurements, a hydraulic turbine.

2·683. Engineering Laboratory. Similar to part of 2·680.

2·684. Engineering Laboratory. Continuation of 2·683.

2·685. Engineering Laboratory. A combination of 2·683 and 2·684.

Mechanical Engineering Continued

2·686, 2·688. Engineering Laboratory. Similar to 2·680. The exercises assigned to the several Courses differ somewhat according to the several fields of interest.

2·687. Hydraulic Laboratory. Supplements classroom theory and includes exercises upon orifices, nozzles, weirs, pipes, hydraulic turbines, centrifugal pumps, and other hydraulic equipment.

2·689. Mechanical Engineering Equipment (B.) A study of various types of equipment with laboratory tests to illustrate methods of determining performance characteristics and operating costs. The equipment used will include steam boilers and engines; internal combustion engines including automotive engines; air fans and compressors; steam and centrifugal pumps. The subject will include a brief discussion of the underlying principles of design, the selection of materials of construction, and oils and lubricants. (For U. S. Army Officers only.)

2·69. Refrigeration and Air Conditioning Laboratory (B). Experiments on, and study of various types of refrigeration, heating and air conditioning equipment. The refrigeration equipment consists of compression and absorption types and includes small commercial and domestic units using ammonia, sulphur dioxide, Freon and methyl chloride refrigerants. A constant temperature room is used in testing units.

2·691. Refrigeration Laboratory (B). Similar to 2·69, omitting air conditioning.

2·692. Refrigeration and Air Conditioning Laboratory (A). Experiments with various refrigeration systems including the application of heating and refrigeration to air conditioning apparatus. Research problems.

2·70. Machine Drawing. Practice in the production of working drawings, including layout, detail and assembly drawings. Instruction is also given in drafting room procedure. *Working Drawings of Machinery*, James, Mackenzie and Sloane.

2·701. Machine Drawing. Engineering drafting room procedure and technique in the production of working drawings of machinery. *Working Drawings of Machinery*, James, Mackenzie and Sloane.

2·71. Theory and Application of Mechanisms. The first portion of the subject consists of a comprehensive study of the theory of mechanisms by means of graphical and analytical methods. Introductory lectures on vector determinations of velocities and accelerations are followed by a discussion of wrapping connectors, cams, linkwork, screws, gear trains, differential mechanisms and gearing, including the theory of conjugate action, methods of production and design of spur, bevel, and screw-gearing. The second portion is of a more advanced character, with special emphasis on such design features as selection of suitable materials, determination of forms and proportions of parts, ease of assembly and repair, friction and provision for wear, etc. Lectures and problems cover the design of machine fastenings, shafting under combined bending and torsion, clutches and brakes, bearings, etc. Certain automotive problems are used to demonstrate the principles discussed. (For U. S. Army Officers only.)

2·72. Machine Design. Diccussion of the theories of common mechanisms, with their application in design. Includes wrapping connectors, screws, spur and bevel gears, worm gearing, shafts, bearings, etc. Materials, forms and proportions of parts, friction and efficiencies are included. (For U. S. Naval Officers only.)

2·730. Machine Design. Lectures and drawing room exercises, covering the kinematic design of the basic mechanisms, such as wrapping connectors, cams, gears, including aggregate combinations, and link work. Serves as an introductory course in machine design by application of the fundamentals of kinematics to geometric design.

2·731. Machine Design. Discussion and design of machine elements with special reference to the selection of materials, proportions of parts and the economies of manufacture and assembly. The subject includes frames, fastenings, flat plates, tanks, and applications to simple machines.

2·732. Machine Design (B). A continuation of 2·731, including shafting, bearings, theory of lubrication, shaft connectors, all forms of gears, flywheels, etc. The work culminates in the complete engineering design of a comprehensive machine.

2·733. Machine Design. Similar to 2·732, particularly adapted to students in the Coöperative Course, II-A.

2·734. Machine Design. Similar to 2·732, with special emphasis on automotive units, especially hydraulic systems.

2·74. Machine Design. A discussion of the principles underlying the design of machine elements, including fastenings, shafting, bearings, belting, gearing, balance wheels, etc. Particular emphasis is laid on the proper choice of materials, methods of manufacture, and rational methods of design.

2·751, 2·752. Machine Design. Advanced (A). A systematic application of the principles of applied mechanics to the design of machines of complicated character. The subjects of centrifugal effects, vibration, balancing, lubrication and combined stresses are treated at considerable length. Lectures and problems on brakes and advanced gear design are also included. *Library research.*

2·761, 2·762. Machine Design. Subjects especially arranged and adapted to the needs of specialists in torpedo design. (For U. S. Naval Officers only.)

2·77. Design of Production Machinery. A discussion of automatic machines used in production work, such as wire working machines, automatic lathes, automatic screw machines, etc.

2·79. Automotive Dynamics (B). A study of the balance of automotive engines and of vibration problems associated with automotive engines and vehicles. *Mechanical Vibration*, Den Hartog.

Mechanical Engineering Continued

2·791. Automotive Engines (B). A study of the fundamental principles of the internal combustion engine, including capacity of two and four stroke engines, efficiency, thermodynamics of ideal and real cycles, combustion and detonation. Lectures and assigned reading are supplemented by laboratory work arranged to emphasize the principles discussed in the class room. *The Internal Combustion Engine*, Taylor and Taylor.

2·792. Automotive Engines (B). A continuation of 2·791. Fuels, lubricants, cooling, carburetion, distribution, ignition, friction and supercharging are studied as applications of fundamental physics and chemistry to the particular problems of the internal combustion engine. Lectures and reading are supplemented by laboratory exercises. *The Internal Combustion Engine*, Taylor and Taylor.

2·793. Automotive Engine Design (B). Based on subject 2·791, but may be taken simultaneously. The lectures cover the fundamental principles of design, and a consideration of materials of construction and dynamic stresses. In the drafting room each student makes computations and assembly drawings of the power section of an automotive engine.

2·794. Automotive Engine Design (B). A continuation of 2·793. The lectures cover the principles of design of cooling systems, fuel systems, accessory drives, etc. In the drafting room the student may design a different type of engine or may continue his first term design in more detail.

2·795. Automotive Vehicles (B). A study of the power plants, transmission systems, running gears, chassis, and bodies of automotive vehicles including developments in domestic and foreign fields.

2·796. Automotive Vehicles (B). Continued study of automotive vehicles including current and future developments. Continuation of 2·795.

2·797. Automotive Engines (B). Same as 2·791, omitting laboratory exercises.

2·798. Automotive Engines (B). Same as 2·792, omitting laboratory exercises.

2·801, 2·802. Advanced Automotive Engine Problems (A). Individual work in research or design by properly qualified graduate students. Problems are selected in consultation with the Instructor, and the hours are arranged to suit the individual case.

2·805. Diesel Engines (A). A study of the fundamentals of the compression-ignition engine, including considerations of air capacity, the charging process, fuel injection, and combustion, from both the design and operation viewpoints. (For Naval Engineering Students only.)

2·806. Diesel Engines (A). A continuation of 2·805. Includes studies of cooling, fuels, lubrication, and installation, with critical examination of existing types. (For Naval Engineering Students only.)

2·82. Diesel Engine Design (B). Lectures and drawing room exercises in the design of oil engines of stationary type. Engines are studied with special reference to the services in which they operate, and to shop methods of construction, as well as to the thermodynamics and mechanical principles of design. Review is made of engine balancing, particularly as applied to large multi-crank engines having pitching couples. A problem is assigned on the design of an engine for a definite service. Inspection trips are made to plants having engines of the type studied.

2·83. Steam Turbine Engineering (B). Thermodynamics, hydrodynamics, and mechanics applied to problems in steam turbine engineering.

2·851. Machine Tool Laboratory. A course in the 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 is given to the cutting angles and adjustments of cutting tools and cutting speeds for each material worked. *Advanced Machine Work*, Smith.

2·852. Machine Tool Practice. A continuation of 2·851. Includes 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. *Advanced Machine Work*, Smith.

2·853. Machine Tool Laboratory. Laying-out work, grinding tools, chipping cast-iron, filing and fitting cast-iron and steel machine parts, alignment and babbitting of bearings, drilling, reaming, counterboring and tapping, grinding drills, soldering. General machine work, including centering straight and taper turning and fitting, screw cutting, chucking, finishing, drilling, tapping, cylindrical grinding, plain and index milling and gear cutting.

2·854. Machine Tool Laboratory. Covers brief parts of 2·851 and 2·852 including instruction in some of the other mechanical processes. *Advanced Machine Work*, Smith.

2·855. Machine Tool Laboratory, Elementary. An abridgment of 2·853 especially adapted to the requirements of experimental physicists. Emphasizes the use of precision tools and hand operations necessary in experimental 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 necessary for the selection of equipment, tool design, production, and inspection. Also study and drawing exercises in tool and fixture design as well as gages. *Principles of Interchangeable Manufacturing*, Buckingham; *Factory Equipment*, Roe and Lytle; *Tool Engineering*, Dowd and Curtis.

Mechanical Engineering Continued

2·872. Preparation for Manufacturing (B). A study of many of the engineering problems which must be solved before a finished article can be manufactured in large quantities after the design of the article has been completed; such as engineering organization, estimating costs of production, the design of tools and equipment, factory extensions, and quality control. The practices of large corporations having the most highly organized engineering departments along these lines will be cited as illustrations and used as the foundation for discussion.

2·88. Metrology and Dimensional Engineering Standardization (A). A study of fundamental units of measure, measuring systems, and calibration of standards; the purpose of measurements in scientific and research work, engineering in general use; a study of conventional measuring instruments, their characteristics and methods of calibration; accuracy of measurements; analysis of measurements; shop measurements and analysis by means of measurement; dimensional engineering standardization; and inspection engineering. *American Engineering Standards, S. A. E. Handbook, Notes prepared for class and Library Research.*

2·901, 2·902. Principles of Fabric Structure (B). A discussion of the properties of fibers as they relate to the properties of yarns and fabrics; the properties of yarns as they relate to fabrics; and the construction and finishing of fabrics to produce certain desirable characteristics in these materials. Will also include material dealing with principles of woven fabric structure together with the formation of knitted, braided, twisted, and felted materials. Structures such as leno, lappet, and swivel, jacquard, pile, and looped fabrics of all sorts will be fully discussed. The details of fabric design and finishing are included with such discussions of mechanisms as are essential to a proper understanding of the details of fabric structure. Mathematical analysis of fabric structure is also included together with the limitations imposed upon the designer in this connection.

2·903. Elements of Textile Manufacturing (B). Deals with the production and properties of textile raw materials and with the operations basic to the manufacture of cotton, wool, silk, flax, jute and rayon.

2·904. Principles of Textile Manufacturing (B). A continuation of 2·903 in which the combination of the operations such as blending, carding, combing, drafting, twisting, etc., into processes as for cotton, woolen, worsted, spun and thrown filament, and bast fiber materials is covered. Involves mill organization studies and a series of plant inspections.

2·905, 2·906. Textile Technical Analysis (A). Deals with the physical determinations of strength, stretch, moisture regain, twist and various mechanical properties of interest to the yarn and fabric technician. The formulation and proper presentation of the data, precision of measurements, graphical interpretation of data, the variable factors which influence textile testing results, and the outlining of present trends in the textile research in this country and abroad are included.

2·907, 2·908. Textile Microscopy (A). The application of optical and microscopical equipment to the technical analysis of textiles. Lectures and laboratory cover the types of equipment, their use and the technique of textile microanalysis for fiber, yarn and fabric. Opportunity is offered for intensive research on projects involving quantitative determinations; the development of technique; the application of photomicrography, polarized light, fluorescence, swelling technique, etc., to textile microscopy. Schwarz, *Textiles and the Microscope. Library References.*

2·911, 2·912. Textile Research Laboratory (A). Opportunity is offered for the student to operate standard textile testing equipment to study the variable factors influencing textile tests and to carry out one or more research problems in the field of physical or optical analysis.

2·92. Principles of Textile Analysis. Lectures, demonstrations and laboratory covering the usual physical and optical analyses of textile fibers, yarns and fabrics. Such subjects as structure, twist, strength, porosity, rigidity, tearing resistance, fastness to light, fastness to washing, fastness to crocking, microanalyses, photomicrography, graphical analysis of data, and report writing are discussed in detail. Schwarz, *Textiles and the Microscope;* Wellington Sears, *Fabric Handbook; Library References.*

2·951 to **2·954.** Manufacturing Practice. These numbers cover the manufacturing work taken by the coöperative students at the plants of the General Electric Company. All students do not necessarily follow the same detailed line of work, neither are they always assigned to the same department. In general, however, the work will be of an investigational and productional nature, rather than of a purely manufacturing calibre.

2·951. Manufacturing Practice. First term's work at General Electric Company.

2·952. Manufacturing Practice. Second term's work at General Electric Company.

2·953. Manufacturing Practice. Third term's work at General Electric Company.

2·954. Manufacturing Practice. Fourth term's work at General Electric Company.

2·96. Study and Research. Original investigation of a selected problem in consultation with the Supervising Engineer for works assignment at plants of the General Electric Company. A comprehensive report of the investigation is to be submitted at the end of the Summer Term to the Department of Mechanical Engineering staff member in charge of the Course.

3·00. INTRODUCTION TO METALLURGY. A series of exercises illustrating the processing of an ore, its reduction and the examination of the resulting metal.

3·01. NON-FERROUS METALLURGY I. Deals mainly with copper, lead and zinc, covering the extraction of the metal from ores and concentrates by pyro-, hydro-, and electro-metallurgical methods and the refining of the crude products. The more general application of such fundamental operations as roasting, sintering, smelting, leaching, etc., is also touched upon. The work of 3·04T is closely coördinated with this subject. Hayward, *Outline of Metallurgical Practice.*

3·02. NON-FERROUS METALLURGY II. Continues the work of 3·01 treating the non-ferrous metals not covered there. Hayward, *Outline of Metallurgical Practice.*

3·03T. NON-FERROUS METALLURGY III. Designed for men who wish special work in some phase of non-ferrous metallurgy. The time may be spent in part in the laboratory, drafting room and library. Each student is allowed to select his own field and will work alone or in collaboration with others. One seminar per week will be arranged for reporting individual progress and to allow general discussion.

3·031. METALLURGY: COPPER AND LEAD (B). Deals mainly with the extraction of the metal from ores and concentrates by pyro- and hydro-metallurgical methods and the refining of the crude products. The principles of the subject are covered in thirty lectures. The remainder of the time is used in the library, laboratory and in conferences. The work in 3·04T is closely coördinated with this subject. Hayward, *An Outline of Metallurgical Practice;* Hofman and Hayward, *Metallurgy of Copper;* Hofman, *Metallurgy of Lead.*

3·04T. METALLURGICAL LABORATORY. The roasting, sintering, smelting and leaching of copper and lead ores are carried out, together with the refining and desilverizing of copper and lead. Practice in the use of various types of electric furnaces is obtained. The production of steel, ferro-alloys, calcium carbide, etc. by electrothermic methods and other pyrometallurgical and electrochemical processes are studied.

3·041. ELECTRIC FURNACES (B). Intended for fourth year and graduate students who desire to obtain some acquaintance with electric furnace operation, without having had any previous training in applied electrochemistry. Thompson, *Theoretical and Applied Electrochemistry and Neostyled Notes.*

3·05. METALLURGY, GENERAL (B). Treats of fuels, refractories, fluxes and slags and their relation to the entire field of process metallurgy. Fundamental principles of roasting, smelting and refining are discussed together with charge calculations, thermal balances and materials balances. Hofman, *General Metallurgy;* Hayward, *An Outline of Metallurgical Practice.*

3·06. NON-FERROUS METALLURGY, ADVANCED (A). For graduate students who have had fundamental courses in non-ferrous metallurgy and wish to continue the study of one or more of the metals. Latitude is allowed in the choice of subject and the time may be adjusted to suit the requirements of the work, which may be a combination of library studies and conferences with laboratory work if desired. The work is confined to production and refining.

3·07. METALLURGY OF COMMON METALS. Designed for engineering students who do not expect to practice metallurgy as a profession. Considers iron and steel, copper, lead, zinc, aluminum, antimony, tin and nickel. The discussion covers 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.*

3·08. GENERAL METALLURGY, ADVANCED (A). Fuels, refractories and the principles of roasting and smelting are studied with greater thoroughness than is possible in the undergraduate courses. A critical analysis is made of the manner in which these principles are carried out in present practice and suggested improvements are discussed.

3·09. METALLURGICAL CALCULATIONS, ADVANCED (A). The reactions involved in various metallurgical operations are studied, with special reference to their thermal values. Heat balances and furnace efficiencies are calculated and a critical study made of the results with a view to suggesting improvements in design or operation of apparatus.

3·10. METALLURGICAL PLANT VISITS. Consists of one week spent in visiting metallurgical plants in New Jersey and Eastern Pennsylvania. The production of iron and steel, zinc, copper, lead and non-ferrous alloys is studied. Students will meet an instructor at a designated place about one week before the opening of the fall term. Recommended for men expecting to register for 3·01, 3·12T or 3·031.

3·11. PRODUCTION METALLURGY. Introductory lectures deal with the general chemistry of metallurgical processes, fuels and refractory materials. Attention is paid throughout the remaining lectures to the world's resources of the various metals and ores with special reference to their production in the United States. In regard to non-ferrous metals, special emphasis is placed on properties and uses, but the basic principles involved in smelting, refining and alloying are described, together with brief descriptions of the various types of furnaces used. About half of the subject deals with iron and steel. The production of pig iron, cast iron, malleable cast iron and the various kinds of steel are gone into. The properties and uses of the various products are discussed. Alloy steels and alloy cast irons are dealt with, and heat treatment is taken up. Opportunity is given to visit a blast furnace, iron foundry, steel casting plant, and a plant with basic and acid open hearth furnaces, blooming mill and finishing mills. (For U. S. Army Officers only.)

Metallurgy Continued

3·12T. METALLURGY: IRON AND STEEL. The production of wrought iron, pig iron, steel and alloy steels is considered in detail. Special attention is paid to the design and engineering operations incident to iron and steel manufacture and to the economic advantages of the various processes. Lectures are supplemented by plant visits which are covered by susbequent reports and seminars. Stoughton, *Metallurgy of Iron and Steel;* Camp and Francis, *Making, Shaping and Treating of Steel.*

3·13T. METALLURGY: IRON AND STEEL. Arranged for U. S. Navy Officers who have had previous work in metallurgy at Annapolis. About half of the subject deals with alloy steels, taking up their manufacture briefly, devoting most time to properties, heat treatment, composition and uses. Alloy cast irons are also taken up. Other lectures deal with specification and inspection, and some work is given on corrosion. Opportunity is given for plant visits. (For U. S. Navy Officers only.)

3·141. METALLURGY: IRON AND STEEL. The class work is simultaneous with 3·12T. Library work and plant visits are omitted. Stoughton, *Metallurgy of Iron and Steel.*

3·15, 3·16. METALLURGY: IRON AND STEEL, ADVANCED (A). Class work, conferences, plant visits and library work, aiming to supplement and to give a more detailed knowledge of the subject than is possible in the undergraduate course.

3·17, 3·18. METALLURGICAL PLANT DESIGN (A). Aims to make the student conversant with some construction details of metallurgical plants. Involves the fundamental calculations for a given problem, the study of detail in working drawings, followed by the preparation of drawings of a plant as a whole and of some of the apparatus in detail, together with a final report.

3·19. METALLURGICAL PLANTS (B). Drafting room, library and conference work. Details of apparatus, plant arrangement and operations are presented at occasional seminars.

3·20T. METALLURGICAL THERMODYNAMICS (B). A short course in thermodynamics emphasizing those portions which are especially useful in metallurgical operation. The free energies of substances at elevated temperatures and the activities of metals in solid and liquid alloys are used in interpreting a number of metallurgical phenomena and in determining the feasibility and limitations of a variety of metallurgical processes.

3·21T. PRINCIPLES OF STEEL MAKING (B). The reactions which are of importance in the manufacture of steel are studied from the viewpoint of physical chemistry. These include reduction of ore, reactions of liquid iron and steel with slags and gases and the chemical effects of alloys and deoxidizing agents. The influence of melting and refining methods upon the properties of the finished product is included.

3·22T. FIRE ASSAYING. The sampling of ore and bullion, the assaying of ores for gold, silver and lead, and of bullions, solutions, matte and miscellaneous furnace products. The fire assay of copper, tin, mercury and platinum is briefly discussed. Typical ores, bullions and solutions are used for analysis; the important standard methods are covered. Stress is laid upon the accuracy of results and the neatness of work and of notes. Bugbee, *Fire Assaying.*

3·23T, 3·24. FIRE ASSAYING, ADVANCED (A). The theory and practice of fire assaying, which includes practice with works methods for gold and silver; the fire assay for tin, mercury and members of the platinum group of metals; also a certain amount of research.

3·30. METALLOGRAPHY. The general methods used in the study of metals and alloys, the construction and interpretation of equilibrium diagrams and the relations between the constitution of alloys and their physical properties are considered. The iron-carbon diagram is studied in detail with its application to the heat treatment and the use of steel and cast iron. Laboratory exercises include the microscopic examination of a series of typical non-ferrous and ferrous alloys. Williams and Homerberg, *Principles of Metallography.*

3·31. METALLOGRAPHY. An intensive study of the non-ferrous metals and alloys, the construction and interpretation of equilibrium diagrams and the relations between the constitution of alloys and their physical properties. The phenomena of plastic deformation, recrystallization, and grain growth are discussed in considerable detail. Laboratory practice is included. Williams and Homerberg, *Principles of Metallography.*

3·32. METALLOGRAPHY AND HEAT TREATMENT. A continuation of 3·31 in which iron, carbon and alloy steels, and cast iron are studied.

3·33. APPLICATIONS OF METALLOGRAPHY (B). Lectures and laboratory conferences designed to familiarize the student with the applications of metallography to industrial problems. In the laboratory the microstructures of normal and defective commercial alloys are examined and discussed. The lectures are devoted to a critical résumé of the fundamentals of modern physical metallurgy which is essential to the proper interpretation of the microstructures.

3·34, 3·35. PHYSICAL METALLURGY, ADVANCED (A). A critical discussion of various subjects falling 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 is paid to the more recent publications on these topics. Students must register for at least six units per term. Additional time may be elected for advanced research problems.

3.36. PHYSICAL METALLURGY. The thermal and microscopic methods used in the study of metals and alloys together with the relations between the constitution of alloys and their mechanical properties are considered. Included are discussions of foundry practice, forging, welding, heat treatment, pyrometry and radiography. (For U. S. Army Officers only.)

3·37. PHYSICAL METALLURGY, ADVANCED. A study of the fundamental properties of metals including the theories

Metallurgy Continued

of metal hardening, the crystalline structure of metals, the relations between alloy diagrams and physical properties, normal and abnormal grain growth and similar topics. (For Army and Naval Officers only.)

3·38, 3·39. Physical Metallurgy, Advanced. A study of the fundamental properties of metals and alloys with particular reference to materials used in torpedo construction. (For U. S. Naval Officers only.)

3·391, 3·392. Properties of Metals. A study of the metallurgical properties of metals and alloys with particular reference to materials used in ship construction. Such topics as the making, microstructure, processing, heat treatment, joining and corrosion resistance of non-ferrous and ferrous alloys are considered. (For XIII-A only.)

3·40. Corrosion and Heat Resisting Alloys (B). A study of metals and alloys with respect to corrosion and heat resistance, including a discussion of inter-crystalline failure, corrosion protection, creep and selection of materials.

3·41. Light Alloys (B). A detailed study of the structure, properties, heat treatment and uses of alloys of aluminum, magnesium and beryllium.

3·42. Powder Metallurgy (B). The physical and chemical methods for the production of metal powders are considered. The pressing and annealing of alloy powder compacts and the resulting properties of the finished compact are stressed. Problems of adhesion, diffusion, recrystallization and grain growth as they apply to this field are treated in detail. Present industrial applications of powder products are included.

3·422. Powder Metallurgy Laboratory (B). Laboratory work and conferences to familiarize the student with powder metallurgy practice and its application to industrial problems.

3·43. Heat Treatment. Conferences and laboratory work dealing with the effect of heat treatment and hot and cold work upon the physical properties of metals used in torpedo construction. (Open only to officers of the U. S. Navy taking Torpedo Engineering.)

3·50. X-ray Metallography (B). Deals with the use of X-rays in the study of metals. Includes radiographic examination of metal parts, as well as the X-ray diffraction study of the atomic and granular structures of metals, and their relations.

3·51. Physics of Metals (B). A discussion of the modern theories of the metallic state resulting from a study of the physical properties of metals.

3·52. Physics of Metals, Advanced (A). A discussion of various problems of the crystalline metallic state and the dependence of physical properties upon structure. Experimental methods of obtaining information in this field are considered. Laboratory work in the form of short research problems is available.

3·60. Ferromagnetism (A). A study of the outstanding properties of ferromagnetism materials, their interpretation, and the application of ferromagnetism to the investigation of the physical structure of metals. (Not offered in 1940–41.)

3·61. Atomic Arrangements in Alloys (A). Covers a few applications of statistical mechanics and thermodynamics to alloys. The discussions begin with a brief introduction to the fundamental concepts, and proceed to those applications which seem of most interest to the class. Topics include problems of order and disorder in alloys, ferromagnetism, phase changes and nonequilibrium states.

3·62. Special Problems in the Physics of Metals (A). Advanced theoretical or experimental work on a problem in the physics of metals.

3·70. Ceramics. An introduction to the more advanced ceramic subjects. The selection of ceramic materials, molding, drying and burning are taken up, as well as the physical properties of finished products. Commercial processes are carried out on a small scale.

3·71. Optical Ceramics (B). Primarily a laboratory subject in which the methods of petrography are applied to the study of ceramic products and raw materials, such as clay, cement, glass, porcelain, refractories, etc.

3·73. Fundamental Ceramic Processes (A). Covers the theory and practice of forming, drying and burning of clay articles, such as white wares, refractories, terra cotta, etc. The principles involved in the manufacture and use of glass, cements and abrasives are also discussed. The principles of kiln and furnace design are discussed and practical examples are analyzed.

3·74. Physical Properties of Ceramic Products (A). Includes the various methods of determining the properties of finished ceramic articles. The influence of manufacturing methods on these properties is taken up in order to bring out effective methods of control.

3·75, 3.76. Special Problems in Ceramics (A). For graduate students who desire to do advanced work in this field on some topic not specifically covered elsewhere. The student makes his own choice of topic and the allotment of time. The latter may be devoted to lectures, conferences, assigned readings, or laboratory work.

3·78. Ceramic Molding Processes. This subject is intended to introduce discussions on the various up-to-date methods used in forming clay wares. There have been a number of recent developments in this field. Some of these new processes and the equipment used to carry them out will be described. A number of laboratory experiments designed to familiarize the student with modern apparatus and equipment for carrying out laboratory tests will be conducted.

3·81. Mineral Dressing I. An introduction to the dressing of minerals, ores, and coals, from the unit-process point of view, with emphasis on the physical, chemical and economic principles involved. The processes studied include crushing, grinding, screening, classification, gravity concentration, flotation, amalgamation, magnetic separa-

Metallurgy Continued

tion, thickening, filtration, and sintering as well as other processes of lesser importance. Gaudin, *Principles of Mineral Dressing.*

3·82. Mineral Dressing II. A continuation of 3·81.

3·83. Mineral Dressing Plant (B). A detailed study of mineral dressing apparatus and equipment for the various processes studied in 3·81 and 3·82. Richards and Locke, *Textbook of Ore Dressing.*

3·84. Mineral Dressing Practice (B). Deals with principles of arrangement, location, and operation of mills; also with mill costs, general economics of dressing operations, typical flowsheets, and fundamentals of design. Richards and Locke, *Textbook of Ore Dressing.*

3·85T. Flotation (B). A study of the flotation process and of its applications to ores, minerals and coals. Gaudin, *Flotation.*

3·86T. Comminution (B). A study of the fundamentals of crushing and grinding. Particular consideration is given to the characteristic properties of the products obtained.

3·87. Quantitative Mineragraphy (B). The mineralogical study of ores and minerals from the point of view of their dressing or subsequent processing. The ores or minerals are studied in polished section, thin section, as loose grains or as polished briquettes. The emphasis is on the quantitative and dimensional aspects of textural and structural relationships.

3·88. Ore Testing (B). Practice in choosing concentration methods for specific ore samples, in developing laboratory dressing technique, and in preparing and writing reports.

3·89. Mineral Dressing Design (A). The working out of 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). Topics selected according to the needs of the students are discussed informally. Examples of suitable topics are afforded by the following fields: 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.

3·91. Mineral Dressing Seminar (A). Selected topics are presented by the students in the field of Mineral Dressing.

ARCHITECTURE

Subjects 4·00 to 4·99

4·021, 4·022. Freehand Drawing. Drawing from simple geometrical solids in pencil, graphite crayon, and wash, to give an understanding of form and its graphic expression after which these and similar simple forms are used in elementary exercises in composition. Exercises are also given in sketching and rendering as applied to architectural subjects.

4·031, 4·032. Freehand Drawing. A continuation of 4·022. The first eight weeks of the year are spent at the Boston Museum of Fine Arts in studying and analyzing the design of simple architectural and sculptural forms. Basic figure construction and anatomy are given, followed by quick sketching direct from the human figure.

4·041, 4·042. Freehand Drawing. A continuation of 4·032. The first four weeks of each term are spent in figure sketching. Problems are given which involve the relationship of drawing techniques to problems in design and materials.

4·051, 4·052. Freehand Drawing (B). A continuation of 4·042. A limited amount of figure sketching is done followed by more advanced problems in design and materials with special reference to an architectural application.

4·053, 4·054. Freehand Drawing (A). A continuation of 4·052. Problems are fitted to the needs of the individual student and are of an advanced nature. Open only to graduate students or others who demonstrate fitness for advanced work.

4·06. Graphics. The fundamental conceptions of orthographic projections and fundamental problems on lines, planes and solids with supplementary exercises in the application of the principles of descriptive geometry to problems of an architectural nature.

4·071, 4·072. Modeling. Aims primarily to develop the student's sense of a third dimension in his study of architectural composition. Sketch exercises in modeling wax upon a given program of an architectural character.

4·081, 4·082. Color, Composition, Theory and Application. Aims to familiarize the student with the theories of color composition and to give him practice in the use of color.

4·091, 4·092. Color, Composition, Theory and Application (B). A continuation of 4·081, 4·082, the problems being of a more architectural character.

4·11. Shades and Shadows. Fundamental knowledge necessary for casting the conventional shadows employed in architectural design. Drawing-room work in the nature of test exercises based on textbook preparation. Covers the application of descriptive geometry methods and also short methods of construction useful in practice. *Notes on Shades and Shadows*, H. W. Gardner.

Architecture Continued

4·12. Perspective. General theories of perspective and the methods of revolved plan and perspective plan. Practical work involving variations, short cuts and office manipulations. *Principles of Architectural Perspective*, Lawrence.

4·312. Abstract Design. Exercises in the general principles of composition as applied to architectural subjects decorative in character.

4·421, 4·422. Architectural History. Lectures, illustrated by stereopticon, covering the periods of Egyptian, Assyrian, Persian, Greek, Roman, Byzantine, Gothic, Renaissance and Modern Architecture, supplemented by reference reading, theme writing, and group conferences.

4·43. Architectural History. Similar to 4·421 and 4·422 but shorter. It is conducted in substantially the same way and covers the same subject matter in less detail.

4·461, 4·462. European Civilization and Art: Classical and Medieval Culture. Constitutes a history of culture, mainly that of Europe. The main currents of science and philosophy are considered; but emphasis is upon literature, sculpture and painting. Lectures, readings, and reports.

4·471, 4·472. European Civilization and Art: the Renaissance and the Seventeenth Century. A continuation of 4·462.

4·481, 4·482. European Civilization and Art: the Eighteenth Century and Modern Culture (B). A continuation of 4·472.

4·491, 4·492. European Civilization and Art (A). Selected topics in the history of culture. Supervised study, with conferences, readings, and reports but without lecture hours, for graduate students.

4·50 to **4·52.** Office Practice. These subjects cover the work taken in the offices of planning commissions by students in the Course in City Planning Practice. Each of the three periods of office practice is undertaken in a different office, the assignments being at the discretion of the instructor in charge of the Course. Problems in design or research are assigned which have a definite relation to the activities of the planning commission concerned, and the work is supervised at regular intervals by an instructor.

4·50. Office Practice. First term's work with the City Planning Board of Boston.

4·51. Office Practice (B). Second period of office practice to be given in one of the following offices: Division of Metropolitan Planning (Boston), the Massachusetts State Planning Board, the New England Regional Planning Commission, the State Board of Housing.

4·52. Office Practice (A). Third and final period of office practice in one of the offices listed under 4·51, the work required in research or design being of an advanced nature.

4·53. Professional Relations (B). Designed to give an understanding of the professional character of the practice of architecture. In it are discussed the personal, ethical, business and legal relations of the architect with clients, builders, craftsmen, engineers, etc., with whom he has to work in the practice of his profession; the relations that should exist between the architect, his professional organizations and the community in which he lives. References are made to legal handbooks upon the laws governing architecture and building, and to the various documents that are issued by the American Institute of Architects. The course includes a number of lectures by individual lecturers selected for their professional standing and accomplishments. *Handbook of the Professional Practice, American Institute of Architects.*

4·541, 4·542. Housing Seminar (A). Offered under the joint direction of members of the Faculty Housing Committee. Through lectures coupled with seminars conducted by specialists in the fields of sociology, economics, city planning, architecture, building construction, and public health, it will survey the field of Housing. The subject will include a general introductory discussion of the housing problem; an intensive development of concepts and relationships in housing from social, technical, economic, and administrative points of view; an historical survey with special critical attention directed to contemporary solutions in Europe and the United States, to be followed by considerations of present social and economic trends and their future implications. Students will be expected to augment their preparation for seminar discussion through case studies. Open only to a limited number of mature students selected by the Faculty Housing Committee.

4·60. Planning and Housing Legislation (A). 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.

4·611. Principles of Planning. This subject consists of a series of lectures and seminars on the objects and scope of city and regional planning and the elements that go to make up a comprehensive plan for the physical development of a city or region. Specific problems of transportation, housing, recreation and zoning are briefly discussed during the second week.

4·612. Planning Techniques. This subject is designed to present the procedure followed by the planning technician in the development of a comprehensive plan, including the surveys, the preparation of the plan itself and the problems involved in its execution. Consideration is also given to the use of zoning and subdivision control in carrying out the objectives of a master plan.

4·613. Planning Administration. This subject consists of lectures and seminars on the principles of organization and administrative procedure in the carrying out of comprehensive plans and zoning ordinances for towns, cities, and regions.

4·614. Planning Legislation. This subject covers briefly the legal aspects of both planning and zoning, including enabling legislation, municipal and county ordinances for zoning and subdivision control, private deed restrictions, etc.

Architecture Continued

4·62. Site Planning and Construction. A subject primarily for students in City Planning, in which problems in site planning are studied with emphasis on the relations to physical conditions, landscape construction, and costs. Problems dealt with include the 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). The major portion of the subject is devoted to the preparation of site and utility plans for a specific project.

4·63. City Planning Administration (A). Organization and administration of planning projects in state, county, region, and city; getting citizen and official interest and sanction; securing appropriations for preparation and carrying out the plan; different problems found in each area and how to meet them; sources of coöperation and how to secure their interest; adaptation of material to newspaper use and public participation; the form of maps most useful for getting public understanding of the proposals and their intent; dramatization of planning.

4·641. Principles of City Planning. The historical background of the modern city planning movement is presented in a series of lectures on the planning of ancient, medieval, Renaissance, and modern towns. The subject deals with the evolution of the modern city and the relation of architecture to problems of city development and civic design, concluding with a discussion of fundamental principles of city and regional planning. *Outline of Town and City Planning*, Thomas Adams.

4·642. Theory of Site Planning (B). Lectures and class exercises supplementing the corresponding work in design and closely related to it. *Design of Residential Areas*, Thomas Adams.

4·651, 4·652. Theory and Practice of City Planning (B). Advanced problems of city and regional planning are studied, together with modern methods of dealing with them. Collateral reading, written reports, and round table discussions are essential features of the subject.

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, for graduate students.

4·672. City Planning Design (B). Application of the principles of site planning to the design of elements in the community pattern including the design of housing groups, shopping centers, and recreational areas.

4·681, 4·682. City Planning Design (B). The practical application of city planning theory to the design of towns, cities, and regions. Individual problems are supplemented by group projects worked out in collaboration, and preliminary and final reports are considered essential accompaniments to each developed study.

4·683. City Planning Design (B). A subject especially arranged for students in Option 2, Course IV-C.

4·691, 4·692. City Planning Design, Advanced (A). A continuation of the undergraduate subject 4·682.

4·694. City Planning Design, Advanced (A). Arranged for students in Course IV-C. A continuation of 4·691.

4·711, 4·712. Architectural Practice. Lectures explaining the scope of architectural practice, the methods and operations within the architect's office, the principles governing the preparation and use of working drawings, shop drawings, scale and full size details and specifications, together with a discussion of the principal building materials and their use. Exercises in the drafting room to give the student some experience in the preparation of working drawings, scale and full size details, ink tracing on cloth, and the layout and use of site contours. Field work covering the use of the stadia method for determining the contours of a specific site. Visits to shops and to buildings under construction, followed by written reports and class discussion.

4·721, 4·722. Architectural Design II. Problems in architectural composition as applied to buildings of simple requirements and varied character. Carried on by means of eight hour sketch exercises in the form of sketch problems without criticism. Some of these are further developed to a final result in a period of from three to five weeks.

4·731, 4·732. Architectural Design III. A continuation of 4·722. The sketch problem exercises are of twelve hours' duration and the problems more advanced in character.

4·741, 4·742. Architectural Design IV. A continuation of 4·732.

4·751, 4·752. Architectural Design V (B). A continuation of 4·742 in methods, the character of the problems being of an advanced nature.

4·761, 4·762. Architectural Design VI (A). A continuation of 4·752.

4·78. Planning Principles. A study of the 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, axial development and balance.

4·811. Construction. Methods of analysis and computation, required in elementary architectural construction, treating of the theory of construction, loads, reactions, the design of beams, columns and various details, a wooden roof truss, slow burning construction. *Mimeograph Notes.*

4·812. Construction. A continuation of 4·811 including simple steel framing, the plate girder, and the elements of design in reinforced concrete. *Mimeograph Notes.*

4·93. General Science. Lectures and classroom discussions on the principles, methods and applications of chemistry and the ways in which these have influenced the progress of culture and our conduct, materials, and mode of life.

4·94. General Science. Lectures and classroom discussions of the fundamental laws of physics and of applications of physics to problems of interest to architects,

Architecture Continued

particularly in the fields of light, sound, and electricity. The treatment is semi-quantitative and makes but limited use of trigonometry and calculus.

THESIS RESEARCH (A). To enable the student to make an investigation leading to his choice of a thesis problem subject and organize the essential data into a complete statement of his program for this exercise.

The following subjects are offered as General Studies:

G24. DEVELOPMENT OF COMMUNITY PLANNING.

G45. AN INTRODUCTION TO ARCHITECTURE.

G64. FINE ARTS.

G65. EXPRESSIONS OF GRAPHIC ART.

G66. THE ARTS OF THE BOOK.

G67, G68. DESIGN IN MANUFACTURED PRODUCTS.

CHEMISTRY

SUBJECTS 5·00 TO 5·99

INORGANIC CHEMISTRY

UNDERGRADUATE SUBJECTS

5·00. CHEMISTRY, ENTRANCE. Lectures, recitations and laboratory given during the summer to cover the entrance recommendation in chemistry.

5·01, 5·02. CHEMISTRY, GENERAL. The fundamental principles of chemical science and the descriptive chemistry of the more common elements and their important compounds. Blanchard, Phelan and Davis, *Synthetic Inorganic Chemistry*.

5·04. CHEMISTRY. Lectures, demonstrated by experiments, covering a review of inorganic chemistry with special attention to principles and the fundamentals in inorganic chemistry. *Mimeographed Notes;* Smith-Kendall, *College Chemistry*. (For U. S. Army Officers only.)

5·061, 5·062. INORGANIC CHEMISTRY (B). Presents in a correlative manner the physical and chemical properties of the elements and compounds. The attempt is made to systematize as far as possible the facts of inorganic chemistry with the aid of a comparatively small number of generalizations. Time is devoted to the discussion of recent theoretical and experimental investigations in this field.

GRADUATE SUBJECTS

5·071, 5·072. SEMINAR IN INORGANIC CHEMISTRY (A). Special topics in inorganic chemistry such as the chemistry of the less common elements, the more complex reactions of the more common elements, reactions in nonaqueous solvents, and the application of modern research tools to inorganic investigation.

5·08. INORGANIC LABORATORY, ADVANCED (A). Intended to acquaint the student with typical research methods, including such procedures as the employment of high vacuum technique, the conduct of operations in inert atmospheres and in non-aqueous media, the isolation of compounds of the rarer elements, etc. In all cases reference to the original literature is required for experimental details.

ANALYTICAL CHEMISTRY

UNDERGRADUATE SUBJECTS

5·10. QUALITATIVE ANALYSIS. Preliminary experiments illustrate principles and give practice in writing equations and in manipulation. Analysis of simple substances and industrial products such as minerals, pigments, slags and alloys.

5·11. QUALITATIVE ANALYSIS. Abridgment of 5·10.

5·12. QUANTITATIVE ANALYSIS. Volumetric and gravimetric analysis, illustrating the more important typical processes. Special attention is given to manipulation, stoichiometry and modern theories of solution.

5·13. QUANTITATIVE ANALYSIS. Continuation of 5·12. A correlative study of the 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.

5·14. ANALYTICAL CHEMISTRY. The chemistry of the more important rarer elements with special reference to methods of separation, identification, and quantitative determination. Discussions of other special topics in Analytical Chemistry such as laws governing co-precipitation, the theory of indicators and the principles underlying potentiometric titrations. A substantial part of the subject is conducted as a seminar.

5·141. ANALYTICAL CHEMISTRY. Instrumental methods of analysis. Chemical applications of the microscope, including microchemical qualitative analysis, spot tests, and the identification of crystalline material by the polarizing microscope. Use of the spectrograph, polariscope, colorimeter, and refractometer.

5·16. ANALYTICAL CHEMISTRY. Special methods designed for laboratory conditions of the practice school in Chemical Engineering.

5·35. APPLIED CHEMISTRY. The theoretical principles underlying the causes of corrosion and preventive measures by means of protective coatings.

Chemistry Continued

ORGANIC CHEMISTRY

UNDERGRADUATE SUBJECTS

5·41. Organic Chemistry I. The fundamental principles of the chemistry of the carbon compounds, based on a study of important substances of the aliphatic, aromatic, and heterocyclic divisions.

5·412, 5·413. Organic Chemistry and Laboratory. The laws and principles of organic chemistry derived from the study of the important classes of compounds. Laboratory experiments include syntheses of representative substances, and the use of reactions for classification and identification. Numerous problems are employed, and much individual instruction is given. (For U. S. Army Officers only.)

5·414, 5·416, 5·418. Organic Preparations. Laboratory practice in standard techniques of synthetic organic chemistry. (Correlative with Organic Chemistry I 5·41.)

5·417. Quantitative Organic Analysis. Determinations of carbon, hydrogen, nitrogen, halogens and sulfur by semi-micro methods of analysis; conferences and discussions.

5·42. Organic Chemistry I. Amplification and extension of 5·41.

5·424, 5·426. Identification of Organic Compounds. Theory and practice in systematic methods of organic qualitative analysis. (A special experimental problem is also included in 5·426.)

5·428. Organic Chemistry Laboratory. Preparations, class reactions and identification of typical organic compounds.

5·43. Powder, Explosives and War Agents (B). Chemical preparation, testing, history and use.

GRADUATE SUBJECTS

5·51T. Functional Groups in Organic Chemistry (A). A broad survey of methods for introducing the various functional groups into organic molecules and of the characteristic reactions of such groups, with particular reference to the influence of environmental factors in each of these aspects of organic chemistry.

5·52T. Mechanism, Structure, and Reactivity in Organic Chemistry (A). Factors, both chemical and physical, which contribute to knowledge in the above fields are discussed.

5·53T, 5·54T. Special Topics in Organic Chemistry (A). The chemistry of heterocyclic compounds, carbohydrates, cellulose, dyes, hormones, vitamins, proteins, terpenes, resins, tannins and rubber are discussed by members of the staff.

5·55. Identification of Organic Compounds (A). The study of systematic methods of organic qualitative analysis including treatment both of individual compounds and mixtures.

5·56T. Structure in Organic Chemistry (A). The mechanism of organic reactions to the extent that it can be inferred from structural evidence. The primary assumptions of structural chemistry. Effect of groups on reactivity. Tautomerism, the electronic interpretation. Pseudo acids and pseudo bases. Markovnikov's rule. Aromatic substances. Conjugate systems, unsaturated ketones, etc. Quinones. Condensations. Ester formation. Nitroamines. Azo- and diazonium compounds. The single carbon atom in prussic acid, cyanic acid, thiocyanic acid, cyanamide, urea, guanidine. The organic pseudo halogens.

5·581, 5·582. Advanced Organic Laboratory (A) Experiments on fractionation, molecular distillation, chromatographic adsorption, micro manipulation, with organic synthesis of an advanced nature. The purpose is to insure a well-rounded knowledge of all types of micro and macro manipulation.

5·591, 5·592. Recent Advances in Organic Chemistry. Discussion of current topics by the staff.

PHYSICAL CHEMISTRY

UNDERGRADUATE SUBJECTS

5·61. Physical Chemistry I. Pressure-volume relations of gases; properties of liquids; general properties of solutions; laws of thermodynamics; thermochemistry; chemical 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. Abridgment of 5·611.

5·62. Physical Chemistry II. Continuation of 5·61. Phase equilibrium, kinetics of chemical reactions; transference; conductance; free energy of chemical changes; electromotive force of cells.

5·621. Physical Chemistry Laboratory II. Laboratory coördinated with the topics of 5·62.

5·622. Physical Chemistry Laboratory II. Abridgment of 5·621.

5·63. Introduction to Thermodynamics (B). Units; fundamental ideas; first law and applications; second law and applications; uses of the thermodynamic functions; ideal and real gases and gas mixtures; chemical equilibrium, univariant systems; ideal and real solutions; voltaic cells; free energy calculations. Noyes and Sherrill, *An Advanced Course in Instruction in Chemical Principles.*

5·64. Introduction to Radiation Chemistry (B). Deflection of charged particles; the identification of isotopes; X-ray spectra and optical spectra of atoms; atomic structure and periodic table; elementary quantum mechanics.

5·642. Radiation Chemistry (A). Introduction to molecular structure. Correlation of spectra with molecular structure and reactivity.

Chemistry Continued

5·66. Surface and Colloid Chemistry (B). Structure of surfaces; surface and interfacial tensions: adsorption; 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.

5·683. Physical Chemistry, Elementary. For students specializing in mechanical and aeronautical engineering.

5·684. Physical Chemistry, Elementary. For students specializing in biology, public health, and sanitary engineering. Gillespie, *Physical Chemistry*.

GRADUATE SUBJECTS

5·71, 5·72. Physical Chemistry (A). For graduate students who have not had the equivalent of 5·61 and 5·62. Noyes and Sherrill, *An Advanced Course of Instruction in Chemical Principles*.

5·741. Advanced Radiation Chemistry (A). Introduction to molecular spectra and the application to thermodynamic calculations and to molecular structure.

5·742. Statistical Mechanics (A). Statistical Mechanics and the theory of intermolecular forces with applications to the equation of state problem.

5·76. Thermodynamics and Chemistry (A). The development of equations for the treatment of chemical reactions and of equilibria in chemical systems. Gibbs, *Thermodynamics*.

5·77. Thermodynamics and Chemistry (A). The phase relations for heterogeneous systems are treated, special attention being given to binary mixtures. Roozeboom, *Die Heterogenen Gleichgewichte*.

5·79. Theory of Solutions (A). The properties of solutions are related to those of the components, with special emphasis on solutions of strong electrolytes.

SPECIAL TOPICS IN CHEMISTRY

5·82. Chemical Literature. Methods of using the journals, books and indexes.

5·83. History of Chemistry (B).

5·844. Engineering Chemistry. A survey of qualitative and quantitative analysis. Particular reference to the analysis and properties of cement, concrete, alloys, paints, pigments, varnishes and other building materials. (For students specializing in Building Construction.)

RESEARCH

5·911, 5·912. Journal Meeting in Inorganic Chemistry (A).

5·921, 5·922. Journal Meeting in Organic Chemistry.

5·931, 5·932. Journal Meeting in Physical Chemistry.

5·941, 5·942. Research Conferences in Organic Chemistry.

5·943, 5·944. Research Conference in Physical Chemistry.

5·945, 5·946. Research Conference in Inorganic Chemistry.

Thesis. Minor researches to test ability to do work of an original character. Written reports and conferences are required and a formal record must be presented for acceptance. The student may select a problem in inorganic, analytical, organic or physical chemistry. Minimum, 32 units.

5·98. Research (A). Research for any of the advanced degrees in inorganic (including analytical), organic or physical chemistry.

ELECTRICAL ENGINEERING

Subjects 6·00 to 6·99

6·00. Principles of Electrical engineering. Derivation of linear circuit theory; calculation of circuit parameters; study of resistance networks; transient and steady-state behavior of simple circuits having suddenly-impressed constant or sinusoidal voltages or currents; association of engineering ideas and applications with the treatment of principles, as far as is feasible. *Electric Circuits* by members of the Department Staff.

6·01. Principles of Electrical Engineering. A treatment of steady-state and transient behavior of linear multibranch circuits having suddenly-impressed sinusoidal voltages and currents, including the use of circle diagrams, the study of polyphase circuits and the method of symmetrical components; simple electromechanically-coupled systems; association of engineering ideas and applications with the treatment of principles, as far as is feasible. *Electric Circuits*, by members of the Department Staff.

6·01T. Principles of Electrical Engineering. Study of steady-state and transient behavior of linear multibranch circuits having suddenly-impressed sinusoidal voltages or currents, including the use of complex function loci, the properties of polyphase circuits, and the method of symmetrical components; simple electromechanically coupled systems; steady-state and transient behavior of simple circuits containing non-linear elements; properties of magnetic materials; magnetic circuits; association of engineering ideas and applications with the treatment of principles as far as is feasible. *Electric Circuits* and *Notes* by members of the Department Staff.

6·02T. Principles of Electrical Engineering. Transformers for power and communication circuits; engineering electronics including the internal phenomena of vacuum and gas tubes, and the analysis of circuits containing such tubes; single-phase and polyphase rectifiers,

Electrical Engineering Continued

amplifiers, oscillators, modulators, and demodulators. *Special Notes* by members of the Department Staff.

6·03. Principles of Electrical Engineering. Transformers for power and communication circuits, rotating magnetic fields, synchronous and induction machines. *Special Notes* by members of the Department Staff.

6·03T. Principles of Electrical Engineering. Polyphase synchronous and induction machines, single-phase alternating-current motors, synchronous converter. *Special Notes* by members of the Department Staff.

6·031. Principles of Electrical Engineering. Transformers for power and communications circuits, rotating magnetic fields, synchronous motors and generators, synchronous converter, polyphase and single-phase induction machines, mercury-arc power rectifiers. *Special Notes* by members of the Department Staff.

6·031T. Principles of Electrical Engineering. Covers same field as 6·031.

6·04. Principles of Electrical Engineering (B). Parallel operation of alternators, synchronous converter, mercury-arc power rectifier, single-phase induction motor, special-purpose alternating current motors, a general survey of transmission-line problems, calculation of line constants, short-line solutions, skin effect, corona, insulator stresses and insulation breakdown, hyperbolic-function solution of long-line problems, graphical methods, circle diagrams, inductive interference, transients, system stability, solution of networks. *Special Notes* by members of the Department Staff and Woodruff, *Principles of Electric Power Transmission and Distribution, 2d edition.*

6·09. Introduction to Electrical Engineering. Lectures and laboratory exercises designed to describe the field of activity of the Electrical Engineer, and the preparation in science, mathematics, economics, and engineering which the practice of the profession requires.

6·11. Principles of Electrical Engineering. Elements of vacuum- and gaseous-tube characteristics and of circuits containing such tubes for the purpose of rectification, amplification, and oscillation. Elements of theory and study of operating characteristics of direct-current motors and generators, transformers, induction motors, synchronous motors, and generators.

6·211. Applications of Electricity in Industry (B). A treatment of electricity in industry, establishing a scientific basis for its modern applications. 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 in 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.

6·221, 6·222. Electric Power Generation (B). The economics and the technique of electric power generation. The 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. The effect of the characteristics of the load curve on cost of generation. Thermal efficiency and commercial economy of various heat cycles. The general layout of the generating station. The calculation of fault currents and the operation of protective devices. The division of load among generating units for minimum cost. The interrelation between steam and hydro generation. By-product generation. Joint operation of industrial and central-station plants. Energy storage systems.

6·241, 6·242. Electric Railways (B). The mechanics of traction, calculation of speed-power-distance-time curves, factors affecting train resistance, energy consumption and power demand as influenced by weight, speed and equipment design, power distribution circuit, division of loads between substations, determination of substation demands and spacings, and motor characteristics and control. The foregoing is studied relative to local and trunk-line transportation.

6·251. Electric Machinery Design (B). Transformers and induction motors. Materials of construction, methods of construction, calculation of electrical characteristics, eddy-current losses in the windings, and the 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. A continuation of 6·251 but also complete within the term.

6·26. Electric Insulation (B). The fundamental laws of electric insulation and their application in electrical engineering. An introductory, but comprehensive treatment aimed at a general orientation in the field. Vacuum, gas, liquid and solid insulation discussed principally from the point of view of the behavior of electrons and ions, atoms and molecules in producing the dielectric properties of engineering insulating materials. Experimental demonstrations are associated with some of the lectures.

6·27. Principles of Illuminating Engineering. An introductory subject giving a broad survey of the whole field of illuminating engineering. Consists of classroom work, problems, and laboratory investigations dealing with light sources, photometric units and measurements, vision, and lighting design. Serves as a foundation for the advanced subjects, also as an elective in Course VI. Moon, *The Scientific Basis of Illuminating Engineering.*

6·271, 6·272. Principles of Illuminating Engineering (B). A 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,

Electrical Engineering Continued

applications to daylighting and built-in artificial lighting. The photochemical theory of vision, data on the visual thresholds and their 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.

6·282. Principles of Radio Communications (B). A broad treatment of radio communication and the underlying theory, including: analysis of signals; physiological and architectural acoustics; microphones, loudspeakers; vacuum-tube amplifiers, oscillators, modulators, and demodulators; transmitting and receiving systems; radio frequency transmission lines; antennas and radiation; wave propagation phenomena.

6·30. Principles of Electrical Communications. An introductory survey of electrical communications systems leading to a consideration of the relation between the response characteristics of such systems and the problem of transmitting intelligence from one point to another. Emphasis is given to the analysis of the network elements of these systems, including transformers, corrective networks, filters and other coupling means.

6·31. Principles of Electrical Communications (B). Vacuum tubes and their associated circuits as elements of communication systems. These elements include vacuum tubes operating as rectifiers, amplifiers, oscillators, modulators and demodulators, and photoelectric cells.

6·32. Principles of Electrical Communications (B). An elementary treatment of electromagnetic wave propagation phenomena, leading to the discussion of various forms of transmission lines as wave guides. The steady state behavior of lines, cables, and related lumped networks, including a study of distortion and line loading. The circuit and radiation characteristics of antenna systems and a brief consideration of propagation phenomena.

6·331, 6·332. Electrical Communications Laboratory. A study of experimental methods used in the solution of communications problems, correlating physical phenomena with their theoretical interpretation. Includes a study of vacuum tubes and vacuum tube circuits, artificial lines and other networks, and radio frequency and acoustical measurements.

6·333. Electrical Communications Laboratory. Embraces in general the subject matter of 6·331 and 6·332, but is not so extensive.

6·34. Electrical Communications Laboratory (B). Special undergraduate laboratory work in vacuum tube circuits, audio- and radio-frequency measurements, and acoustics arranged to suit the needs of the individual student.

6·40. Elements of Electrical Engineering. Applications of the general principles of the electric and magnetic circuit to the generation, distribution and utilization of direct-and alternating-current power. Hudson, *Engineering Electricity.*

6·42. Elements of Electrical Engineering. Applications of the general principles of the electric and magnetic circuit to the generation, distribution and utilization of direct- and alternating-current power with special reference to ordnance service. Hudson, *Engineering Electricity.* (For U. S. Army Officers only.)

6·43, 6·44. Electrical Engineering. Specially arranged to meet the needs of Naval Officers studying Naval Construction and Engineering. (Not offered 1940–41.)

6·47. Applications of Electricity in Industry. Considerations governing the choice, application and economics of distribution and use of electrical energy in industry. Principles employed in electric drive, electronic and photoelectric devices, electric furnaces and ovens, and movement of fluids and solids. Class work supplemented by laboratory work illustrating and developing the principles presented in class.

6·48. Electrical Equipment of Buildings. Lectures on the 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). The theory of symmetrical components and application to electric power systems operating under unbalanced conditions. The 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. A comprehensive treatment of electric power systems in the steady state. Reference Books: Lyon, *Applications of Symmetrical Components;* Wagner and Evans, *Symmetrical Components.*

6·512. Electric Power Circuits (A). A comprehensive study of transients on long lines. The general theory of travelling waves, followed by a consideration in detail of reflections and refractions at junction points, circuit discontinuities and terminals, the 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. Reference Books: Ruedenberg, *Elektrische Schaltvorgänge;* Bewley, *Traveling Waves on Transmission Systems.*

Electrical Engineering Continued

6·513. Power System Stability (A). A comprehensive study by analytical, graphical, and network analyzer (a-c calculating board) methods of steady-state power-system problems, such as those associated with system expansion and interconnection, voltage regulation, steady-state stability, etc. The theory and construction of performance charts for synchronous machines and combinations of power-network elements. A general discussion of the problem of power-system stability and its place in power-system design and operation. An exposition of methods for the determination of static power limits. A portion of the time is devoted to the solution of steady-state power-flow and stability problems on the M.I.T. Network Analyzer. Dahl, *Electric Power Circuits, Vol. II. Power System Stability.*

6·514. Power System Stability (A). Stability of power systems during disturbances. The effect of short circuits, sudden switching, etc. Solution by simplified methods as well as by complete point-by-point methods of analysis. Regulators and excitation systems. A comprehensive discussion of their action, involving determination by analytical and graphical methods of performance during voltage build-up and build-down, of their effects on the synchronous machines during disturbances, etc. Discussion of methods for improvement of stability, Damper windings and their effects. Effect of different methods of grounding the neutral points of the system. A portion of the time is devoted to the solution of power-system transient-stability problems on the M.I.T. Network Analyzer. Dahl, *Electric Power Circuits, Vol. II. Power System Stability.*

6·515. Power Systems Laboratory (A). Power-network analysis using the network analyzer (an alternating-current calculating board). Problems on the latter include those relating to steady-state operation; to symmetrical and unsymmetrical faults; and to steady-state and transient stability. Problems to be solved are preferably submitted by the student.

6·521, 6·522. Advanced Alternating-Current Machinery (A). Devoted to the analysis of the more intricate electrical problems met in the operation of alternating-current machinery. The following are some of the problems discussed. The effect of unbalanced conditions on the operation of synchronous and induction machines. Eddy currents in laminations, solid rotors, and the conductors of direct-current and alternating-current machines. Electromagnetic field problems. Harmonic analysis of the magnetic density existing in the air gap of synchronous and induction machines and its effect on the generated e.m.f., the torque, and on vibration. Transient conditions due to the sudden alteration of the electric circuits or to the sudden application of the shaft load of synchronous and induction machines, particularly the effect of sudden short circuit on the current and torque and the conditions arising during pulling into step and phase swinging.

Facilities are available in the machine-transients laboratory for experimental work supplementary to the classroom instruction.

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). The economics and the technique of electric power generation. The 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. The effect of the characteristics of the load curve on cost of generation. Thermal efficiency and commercial economy of various heat cycles. The general layout of the generating station. The calculation of fault currents and the operation of protective devices. The division of load among generating units for minimum cost. The 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). The electrical and mechanical principles and economic considerations relating to railway electrification. The 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. The foregoing is studied as regards electrification in particular and transportation in general.

6·561. Advanced Network Theory (A). Summary and generalization of methods of network analysis. Characteristics of four-terminal networks. Study of reactance functions and synthesis of nondissipative networks. Determination of equivalent and reciprocal networks. Conventional filter theory. Laboratory work is given. Guillemin, *Communication Networks, Vol. II.*

6·562. Advanced Network Theory (A). Methods of filter design based upon the lattice structure of filters hav-

Electrical Engineering Continued

ing linear phase characteristics. Fundamental methods and special artifices for the reduction of a lattice design to an unbalanced form. Effect of incidental dissipation. Transient behavior of selective networks. Design of equalizers and delay corrective networks. Guillemin, *Communication Networks, Vol. II.*

6·571, 6·572. Principles of Illuminating Engineering (A). An advanced subject dealing with the latest researches in physiological optics and their applications to lighting, the vector field method of calculating illumination, and the design of lighting system 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 (a method which includes the Heaviside operational calculus). Requisite background in complex variable theory is supplied. Bush, *Operational Circuit Analysis.*

6·586. Engineering Applications of Static Field Theory (A). Engineering treatment of methods for the solution of Laplace's and Poisson's equations and their application to such problems as the electrostatic field in transmission-line insulators, transformer bushings, high-tension cables; the field of diodes and triodes, magnetic fields in dynamo-electric machinery, heat-flow fields, the light field, etc. Provides a supplement to the usual electrical circuit theory (which is confined largely to one space dimension) by developing methods for two and three dimensions, methods which are becoming of increasing importance in engineering practice. Rothe, Ollendorff and Pohlhausen, *Theory of Functions;* Byerly, *Fourier Series and Spherical Harmonics.*

6·59. Communications Laboratory (A). A graduate laboratory subject in commuuications in which the student carries out work on a substantial problem or selected group of problems in consultation with a member of the staff who is particularly qualified in the field. The student is expected to show a mature independence of attack and investigatory ability. His work is guided by conferences, with opportunity for detailed criticism and discussion.

6·60. Mathematical Analysis by Mechanical Methods (A). A study of computation procedures and the mechanical methods developed for performing them. General principles are developed and illustrated by existing equipment. Emphasis is placed on the methods adapted to the treatment of important problems where ordinary processes are extremely laborious.

6·605, 6·606. Dynamic Analysis of Automatic Control Systems (A). A unified treatment of the principles of closed-cycle control systems with emphasis on the quantitative treatment of the stability requirements and the transient and steady-state response to arbitrary forcing functions. The treatment is applicable to a wide range of follow-up systems involving several degrees of freedom; for example, rotational and translational mechanical systems, voltage regulators, or industrial-process-control systems; and covers high-power fast-response electrical and hydromechanical servomechanisms for output drives. The classwork is supplemented with laboratory work on typical closed-cycle control mechanisms.

6·61. Generation and Utilization of Super-Voltages (A). Principles and techniques involved in the production, measurement, and utilization of very high voltages. Analysis of direct-current electrostatic, alternating-current, and impulse-voltage sources. Theory and characteristics of high voltage insulating media with emphasis on compressed gases and high-vacuum insulation. Physical properties of high energy X-rays and their production for medical and industrial use. 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.

6·62. Principles of Electrical Communications (A). Deals with thermionic gaseous conduction and photoelectric tubes and their associated external networks. Includes an advanced study of linear and nonlinear amplifiers, amplitude and frequency modulators, regenerative and super-regenerative circuits and oscillators. The class work is supplemented with laboratory problems.

6·621, 6·622. Radio Lines, Antennas and Propagation (A). Treats those parts of the radio system that effect transmission of energy between transmitting apparatus and receiving apparatus. First term — theory and application of radio frequency wave guides of various types, including coaxial and hollow pipe, as energy conductors and circuit elements. Second term — theory and practice of antennas for broadcast, short wave, and microwave services, including applications to air navigation. Engineering aspects of radio wave propagation. General principles are derived from electromagnetic theory, followed by application to practical problems.

6·627. Patents and Their Relation to Science and Engineering (A). Considers engineering significance of patents. By means of typical cases, nature of patents, machinery incidental to obtaining them, their effects in industry are considered. Appeals, interferences, court litigations are treated by actual illustrations. These illustrations range from simple to highly technical in character. Although the subject does not pretend to cover patent law it naturally leads to an understanding of the working of the patent law. Free use of mathematics, physics, chemistry, and electricity, will be made in the presentation. Arranged for advanced students in engineering and science.

6·628. The Patent Background of Electrical Communications in the United States (A). Covers patent background of communications systems of this country and, to an extent, of other countries. Background is discussed in relation to corporate development of several large communications organizations. Emphasis is placed on growth of electronic art including vacuum tubes and tube circuits; growth of telephone and telegraph are included. Consideration is given regulatory legislation in the communications field.

Electrical Engineering Continued

6·631. Engineering Electronics (A). The 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.

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.

6·64. Applications of Atomic Physics in Electrical Engineering (A). A majority of the modern devices used by electrical engineers can be understood only with some knowledge of atomic physics. Important electrical apparatus like gas- and dry-rectifiers, vacuum- and barrier-layer photocells, electrolytic condensers, lightning arresters, piezo-electric resonators, etc. will therefore be discussed in this subject from the standpoint of: How are they made? Why do they work? Under what circumstances do they fail? This type of analysis, supported by experiments, will bring an understanding of the atomistic phenomena involved, of the limitations imposed by them, and of the research problems facing us today.

6·651, 6·652. Electric Power Distribution (A). The theoretical principles of electric power distribution. The distribution system in theory. Calculation of power-system short-circuit transients. Limitation of short-circuit currents, maintenance of voltage, and the control and transfer of power. Theory of electric power cables, dielectric properties, calculation and limitation of sheath currents. Low-voltage and medium-voltage distribution networks. Interlacing of primary cables, load division and transformer spacing. Theory of relays, methods of obtaining selectivity and their applications. Load characteristics, economic problems in electric distribution, allocation of demand costs, determination of cost of energy loss and rate structures.

6·661, 6·662. Principles of Electric Machine Development (A). Design of transformers, reactors, direct-current machines and alternating-current machines and predetermination of characteristics. Voltage waveform of generators. Calculation of eddy-current loss in windings of transformers and a-c. machines, and methods of reducing the loss. Unbalanced magnetic pull. Choice of slot numbers. Methods of reducing noise and vibration. Flux plotting. Heat flow. Ventilation.

6·671, 6·672. Vibrations (A). The theory of vibration of mechanical systems including certain acoustical and hydraulic problems. The complex-notation method will be generally used. (Students from other courses will be given a short preliminary instruction in this method while the Electrical Engineering students are working on more purely electrical problems. Thereafter the two groups will be united.) Forced, transient, and self-induced vibration. Single and multiple degrees of freedom. Analogies between electrical and mechanical systems. Non-linear systems. Application to mechanical devices, machines, and structures. Vibration measurements and corrections. The use and limitations of models, mechanical and electrical. Noise in machines, its causes and control. The control of temperature oscillations. The tide and an analysis of tidal power possibilities. Stresses in busbars and busbar supports. Inertia effects in high-speed mechanisms.

6·68. Special Problems in Electrical Engineering (A). Provides an opportunity for individual study, under a staff member, of advanced subjects related to Electrical Engineering not otherwise included in the curriculum. The program is laid out to suit individual requirements by students and staff members interested.

6·69. Sound in Electrical Communications (A). A study of the 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. Electrical Measurements Laboratory, Advanced (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. Electrical Engineering Laboratory, Advanced (A). Laid out in accordance with the needs of the individual student, special problems on direct and alternating-current machinery being selected.

6·75, 6·75T, 6·751. Electrical 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 measurement of the properties of linear circuit elements, and the transient and steady state behavior of circuits made up of such elements. *Instructions for Students in the Electrical Engineering Laboratories, Tenth Edition*, 1940.

6·76T. Electrical Engineering Laboratory. Choice of work by the student, subject to counsel of his instructor, from a broad selection of topics having to do with the measurement of the properties of non-linear circuit elements, including electronic devices, and the behavior of circuits in which such devices are used.

6·77. Electrical Engineering 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, Tenth Edition*, 1940.

6·78. Electrical Engineering 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, Tenth Edition*, 1940.

6·781. Electrical Engineering Laboratory. Polyphase circuits, symmetrical phase components, power transformer, synchronous generator, synchronous motor, single-

Electrical Engineering Continued

phase and three-phase induction motors, power rectifiers and power filters with special emphasis on interference problems. *Textbooks same as for* 6·78.

6·79. Electrical Engineering 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 Engineering Laboratory (B). For Electrical Engineering students who desire work in addition to that included in any one of subjects 6·75T, 6·76T, 6·77, 6·78 or 6·79, and for any other students requiring a special program. Arranged to suit the requirements of the individual student.

6·81. Electrical Measurements Laboratory. Choice of work from a broad selection of topics dealing with methods of measurement of the electrical and magnetic properties of metals. *Instructions for Students in the Electrical Engineering Laboratories, Tenth Edition*, 1940.

6·82. Electrical Engineering Laboratory. Experiments designed to illustrate the operating characteristics of common types of direct- and alternating-current motors and generators and transformers; experiments with elementary vacuum and gaseous-tube circuits. Ricker and Tucker, *Electrical Engineering Laboratory Experiments, Fourth Edition; Instructions for Students in Electrical Engineering Laboratory, Tenth Edition*, 1940.

6·83, 6·84. Electrical Engineering Laboratory. Correlated with and supplementing 6·43 and 6·44. (Not offered 1940-41.)

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, Tenth Edition*, 1940.

6·88. Electrical Engineering Laboratory. Twelve laboratory exercises covering the determination of the characteristics of the ordinary types of electrical machinery, control apparatus and electronic devices. The laboratory is supplemented with conferences in which fundamental principles underlying the laboratory work are reviewed. Textbooks same as for 6·85, and Albert, *Fundamental Electronics and Vacuum Tubes*.

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 to **6·904.** Manufacturing Practice. These subjects cover the manufacturing work taken by the coöperative students at the plants of the General Electric Company in Lynn, Schenectady, Pittsfield and Philadelphia. The students are not all assigned to the same jobs; neither are they always assigned to the same departments. The following is the list of the various departments to which students are assigned and it also indicates the approximate order in which the manufacturing practice is given:

GENERAL ELECTRIC COMPANY

Manufacturing planning including the design and manufacture of special machines, as well as quantity production methods.
Standardizing Laboratory and Meter Testing.
Direct-current Motor Test.
Alternating-current Motor Test.
Illumination Department.
Transformer Test.
Turbine Test.
Refrigeration, Air Conditioning and Heating Appliances.
Power Plant.
Research in various departments including the Lynn, Schenectady and Pittsfield Research Laboratories.

6·901. Manufacturing Practice. First term's work at plants of General Electric Company.

6·902. Manufacturing Practice. Second term's work at plants of General Electric Company.

6·903. Manufacturing Practice. Third term's work at plants of General Electric Company.

6·904. Manufacturing Practice. Fourth term's work at plants of General Electric Company.

6·911 to **6·914; 6·921** to **6·924.** Public Utility Practice. The subjects in Public Utility Practice are given by the Boston Edison Company and the Boston Elevated Railway. The various departments to which the students are assigned are listed below in the approximate order in which the work is given at:

BOSTON EDISON COMPANY

Maintenance of Line Department.
Standardizing and Testing Departments.
Steam Division of Generating Department.
Electrical Division of Generating Department.
Sales Department.
Installation Department.
Supply Department.
Electrical Engineering Office.
Scientific Research and Study covering the many Public Utility Problems.

BOSTON ELEVATED RAILWAY

Department of Rolling Stock and Shops.
Maintenance Department.
Transportation Department.
Power Department.
Miscellaneous Work.

6.911. Public Utility Practice (Edison). First term's work at the plants of the Boston Edison Company.

6·912. Public Utility Practice (Edison). Second term's work at the plants of the Boston Edison Company.

6·913. Public Utility Practice (Edison). Third term's work at the plants of the Boston Edison Company.

6·914. Public Utility Practice (Edison). Fourth term's work at the plants of the Boston Edison Company.

Electrical Engineering Continued

6·921. Public Utility Practice (Elevated). First term's work at the plants of the Boston Elevated Railway.

6·922. Public Utility Practice (Elevated). Second term's work at the plants of the Boston Elevated Railway.

6·923. Public Utility Practice (Elevated). Third term's work at the plants of the Boston Elevated Railway.

6·924. Public Utility Practice (Elevated). Fourth term's work at the plants of the Boston Elevated Railway.

6·941 to **6·944.** Communications Practice. These subjects cover the Communications work taken by the coöperative students at the various plants and laboratories of the Bell Telephone System. The first assignment is usually spent with an operating telephone company, the second in the plant of the Western Electric Company at Kearny, N. J., and the third in the Bell Telephone Laboratories in New York City. The fourth term of practice is spent with any one of these organizations, depending upon the individual interest of the students.

6·941. Communications Practice. First term's work at the plants of the Bell System.

6·942. Communications Practice. Second term's work at the plants of the Bell System.

6·943. Communications Practice. Third term's work at the plants of the Bell System.

6·944. Communications Practice. Fourth term's work at the plants of the Bell System.

6·951 to **6·954.** Electronic Apparatus Manufacturing Practice. These subjects cover the shop, laboratory, and engineering experience of the coöperative students in the plants of the General Radio Company, Cambridge.

6·951. Electronic Apparatus Manufacturing Practice. First term's work in plants of General Radio Company.

6·952. Electronic Apparatus Manufacturing Practice. Second term's work in plants of General Radio Company.

6·953. Electronic Apparatus Manufacturing Practice. Third term's work in plants of General Radio Company. (Not offered 1940–41.)

6·954. Electronic Apparatus Manufacturing Practice. Fourth term's work in plants of General Radio Company. (Not offered 1940–41.)

BIOLOGY AND PUBLIC HEALTH

Subjects 7·00 to 7·99

7·01. General Biology. An introduction to the study of living things. Essentially a general discussion of the fundamental facts and principles common to all the biological sciences. Elementary and preparatory in character and in aim.

7·03. Theoretical Biology (B). Advanced lectures and recitations in general biology designed to acquaint the student with the principal theories and hypotheses which have played an important part in the development of biological science, and particularly of those which underlie the more fruitful research work of the present day. The two major problems discussed are heredity and oecology. Sinnott and Dunn, *Principles of Genetics.*

7·06. Botany. Beginning with the lowest forms of plant life, the various groups of algae and fungi are systematically studied and later, higher cryptogams. Some attention is paid also to the structure and development of flowering plants. The fundamentals of plant physiology are stressed. One hour a week is given to lectures on limnology and to laboratory work on the microscopic examination of water. Mottier, *Textbook of Botany for College Students.*

7·08. Parasitology (B). Invertebrate zoölogy with special reference to the parasitic forms and their relation to disease in man and the domestic animals. Lectures with demonstrations. Chandler, *Introduction to Human Parasitology*, 1930.

7·09. Parasitology, Advanced (A). Advanced work involving intensive study of some of the more important parasites causing diseases of domestic animals and man. The student will be required to study fresh materials from original sources, the aim being to acquaint him with methods of isolation and investigation which he could apply in problems of this character which might arise in his professional career.

7·10. Invertebrate Zoölogy. A systematic study of the invertebrate animals, considering their form, structure, distribution, and economic value. Hegner, *Invertebrate Zoology.*

7·131. Advanced Histology (B). A seminar and laboratory course intended to give the student practice in the preparation and interpretation of special histological materials and in embryology.

7·132. Advanced Histology (A). Continuation of 7·131 in the direction of cytological and similar special materials.

7·14. Comparative Anatomy. Covers the fundamentals of comparative gross anatomy of vertebrates and the essential histology of the organs. The structures will be partly dissected out by students and partly demonstrated by the instructor. Classification and general zoölogy of the vertebrates are also considered.

Biology and Public Health Continued

7·17. Biology of Food Supplies. A consideration of the growth, structure, and physiology of important food animals and crop plants, in relation to their utilization by man. Special attention is given to those animals, particularly invertebrates, which injure or infest food supplies. Robbins and Ramaley, *Plants Useful to Man.*

7·18. Technical Aspects of Entomology (A). Numerous insects and mites are known to be of the highest importance to public health and the food industries due to their abundance and destructiveness. The general problems of their recognition and control are considered. Attention is also given to the insects beneficial to man.

7·20. Physiology, Elements of. Lectures, laboratory, and reports on the physical and chemical bases of physiological function. The nature of protoplasm, and the nature of energy conversions, metabolism, and special application of general principles in organ functions comprise the topics covered. Designed to show the general bearing of physiology upon all biological studies.

7·201. Advanced Physiology (A). The application of mathematics to the analysis of biological data and of biological variability. A study of the physical and chemical properties of protoplasm; colloidal phenomena, diffusion, osmosis, membrane potentials, permeability; tropisms, photoreception; radiation, pressure, and temperature effects; photosynthesis.

7·22. Personal Hygiene and Nutrition (B). Consideration of personal health and disease, their conditions and causes; exercise, work, play, oral hygiene, hygiene of clothing, of the feet, of the alimentary canal, mental hygiene, etc. Special attention is given to diet from the standpoint of the science of nutrition.

7·23. Applied Nutrition (A). First portion of the subject is concerned with the nutritional requirements from infancy to old age and with the clinical methods by which these requirements are determined. The results of studies on population groups are studied to show the effects of malnutrition and undernutrition on the one hand, and the effects of adequate and optimal nutrition on the other. The final third of the term is devoted to practical field work in applied nutrition at the Food Clinic of the Boston Dispensary. Individual case studies are made with normal and malnourished children and the practical difficulties in securing adequate dietaries for various types of children under poor social conditions are given special consideration.

7·24. Advanced Nutrition (A). Considers the chemical, biological, physical and clinical methods for measuring or assaying substances and elements of nutritional importance, such as vitamins, minerals, and amino-acids. Methods for the detection of clinical and sub-clinical nutritional deficiencies, quantitatively and qualitatively, employing modern instrumentation and procedures, are examined.

7·28. Limnology. A study of the biological productivity of inland waters, and of the physical, chemical and biological influences determining it. The applications considered may be (a) microörganisms causing tastes and odors in public supplies, or (b) scientific fish stocking. Whipple, *Microscopy of Drinking Water.*

7·29. Bacteriology. Deals with fundamental principles of bacteriology and the general relations of microorganisms to chemical changes such as fermentation, putrefaction, and disease. Particular emphasis is placed on the examination of water supplies and the protection of community water sources. Buchanan, *Bacteriology;* Prescott and Winslow, *Elements of Water Bacteriology.*

7·301, 7·302. Bacteriology (7·302, B). Fundamental work in the biology of the bacteria. The first term is devoted to general bacteriology with a thorough study of selected types. The second term is devoted to special study of the bacteriology of water, sewage, air, and foods. Zinsser and Bayne-Jones, *A Textbook of Bacteriology;* Prescott and Winslow, *Elements of Water Bacteriology,* 1931, *Standard Methods of Water and Sewage Analysis; Standard Methods of Milk Analysis;* Hammer, *Dairy Bacteriology.*

7·321, 7·322. Bacteriology, Advanced (A). Reports and discussions of bacterial metabolism and growth, certain diagnostic tests, and recent developments in bacteriology. In the second term, laboratory problems and demonstrations include bacterial dissociation, filterability, bacteriophage, and special problems.

7·33. Plant Diseases. A brief survey of the types of plant diseases of economic significance which are caused by bacteria and fungi. Owens, *Principles of Plant Pathology.*

7·34. Limnological Fieldwork. (At Camp Technology.) A study of the biological and chemical characteristics of stream and lake waters, including temperature determinations at various depths, and the use of field kits in the microscopic examination of the plankton and for the examination for color, turbidity, and dissolved oxygen and carbon dioxide, etc., Sanitary chemical, microscopic and bacteriological examinations of these waters are also made in the laboratory. For those qualified; special work in relation to fish stocking may be taken. Whipple, *Microscopy of Drinking Water;* American Public Health Association, *Standard Methods of Water Analysis.*

7·35. Planktonology (A). A consideration of those animals and plants which drift about in the water, unattached. The identification, life history, and distribution are particularly considered.

7·36. Microbiology. A broad survey of the theory and practice involved in fermentation processes, and the industrial and economic applications of microbiology in agriculture and the manufacture of biochemical preparations. Industrial alcohol, vinegar, acetone, butyl alcohol, glycerin, fermentation acids, and the applications in the leather and food industries are especially considered.

7·361. Industrial Microbiology. The same as Microbiology (7·36) but with extended laboratory work.

7·362. Industrial Microbiology (B). A continuation of the preceding with more detailed laboratory investigation on a semi-commercial scale.

Biology and Public Health Continued

7·371, 7·372. Advanced Industrial Microbiology (A). Advanced studies involving the 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. Special emphasis is placed on the study of the most recent cultural and production methods and the biochemistry of the fermentations or the changes concerned. Among the subjects which may be considered are the biochemical activities of the acetic acid bacteria; the preparation of organic acids, alcohols, alcoholic beverages, enzyme products, lipids, sterols and other substances; and the relation of certain biological agents to the textile, timber and leather industries. Laboratory problems, reports, lectures, discussions. Prescott and Dunn, *Industrial Microbiology;* Smith, *Industrial Mycology;* Bernhauer, *Garungschemisches Praktikum.*

7·38. Germicides and Antiseptics (A). A study of the basic principles, both in theory and application, of chemical and physical disinfection, bacteriostasis and fungistasis in their relation to industry, medicine, and agriculture. Methods of evaluation, the germicidal efficiency of agents, and the preparation of germicidal compounds are considered. Lectures, discussions, and laboratory problems.

7·39. Bacteriology of Foods (A). Lectures and advanced laboratory work of a quantitative nature concerning the handling and storage of foods and their bacterial deterioration. Among the subjects considered are food storage in atmospheres of inert gases, food fumigation, recent advances in food packaging, and the regulation of bacteria thereto.

7·41. Chemistry of Water. Chemical examination of potable and of polluted waters, with lectures on the significance of the results. American Public Health Association, *Standard Methods of Water Analysis;* Theroux, Eldridge and Mallmann, *Analysis of Water and Sewage.*

7·411. Sanitary Biology (A). Lectures, discussions and laboratory work pertaining to the biology, chemistry and physics of air, water and sewage with particular emphasis on laboratory procedures for determining potability of water supplies, the quality of sewage and sewage effluents and the factors in the atmosphere that make for human health and comfort.

7·42. Chemistry of Foods. Analytical methods, fundamental basis of nutrition; extent, character and legal status of food adulteration. Woodman, *Food Analysis.*

7·50. Communicable Diseases (B). The fundamental biological facts of infection, resistance, and immunity. The biological characteristics of infectious diseases of special interest to the sanitarian are considered in detail. Park and Williams, *Pathogenic Microörganisms;* Zinsser and Bayne-Jones, *A Textbook of Bacteriology.*

7·52. Industrial Hygiene (B). The maintenance and the effectiveness of the worker with a consideration of factory sanitation, industrial fatigue, occupational accidents, industrial poisoning, dust control, ventilation, and health administration in industry. Each student is assigned work in the detection and estimation of toxic substances or in the investigation of some industrial health problem according to his individual needs.

7·53. Air Examination (B). Considers the relation of the composition and physics of air to health, comfort, and efficiency. The physiological bases for air conditioning are indicated. Laboratory work covers the use of instruments for air testing, and the determination of certain dangerous gases, mineral and organic dusts, and microbic organisms in air.

7·541, 7·542. Public Health Administration (B). Lectures and discussions on the history, organization, and administration of health departments and private health agencies, local, state, and national, and on current public health problems, their valuation and the methods by which they are handled in health departments.

7·543. Health Department Practice (A). Lectures, discussions, laboratory and field work dealing with the organization, activities and statistical analysis of municipal, county, state and federal health agencies. Appraisal forms for local health work will be discussed as well as the organization and conduct of public health surveys.

7·55. Public Health Bacteriological Methods. Similar to 7·551, with haematology and procedures not directly related to pathogenic bacteriology omitted.

7·551. Public Health Laboratory Methods (B). Methods in use in state and municipal bacteriological laboratories considered. Training given in pathogenic bacteriology, including diagnosis of diphtheria, examination of specimens for tuberculosis and typhoid, microscopical diagnosis of malaria, etc. Haematology is included.

7·552. Immunological Methods (B). Methods used in serological laboratories and production of biologicals are studied in detail. The Wassermann, Kahn, Hinton, Kline, and other tests for syphilis are included.

7·56. Principles of Sanitation (B). Lectures, problems and field work in the relationship of the environment to the public health, including air, water, sewage, milk, food supplies, insects, rodents, housing, public buildings and other similar factors.

7·57. Municipal Sanitation (B). Lectures and problems dealing with principles of sanitation as applied to the community, and including water supply, sewage and sewage disposal, sanitation of swimming pools and disposal of refuse.

7.58. Vital Statistics (B). Lectures, recitations, and problems by which the student acquires a working knowledge of statistical methods, consideration of errors, and the preparation, graphic representation, critical analysis, and interpretation of data.

7·59. Sanitation (B). Engineering aspects of public milk supplies, including sanitation of production, transportation, and mechanical equipment used in pasteurization and handling, and other machinery incidental to the handling of milk and milk products; the principles of public

Biology and Public Health Continued

health surveys; water supplies and excreta disposal in unsewered communities; street cleaning; control of mosquitoes, flies, and other insects; rodent control and ratproofing in buildings; housing; inspection and control of shellfish areas; the sanitary aspects of food manufacturing, including plant sanitation, etc.; refuse disposal practice; smoke and noise prevention; relation of animal diseases to human welfare; general sanitary inspection methods and the principles of epidemiology. Prescott and Horwood, *Sedgwick's Principles of Sanitary Science and Public Health.*

7·591. Public Health Engineering (A). Lectures, discussions, laboratory and field work dealing with the various activities of the public health engineer, such as sources and modes of infection, epidemiological procedures in water, milk, food and insect-borne diseases; rural sanisation; sanitation of swimming pools and summer camps; street cleaning and refuse collection and disposal; sanitation of foods, food stores and restaurants; housing; school tanitation; the principles of air conditioning and other atmospheric problems in relation to health and comfort.

7·592. Public Health Engineering (A). Lectures, discussions, laboratory and field work dealing with water supplies and their purification; sewage and its treatment; milk supplies and their production, sanitation and supervision; and the safeguarding of shellfish.

7·601, 7·602. Health Education (A). A consideration of the procedures and methods used by health departments and school departments in health education. The health program of the school system is discussed in detail is to both organization and method. Practical field work as provided. Turner, *Principles of Health Education.*

7·603. Public Health Education (A). A study of the methods and materials used in the health education of the general public by health departments and private health agencies with practice in the preparation of such materials. The press, radio, cinema, lecture, exhibit, report, personal contact, and community campaign are considered. Bauer and Hull, *Health Education of the Public.*

7·604. School Health Administration (A). Deals with the organization of the health work expected of teachers, doctors, nurses, physical educators, nutritionists, and others, presenting the objectives, activities, costs, and measures of accomplishment for each phase of the work.

7·63. Public Health Field Work (A). Conferences and field work in connection with clinics, departments of health, health centers, and other organized agencies for improving the public welfare. As examples, students might be required to study and report on new installations for water supply, sewage or waste disposal or housing projects, or to make extensive personal surveys of health departments, to assist health officers in investigations of epidemics, or in other ways to participate in health measures as carried out in the metropolitan district.

7·64. Public Health Problems (A). Seminar work in which the student makes an investigation of the methods of study of special problems in laboratory technique or in public health administration, such as the control of communicable diseases, the organization and supervision of food inspection, or the application of the principles of sanitary science to other problems.

7·65. Health Hazards in Special Industries (A). The specialized study of the dangers in particular industries, such as the rubber, textile, steel, and fiber industries, and those involving the possibility of infection or of injury through abrasive particles, by poisonous gases or solvents, or other special dangers. Preventive or palliative measures in such cases are also considered.

7·66. Epidemiology (A). Conferences devoted to a detailed consideration of the natural history of epidemics, such as typhoid fever, diphtheria, and scarlet fever, and their causes in their relation to public water supplies, milk supplies, sewage systems, insects, and personal causative factors. The student by critical examination of the more celebrated and instructive examples is enabled to prepare himself for the interpretation of corresponding phenomena arising in actual practice. A thorough review of the literature on other infectious diseases, including measles, whooping cough, influenza, tuberculosis, poliomyelitis, cerebrospinal meningitis, is included.

7·67. Functional Pathology (A). Lectures and recitations to correlate mechanics, physics, chemistry, biochemistry, and physiology with disease manifestations.

7·68. Pathology (A). The principles of general pathology, with laboratory studies on prepared slides and gross specimens.

7·701, 7·702. Technology and Chemistry of Food Supplies. Lectures, discussions, and reports on the chemical composition, production, consumption, statistics, and methods of treatment of food materials. The 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 will be discussed in detail. The fundamental principles involved in physical processes such as refrigeration, dehydration, and salting, and the microbiology and chemistry of the processes is studied. The laboratory work includes numerous exercises involving the chemical analysis of various foods and food products. Prescott and Proctor, *Food Technology;* Woodman, *Food Analysis.*

7·71. Food Technology. Lectures, laboratory work and reports concerning the manufacture, processing, transportation, packaging, and laboratory control of foods and food products. Included in the course will be selected phases of the dairy, packing-house, refrigeration, canning, bakery, fisheries, and beverage industries with particular emphasis on the technical problems involved. Opportunity for students to study special problems in their field of interest will be afforded.

7·711. Technology of Food Products (B). Lectures, reports and laboratory experiments in the methods of food preservation and manufacture. Semi-plant scale operations in dehydration. The production of fruit juices and concentrates, canning processes, and quick-freezing of various foods included. Cruess, *Commercial Fruit and Vegetable Products;* Tanner, *The Microbiology of Foods.*

Biology and Public Health Continued

7·712. Technology of Food Products (B). A continuation of 7·711 with particular 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.*

7·721, 7·722. Advanced Food Technology (A). Advanced 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.*

7·80. Biochemistry. (B) Primarily a laboratory subject with experiments designed to illustrate basic principles of biochemical procedure, as applied in various fields. The laboratory work does not lay emphasis upon clinical aspects of physiological chemistry. Lectures cover the nature of chemical processes in plants and animals with special attention to the metabolism of foodstuffs and the nature of protoplasms.

7·802. Quantitative Biochemistry (B). Covers quantitative techniques in diagnostic analysis of normal and abnormal constituents in blood, urine, and tissue.

7·81. Zymology (A). Lectures, recitations and reports, with laboratory work on quantitative study of enzyme reactions, their products, and the conditions governing activity.

7·82. Biochemistry, Advanced (A). Technique for biochemical analyses and bio-assays, based on the recent literature. Discussions, reports, and laboratory problems.

7·831, 7·832. Microbiological Chemistry Laboratory (A). A laboratory course which emphasizes the quantitative aspects of the metabolic activities of microorganisms. Special problems in the general biochemistry of the yeasts, molds, and bacteria are investigated and the student is acquainted with many of the analytical and research methods now in use in various laboratories. Isolation and identification of various metabolic products, metabolic balance sheets, and respiration studies are included.

7·84. Biophysics (B). Lectures, laboratory and reports devoted chiefly to electrophysiology. The application of vacuum tubes to the observation of biological phenomena is considered in detail. Problems include the action potentials of nerves, cardiography, encephalography, and the electrical impedance of living tissue. Attention is also given to the physiological basis underlying acoustical measurements and to the techniques used.

7·91. Biological Engineering I (A). Typical problems related to the effects of radiation. Exercises are directed toward developing facility in the use of apparatus for obtaining and measuring monochromatic energy in the visible and ultra-violet portions of the spectrum and in the treatment of biological samples.

7·92. Biological Engineering II (A). Devoted to selected problems in biology utilizing techniques of physics and the allied sciences. Attention is given to the application of these techniques as diagnostic aids in medicine.

7·941, 7·942. Research Problems (A). Directed research by graduate students in a field of biological science, but not contributory to the thesis.

The following subjects are offered as General Studies. For description of subjects see Division of General Studies.

G28. Economic Geography.

G86. Principles of Sanitary Science and Public Health.

G88. From Molecule to Man.

PHYSICS

Subjects 8·00 to 8·99

GENERAL PHYSICS

8·00. Physics (Entrance). Covers the entrance requirement in Physics. No laboratory work is given.

8·01. Physics (Mechanics). Lectures, recitations, supervised problem and laboratory work devoted to a study of the fundamental laws of point and rigid body mechanics. Free use is made of elementary calculus.

8·012. Physics (College Transfer). Given during the first term for those college transfer students who already have been allowed partial credit for 8·01 and 8·02 on the basis of a substantial course in general physics taken prior to their transfer. The subject is not to be taken by any student under requirement to take or to repeat 8·01 and 8·02. It is designed to supplement the transfer student's training in amount necessary to cover the requirements of 8·01 and 8·02. Free use is made of the calculus.

8·02. Physics (Mechanics and Heat). Lectures, laboratory and recitations. The subject is 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). An 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 comprise the principal topics. The work is quantitative throughout and free use is made of calculus, both in the theory and applications.

Physics Continued

8·034. Physics (College Transfer). Given during the second term for those college transfer students who already have been allowed partial credit for 8·03 and 8·04 on the basis of a substantial course in general physics taken prior to their transfer. The subject is not to be taken by any student under requirement to take or to repeat 8·03 and 8·04. It is designed to supplement the student's training in amount necessary to cover the requirements of 8·03 and 8·04. Free use is made of the calculus.

8·04. Physics (Electricity and Optics). A continuation of 8·03, approximately one-third of the course bringing to a conclusion the study of electricity. The discussion of electromagnetic waves leads to optics, which is devoted to both geometrical and physical optics. The quantitative character of 8·03 is continued and free use is made of calculus.

8·05. Vibrations and Sound (B). The first part of the subject is a study of the dynamics of vibrating bodies; coupled oscillators, strings, membranes and plates. The second part is a study of the transmission and radiation of sound. The properties of loud speakers and microphones are treated, and the characteristics of speech and hearing are discussed.

8·051. Special Problems in Acoustics (A). An advanced problem in acoustics or vibrations with assigned reading and consultations.

8·09. Physical Measurements. Introduction to experimental physics with emphasis on laboratory manipulation. Includes 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, 8·12. Experimental Physics (B). Designed to train the student in methods of analyzing experimental problems to determine suitable methods of achieving a desired result, both in the design and use of experimental equipment. The case system is used and the entire field of experimental physics, both pure and applied, is drawn on. In the laboratory work the experiments are of a semi-research character, designed to develop initiative, resourcefulness, and familiarity with modern experimental technique.

8·13. Undergraduate Colloquium (B). Student reports on topics of current interest in physics.

8·14. Production and Measurement of High Vacuum (B). A laboratory subject involving one three-hour laboratory each week. Includes the theory and various techniques underlying the design and use of high vacuum systems both in glass and in metal. Elementary instruction in glass blowing will be given.

OPTICS AND PHOTOGRAPHY

8·15. Photography. An elementary subject intended primarily as an elective for students not in Course VIII.

8·152. Advanced Photography. An advanced laboratory subject. The experiments are concerned chiefly with the determination of the various characteristics of photographic materials and are designed to give practice in photographic technique.

8·161. Optics. Fundamental principles of geometrical, physical and physiological optics. Includes 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 a detailed description of the performance of well-known optical systems such as telescopes, microscopes, photographic objectives, and projection systems.

8·162. Optical Measurements. Laboratory exercises illustrating the principles, methods and manipulation of optical instruments.

8·173. Color Measurements (B). The measurement and specification of color in both the objective and subjective sense and the application of such methods to industrial problems. The experiments are designed to illustrate the photometric and chromatic properties of the human eye and to give experience in the technique of spectrophotometry and colorimetry.

8·174. Motion Picture Photography (B). A lecture subject of a semi-professional character intended primarily for students planning to enter the motion picture industry. The subject matter is included in the Journal or Transactions of the Society of Motion Picture Engineers.

8·181, 8·182. Optics Seminar (A). A discussion of important problems in photography and optics, including a review of the current literature and the results of researches in these fields at the Institute.

8·183. Special Problems in Optics (A). Supervised experimental work in the optics laboratory, to be taken by students who desire to carry out special investigations not under the head of thesis work.

8·191. Microscopy and Photomicrography. Experimental lectures, approximately one-half of which are devoted to the optics of the microscope and the technique of photomicrography. The second half of the subject is concerned with the application of the microscope to such fields as biology, chemistry, crystallography, metallography, ceramics, and textile technology. The lectures during the latter half of the subject are given by experts in the above-mentioned fields.

8·194. Advanced Physical Optics (A). Primarily for students intending to specialize in optics. Open only to graduates or to seniors who have previously demonstrated marked ability in this field. (Not offered in 1940–41.)

ELECTRONICS

8·201. Electronics. The electron and its properties, electronic devices, thermionic and photoelectric emission, with introduction to the quantum theory and Fermi statistics.

8·202. Electronic Laboratory. Intermediate electrical and electronic measurements, to accompany 8·201.

8·21. Electronic Phenomena (A). An introduction to modern electron theory including an elementary treatment of Maxwell-Boltzmann and Fermi-Dirac statistics with applications of these theories to thermionic and photoelectric emission from metals and to gas discharge phenomena.

8·212. Experimental Electronics (A). The theory and use of modern experimental apparatus as applied to electronic investigations. This include experiments with the Compton quadrant electrometer, the FP-54 vacuum tube "Electrometer," the cathode ray oscillograph and the thyratron, as well as experiments of a fundamental nature on thermionic emission, photoelectric effect, and gas discharge phenomena.

8·213. Advanced Electronics (A). A comprehensive introducion to the fundamental investigations of thermionic and photoelectric emission of electrons from metals and of the general problems associated with gas discharge phenomena. Both the theoretical and the experimental aspects of these problems are discussed in detail. (Alternate years. Not offered 1940–41.)

8·214. Advanced Electronics (A). Continuation of 8·213, dealing primarily with problems associated with gas discharge phenomena. (Alternate years. Not offered 1940–41.)

8·215. Special Problems in Electronics (A). An advanced problem in electronics, with assigned reading and consultation.

X-RAYS AND THE STRUCTURE OF MATTER

8·26. Molecular Structure (A). Electric and optical properties of molecules, gases and liquids. Theory of polar molecules, refraction, scattering of light and Kerr effect. (Alternate years. Offered 1940–41.)

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. A general review of the structure of matter as determined by X-ray diffraction analysis.

8·271. Advanced Physics of X-rays (A). Selected topics in the physics of X-rays. The production, absorption, and scattering of X-rays. Dispersion phenomena. X-ray photoelectric effect. Compton effect. (Alternate years. Offered 1940–41.)

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, Application of space group theory to crystal structure determination. Diffraction in perfect and imperfect crystals. Fourier treatment of X-ray diffraction and the Patterson-Harker analysis. Various applications of the theory of X-ray scattering. (Alternate years. Not offered 1940–41.)

8·281. Crystal Chemistry (A). A correlation of the results of X-ray analysis of the structure of crystalline and noncrystalline matter. The structure of metals and intermetallic compounds, ionic and nonionic crystals, molecular structures including the organic materials, high polymers, and silicates will be discussed. The structures will be considered with reference to atomic size, kind of chemical bonding, structures of radicals or complexes involved. So far as possible the structures will be correlated with the physical properties of the material. (Alternate years. Not offered 1940–41.)

8·29. Quantum Theory of the Solid State (A). Motion of electrons in a periodic potential field. Methods of calculation of the elastic properties of solids. Discussion of electric conductivity, of the magnetic and optical properties of solids, and of the structure of alloys. (Alternate years. Not offered 1940–41.)

8·30. Special Problems in Crystal Physics (A). An advanced problem in X-ray diffraction or crystal physics, with assigned reading and consultation.

ATOMIC STRUCTURE AND SPECTROSCOPY

8·311. Atomic Structure. The study of electron and ion beams, and of the 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 of the periodic table. The vector model. Elements of band spectra.

8·312. Atomic Structure Laboratory. A 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). Deals with the characteristics of atomic spectra and their description in terms of quantum numbers, their interpretation in terms of current theories of atomic structure, and their use in explaining the chemical properties of the elements.

8·341, 8·342. Spectroscopy Seminar (A). Discussion and reports by students of special topics in spectroscopy.

8·343. Special Problems in Spectroscopy (A). Supervised experimental work in the Spectroscopy Laboratory, to be taken concurrently with the Spectroscopy Seminar by students who desire to carry out special investigations not under the head of thesis work.

Physics Continued

8·344. Practical Spectroscopy (B). A subject on the design of spectroscopic apparatus and its application to special problems in astronomy, biology, chemistry, physics, medicine, metallurgy, and engineering. Special emphasis will be laid on methods of spectroscopic analysis, both qualitative and quantitative.

8·345. Applied Spectroscopy (B). A laboratory subject consisting of the use of spectroscopic equipment in problems connected with the fields covered by 8·344 and designed to be taken concurrently with that subject.

8·346. Quantitative Spectroscopic Analysis (B). The work of the last two weeks of 8·344, designed for those interested in the application of quantitative spectroscopic analysis to industrial problems.

NUCLEAR PHYSICS

8·411. Nuclear Physics (B). Treats the principal fields in the study of atomic nuclei, building each up from its beginnings to the status of present knowledge. The treatment is primarily factual, the experimental results being correlated with those given by current theories. Lectures are supplemented by laboratory work in which the student deals directly with the latest types of apparatus. Includes the properties of stable nuclei; isotopes, nuclear moments, mass and charge; radioactive transformations; mathematical theory of statistics and fluctuations; properties of alpha rays, gamma rays, electrons and positrons.

8·412. Nuclear Physics (B). Continuation of 8·411 considering the nuclear spectra of alpha, beta, gamma rays and nuclear energy levels; nuclear force fields and scattering of alpha rays, protons, neutrons and electrons; excitation and transmutation of nuclei; artificial radioactivity; cosmic rays; applications of nuclear techniques to chemistry, biology, geology and other fields.

8·42. Seminar in Nuclear Physics (A). Discussion and reports on special topics in nuclear physics, mainly from the experimental point of view.

8·43. Theory of Nuclear Structures (A). A review of current theories of the structure of atomic nuclei. Calculation of nuclear binding energies and collision reactions. Nature of internuclear forces. Theory of radioactive decay. (Alternate years. Not offered 1940–41.)

8·441, 8·442. Special Problems in Nuclear Research (A). Supervised experimental work on radioactivity, nuclear bombardment, and general nuclear research, for students who wish to carry out special investigations which do not come under the head of thesis work.

THEORETICAL PHYSICS

8·461. Introduction to Theoretical Physics I (B.) Mechanics, vibrating particles, strings, and membranes, with study of ordinary and partial differential equations, Fourier series, and vector analysis.

8·462. Introduction to Theoretical Physics II (B). Elasticity and hydrodynamics, heat conduction, electromagnetic theory, potential theory, and the electromagnetic theory of light.

8·463. Introduction to Theoretical Physics III (A). Wave mechanics and quantum theory, classical and quantum statistics, structure of atoms and molecules, and the properties of matter.

8·471. Historical Development of Physics (B). A survey of the fundamental contributions to physics in the order in which they appeared, from Archimedes to Einstein. The original papers are studied as far as this is possible, and the students themselves give a number of the lectures.

8·481. Advanced Mechanics I (A). The mechanics of particles and rigid bodies treated by the generalized methods of Lagrange and Hamilton. (Alternate years. Not offered 1940–41.)

8·482. Advanced Mechanics II (A). A continuation of 8·481, including the transformation theory of dynamics, the elements of perturbation theory and the general theory of orbits, non-holonomic and dissipative systems and the theory of vibrations. (Alternate years. Not offered 1940–41.)

8·491. Methods of Theoretical Physics (A). An advanced subject coördinating and developing the methods used in the solving of problems in electrostatics, hydrodynamics, heat flow, diffusion, wave motion, wave mechanics, etc. The equations governing these phenomena are developed and the effects of boundary conditions on the solutions are studied. The uses of Green's functions, eigenfunctions, variational methods, and conformal transformations are discussed in detail. (Alternate years. Offered 1940–41.)

8·50. Heat and Thermodynamics. 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.

8·511. Thermodynamics and Statistical Mechanics. Introduction to the principles of thermodynamics and statistical mechanics, including quantum statistics, with application to properties of gases and solids, change of state, chemical equilibrium, and radiation.

8·512. Statistical Mechanics (A). The basic principles of statistical mechanics with applications to physical problems. (Alternate years. Offered 1940–41.

8·521. Quantum Mechanics (A). An advanced subject in modern atomic theory. The Dirac operator method is developed, and the theories of electron spin and of the interaction of radiation and matter are discussed. The theories are applied in the study of atomic and molecular spectra, collision processes and other topics. (Alternate years. Offered 1940–41.)

8·54. Electromagnetic Theory (B). Formulation of field equations. Generalization to material media with discussion of theories of dielectric constant, permeability and polarization. Energy of the electromagnetic field — Poynting theorem. Wave propagation in unbounded media. Boundary conditions and propagation in bounded

Physics Continued

media: reflection and refraction of electromagnetic waves, with particular emphasis on the theory of propagation along conductors. Field due to an oscillating dipole and application to calculation of radiation from systems having known current distribution; antenna theory.

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. Offered 1940–41.)

8·57. Cosmic Rays and High Energy Phenomena (A). Theory of geomagnetic latitude, longitude and azimuthal effects. Atmospheric energy absorption of primary cosmic ray particles. Shower production and bursts. Galactic rotation. (Alternate years. Not offered 1940–41.)

8·58. Theory of Relativity (A). Restricted and general relativity, cosmological considerations, attempts at a unification of electricity and gravitation, quantum theory and relativity. (Alternate years. Offered 1940–41.)

8·591, 8.592. Theoretical Seminar (A). Discussion and reports by students on special topics in theoretical physics.

8·60. Special Problems in Theoretical Physics (A). Reading, consultation, and original investigation on a problem in theoretical physics.

The following subject is offered as a General Study. For description see Division of General Studies.

G5. Descriptive Astronomy.

CHEMICAL ENGINEERING

Subjects 10·00 to 10·99

10·11. Problems of the Chemical Engineer. Describes the field of activity of the chemical engineer and the preparation along both chemical and engineering lines which the practice of the profession requires.

10·15. Thesis Reports. Intended to give seniors training in the presentation of the results of technical investigations by oral and written reports. An attempt is made to reproduce the variety of situations which confront the practicing engineer in presenting oral reports to groups with varying degrees of engineering training and experience. Thesis reports consist of periodic oral and written reports on progress of thesis before fellow students and staff members in chemical engineering. Committee reports consist of oral reports on some technical problem before student groups from various branches of engineering. The Department of English coöperates in this work.

10·17. Industrial Chemistry. Deals chiefly with the industrial aspects of fuels, combustion and furnaces through the solution of numerous problems. Lewis and Radasch, *Industrial Stoichiometry*.

10·18. Industrial Chemistry. The more important industrial chemical processes are studied from the point of view of both the chemical reactions forming the basis of the process, and the plant necessary to carry on these reactions. In this way the interrelationships of the different industries as to raw materials, sources of energy, and standard types of apparatus are developed and a general survey of the field obtained. Extensive problem work is included.

10·201. Industrial Chemistry. Similar to 10·18 except that problems are of a less advanced character.

10·203. Industrial Chemistry. Similar to 10·18 except that problems are of a less advanced character.

10·21. Industrial Chemistry (B). A continuation of 10·18. Devoted to those industries which deal with amorphous solids, including glass, ceramics, leather, paints, textiles, paper, rubber, etc.

10·25. Industrial Chemistry (A). Covers industrial stoichiometry and the industrial chemistry of the more important chemical industries. It includes a detailed discussion of the interrelationships of the important industries and problem work on the various processes discussed. The subject is designed 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). A study of the evolution of a chemical process from the idea as originally formulated through the successive stages of laboratory development to the design and equipment of the necessary plant.

10·27. Industrial Chemical Laboratory (A). Provides experience in methods of attack upon typical industrial chemical problems, the solution of which necessitates brief laboratory investigation. The problems are of current industrial interest and emphasis is placed upon the interpretation of experimental results and their effective presentation in a series of group conferences. (Not offered 1940–41.)

10·28. Chemical Engineering. A study of the thermal properties of matter and the energy relationships underlying mechanical and chemical processes, including a thorough 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. The second law is developed and its more elementary applications discussed.

Chemical Engineering Continued

10·29. Chemical Engineering (B). Devoted primarily to the quantitative engineering applications of the second law. Includes 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. Because of its vital importance, attention is given to high pressure operations, particularly the influence of pressure on thermal effects and chemical equilibrium.

10·30. Engineering Equipment. Intended to give 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 will be placed on the determination of the operating characteristics of such equipment under plant conditions.

10·31, 10·32. Chemical Engineering (B). These subjects cover the basic principles underlying the unit operations of chemical industry. Because most of the operations involve fundamental problems in flow of heat this topic is first discussed in detail. There follows an analysis of the operation of evaporation, distillation, drying, humidification, filtration, subdivision of solids, hydraulic classification and similar topics. Emphasis is laid on quantitative relationships and these are illustrated by the solution of numerous problems. Walker, Lewis, McAdams and Gilliland. *Principles of Chemical Engineering.*

10·311. Heat Transfer (B). A study of the fundamentals of conduction, convection, and radiation of heat, with applications to problems arising in practice. (For Naval Engineering Students only).

10·33. Analytical Treatment of Chemical Engineering Processes (A). The analysis of the unit operations of chemical engineering almost always involves three major principles: the conservation of matter and energy, the laws of equilibrium, and those of reaction rate. In a large majority of cases the latter reduce to problems of diffusion, requiring certain mathematical techniques, the presentation of which is the fundamental purpose of this subject. It involves the training in setting up ordinary and partial differential equations corresponding to specific physical situations, and presents methods available for their solution, including various graphical constructions. Sherwood and Reed. *Applied Mathematics in Chemical Engineering.*

10·38. Explosives Plant Engineering. Includes a survey of the fundamentals of physical chemistry and chemical engineering, followed by a more advanced application of these subjects to the industrial operations involved in the manufacture of ordnance material with particular reference to propellants and high explosives. (For U. S. Army and Naval Officers only.)

10·39. Theory of Interior Ballistics. A study of the theories underlying the ignition and combustion of propellants in the gun and that of the motion of the projectile along the bore. Followed with applications to the design of guns and ammunition. (For U. S. Army and Naval Officers only.)

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 is laid on behavior of complex mixtures, correlation of data, and methods of approximation.

10·41. Distillation (A). A quantitative study of the basic principles of distillation, as applied to binary mixtures, both of complete and limited miscibility and to multicomponent systems. Problems include batch and continuous simple distillations, steam distillation, vacuum and pressure distillation, rectification, heat recovery and the like. Special attention is paid to graphical methods.

10·45. Distillation and Absorption (A). A quantitative study of distillation, including rectification of binary and complex mixtures. Also includes a study of diffusional processes, with particular attention given the design computations for gas absorption equipment. A combination and condensation of subjects 10·41 and 10·46.

10·46. Absorption and Extraction (A). The basic principles of equilibria, mechanism and rate of interaction are studied in detail. Quantitative applications include 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. Particular attention is paid to graphical methods.

Includes a study of the basic principles of extraction by liquids, solvent recovery by adsorption and the leaching of various solids. Sherwood, *Absorption and Extraction.*

10·50. Heat Transmission (A). A subject applying the fundamentals of conduction, radiation and convection of heat to the problems and situations most frequently encountered in chemical industry. Emphasis is laid upon the general relationships between fluid dynamics and diffusional processes. The approach to the problem is empirical, but dimensionally sound. Graphical methods are used in large degree. Every effort is made to orient the student as to the trends of present development. McAdams, *Heat Transmission.*

10·52. Chemical Engineering II (A). Offered for graduates of other schools whose training in chemical engineering has been along somewhat different lines from that given in 10·31 and 10·32. Emphasis is placed on basic theories in flow of fluids and flow of heat and application is made to problems of an advanced character. Attention is paid to recent developments in chemical engineering.

10·53. Chemical Engineering Design (A). Open only to students who have taken the fieldwork of Course X-A. The problems involve the design of a complete plant, from the viewpoint of both chemical engineering and economics.

10·54. Economic Balance in Chemical Industry (A). Lectures and conferences planned to develop original power in the solution of problems in chemical industry. The problems cover a wide range of topics, but in each case the various factors under the control of the designer are

Chemical Engineering Continued

analyzed quantitatively, to determine the optimum design from the viewpoint of cost and economic return.

10·55. Economic Balance (A). A shorter subject of the same character as 10·54.

APPLIED CHEMISTRY

10·61. Industrial Electrochemistry (A). A discussion of the principles underlying electrolysis, electrodeposition, and electrophoresis. This will be followed by a study of industrial applications such as refining of metals, production of gases, electroplating, and manufacture of organic and inorganic derivatives, with emphasis on modern developments.

10·62. Applied Chemical Thermodynamics (A). Energy relations of chemical processes. Equilibria and thermal effects in heterogeneous and homogeneous systems, and technique of utilization of data in interpretation and practical control of chemical reactions.

10·63. Industrial Chemistry II (A). A study of the chemical industries which deal primarily with amorphous materials, including thermoplastics, textile fibres, cellulose products, leather and rubber. A brief survey of the general principles of colloidal chemistry is followed by analyses of important problems encountered in these industries.

10·65. Catalysis and High Pressure Processes (A). A study of the 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., together with a discussion of industrial applications, equipment requirements, and opportunities for research.

10·661. Introduction to Colloid Chemistry (A). A discussion of the colloidal state of matter and of the characteristics and behavior of colloids; a description of natural colloids and of the different methods of producing matter in the colloidal state, and a consideration of the methods applied in the study of substances in the colloidal state.

10·662. Colloid Chemistry (A). A continuation and extension of 10·661, with special attention to recent developments in surface reactions, gel formation, and their technical significance.

10·663. Introduction to Applied Colloid Chemistry (A). This subject constitutes a prerequisite to 10·63 Industrial Chemistry II, and is given for the purpose of acquainting those who have had no course in colloid chemistry with the fundamentals of this science. It has been 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.

10·672. Colloid Seminar (A). A seminar subject paying particular attention to industries using typical colloids as raw materials.

10·673. Colloid Chemistry Laboratory (A). Designed to train a limited number of of men in the use of special instruments such as stalagmometers, bubble pressure pipettes, and surface and interfacial tensiometers. Also includes the laboratory technique of dialysis, electrodialysis, cataphoresis, modern microscopic technique, and micro-dissection, as well as the theoretical background pertaining to these methods.

10·674. Colloid Chemistry Laboratory (A). Continuation of 10·673.

10·68. Corrosion (A). Designed to assist in the selection of equipment for use in chemical engineering processes. Major emphasis is placed on resistance to corrosion and considerable time is devoted to theories of corrosion and methods of prevention.

10·69. Plastic and Other High Polymeric Substances (A). A general survey of the chemical and physical properties and molecular structure of organic and inorganic high polymeric substances. Emphasis will be placed on specialized colloid chemical and physical methods of investigation necessitated by the unique properties of this class of materials. An attempt will be made to correlate theoretical considerations of structure with properties of practical industrial importance.

FUEL ENGINEERING

10·70. Principles of Combustion (A). Open to graduate students who wish to specialize in the engineering rather than the chemical phase of fuel engineering. As emphasis will be placed on the application of fundamental principles in combustion reactions, the subject matter will include instruction in physical and organic chemistry of particular importance in fuel engineering. Numerous problems, illustrating the quantitative application of these principles in fuel processing and utilization, will be assigned.

10·71. Fuel Engineering (A). An advanced subject in fule engineering for students with an adequate background of physical and organic chemistry and thermodynamics. The subject includes such material as the mechanism of the combustion reactions, and the application of combustion principles to problems of design or use of equipment for fuel processing and utilization.

10·74. Furnace Design (A). A study of principles and calculations of furnace design and construction dealing with rates of heat transfer and with flow of gases in furnaces. The quantitative design and layout of several furnaces, retorts or still-settings will be carried out.

10·76. Seminar in Radiant Heat Transmission (A). Will stress the theory and derivations incident to heat transfer in furnaces. Among the subjects considered will be the 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.

Chemical Engineering Continued

10·79. Automotive Fuels (A). A brief 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 will be assigned throughout the term and a comprehensive report required on some motor fuel subject.

SCHOOL OF CHEMICAL ENGINEERING PRACTICE

10·81. School of Chemical Engineering Practice — Bangor Station (A). At this station emphasis is placed on the study of electrolysis, drying, humidification, evaporation, absorption and causticization. This work is carried out in the plant of the Eastern Manufacturing Company 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). The work involves studies of distillation, heat transfer, fluid flow, handling of corrosive materials, plant layout, and industrial chemical operations such as those employing catalysis and high pressure. This program is carried on 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). The work deals primarily with 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. The work is done 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 primarily for post graduate students on thesis or preparing for the oral examination for the Doctor of Science degree.

GEOLOGY

Subjects 12·00 to 12·99

12·01. Mineralogy. Lectures and laboratory work on the fundamentals of crystallography and mineralogy. The introductory study of crystal models is followed by instruction in blowpipe analysis. These preliminaries are then applied to the study of minerals by intensive work in determinative mineralogy. A close acquaintance is made with about one hundred and ten of the commonest minerals. Warren, *Determinative Mineralogy;* Dana, *Manual of Mineralogy.*

12·03. Theoretical Mineralogy (B). An introduction to our present knowledge of the structure of crystals, and the application of this knowledge to mineralogy. Lecture topics include: the fundamental laws of crystal chemistry, radius ratio, coördination number, polarizability, ionic structures, electron pair bond structures, metallic structures; the silicates and silica framework crystals; isomorphism; polymorphism, cluster vibrations, cluster rotations, disordered structures, superstructures, solid solution and segregate phase formation; crystal growth and habit, crystal imperfections and lineage structures; the plastic deformation of crystals, translation-gliding and twin-gliding; the structural aspects of certain physical properties such as cleavage; phase diagrams.

12·05. Mineralogical Seminar (A). Seminar hours devoted to the presentation and discussion of literature bearing on certain phases of theoretical mineralogy. (Alternate years. Not offered 1940–41.)

12·06. Mineralogical Research (A). Supervised research on some mineralogical or crystallographic problem. It is intended that each investigation will result in a publication.

12·15. Petrography. Lectures on the occurrence and genesis of rocks and rock minerals, principally of igneous

Geology Continued

and metamorphic types. Laboratory work on thin rock sections using the polarizing microscope. Supplemented by field excursions to instructive nearby localities. Harker, *Petrology for Students;* Tyrrell, *Principles of Petrology;* Rogers and Kerr, *Thin-section Mineralogy.*

12·16. Chemical Petrology Seminar (A). Discussion of the physical chemistry of rock systems and the literature of petrogenesis. Igneous rocks will receive most attention. Useful reference texts are: Bowen, *Evolution of the Igneous Rocks;* Daly, *Igneous Rocks and the Depths of the Earth;* Barth, *Eruptivgesteine.*

12·17. Advanced Petrography (A). A laboratory subject designed to acquaint students with methods and instruments used in petrological research. Chemical petrology methods include (1) The electric counter and staining techniques to determine mineral and chemical compositions. (2) The double variation method for index determination. (3) The compensator method for determination of birefringence. (4) The extinction, zonal, and Federov methods for determination of twin laws and chemical composition of feldspar. Structural petrology methods include (1) Statistical analysis of oriented thin sections by optical and X-ray techniques. (2) Preparation of diagrams and evaluation of the data obtained.

Since the majority of the foregoing methods utilize the universal stage, the subject will serve to demonstrate optical principles as well as methods.

12·18. Structural Petrology Seminar (A). Discussion of rock fabrics, with emphasis on the relations of fracture, plastic and viscous flow, and recrystallization. The topics covered will be based on Balk: *Structural Behavior of Igneous Rocks;* Fairbairn: *Structural Petrology,* and Knopf and Ingerson, *Structural Petrology.* (Alternate years. Not offered 1940–41.)

12·211. Optical Crystallography. Study of the optical properties of crystals with special reference to the identification of crystalline substances with the aid of the polarizing microscope. Students primarily interested in mineralogy and petrography study, in the laboratory, the optical properties of mineral crystals; other students receive instruction on the properties of common inorganic crystals. Winchell, *Elements of Optical Mineralogy, Fourth Edition, Part I.* Larsen and Berman, *Microscopic Determination of the Nonopaque Minerals* (*U. S. Geological Survey Bull.* 848).

12·26. Structural Crystallography (A). A development is given of the determination of crystallographic information from X-ray diffraction data. The lectures include: simple aspects of X-ray diffraction theory useful in crystallographic investigations, the reciprocal lattice, diffraction from a rotating crystal, and the Weissenberg method. Particular attention is given to the crystallographic information obtainable by this important method: point group symmetry, space lattice type, simplest unit cell, full diffraction symmetry and space group. In the laboratory, the student applies this theory to the determination of the characteristics of an assigned crystal. In simple cases the positions of the atoms may also be located.

12·301, 12·302. General Geology. A study of 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 is devoted to physical geology — minerals, rocks, and the geologic work of streams, oceans, glaciers, and the wind. The second term is devoted to a brief study of structural geology, followed by historical geology. Lectures, laboratory demonstrations and work on specimens and maps, and during favorable weather, field trips to points of geologic interest in the vicinity.

12·321. Applied Engineering Geology. Geology adapted to the needs of engineers. Ries and Watson, *Elements of Engineering Geology.*

12·322. Applied Engineering Geology. The relations of geology to engineering problems, with reviews of actual cases.

12·38. Geomorphology (B). A study of the fundamental principles of geomorphology. Constructional land forms — plains, plateaus, mountains and volcanoes — are first examined and classified. Then the student considers 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 the histories of valleys, of glacial and aeolian land forms, and of shore lines are developed, leading to the final intergradation of the destructional with constructional land forms. The method will not be that of lectures, but will consist of inductive class discussions, with laboratory work and reading in selected literature. Opportunity for voluntary field work will be offered.

12·40. Economic Geology. Lectures on the occurrence and origin of ore deposits. Lindgren, *Mineral Deposits, Fourth Edition.*

12·41. Economic Geology Laboratory (B). The student is trained in the determination of ore minerals and their relationships in hand specimens and in polished sections. The laboratory results are correlated with the geological occurrence of the ores. Intended as a laboratory supplement to 12·40.

12·42. Applied Economic Geology (B). Considers the application of geology to: prospecting for new ore bodies, geophysical prospecting, alluvial prospecting, diamond drill core interpretation, mine sampling and ore estimation. The various methods of underground geological mapping are discussed. (Alternate years. Offered 1940–41.)

12·431, 12·432. Economic Geology Laboratory, Advanced (A). Laboratory study of specimens or suites of specimens from mineral deposits; metallographic or petrographic work.

12·433, 12·434. Economic Geology Seminar, Advanced (A). Seminar including reading and reports based upon the literature of ore deposits.

Geology Continued

12·44. Economic Geology of Fuels (B). The origin and the geological occurrence and utilization of deposits of natural gas, petroleum and coal.

12·511, 12·512. Paleontology. Designed to give a knowledge of the past life of the earth through a comparison with living plants and animals. Shimer, *Introduction to the Study of Fossils, Second Edition.*

12·52. Paleontology, Advanced (A). Laboratory work and assigned reading upon the Invertebrata or upon some aspect of stratigraphic geology.

12·53. Index Fossils (A). The determination of the geologic age of rock formations in North America through a study of their included organic remains. Grabau and Shimer, *North American Index Fossils.*

12·54. Micropaleontology (A). A study of fossil microscopic plants and animals.

12·55. Organic Evolution, Advanced (A). Study of various phases in the evolution of plants and animals.

12·581. Sedimentation (B). A brief survey of the chief types of sediments and sedimentary rocks with pertinent discussions on the 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 microscopic 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). A study of glaciers, their origin, motion, resulting topographic forms, and types of deposits.

12·62. Geological Climates Seminar (A). (Alternate years. Not offered 1940–41.)

12·63. Physical Geology Seminar (A).

12·64. Geology of North America (A). Beginning with the present physiography of the continent, the geological history of each province is studied. This includes the stratigraphy, orogeny and igneous intrusives and extrusives and the influence of these upon the present structure and topography of the continent. (Alternate years. Offered 1940–41.)

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). Lecture-seminar on problems in geology. The seminars will be held in alternate weeks, and will be 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. A synoptic program of the course will be given at the beginning of each year at department headquarters.

12·70. Structural Geology (B). Deals with the original or primary structural features of igneous and sedimentary rocks and with the nature and causes of secondary structural features, joints, fissures, faults, folds and rock cleavage, their manner of formation and significance.

12·71. Structural Geology, Advanced (A). The causes, nature and significance of structural features produced in rocks by earth movements.

12·79. Applied Engineering Geology. Designed for advanced students in engineering who have not had systematic training in geology. Intensive study of essential fundamentals of geological materials and processes, followed by consideration of applications of geology to engineering, largely by the review of actual cases.

12·80. Geology of Coal and Petroleum (B). The geological occurrences of petroleum and coal deposits and the methods of investigating petroleum and coal properties.

12·81. Geology of Petroleum, Advanced (A). The stratigraphy and structure of the oil fields of the world, with special reference to those of the United States, are considered. Application is made of data in known petroliferous provinces to illustrate methods of exploration in the development of new regions.

12·851, 12·852. Theoretical Geophysics, Advanced (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. *The Earth,* Jeffreys.

12·86. Elements of Seismology (B). A general introductory survey of seismology. The nature of earthquakes and their effects, and the propagation of seismic waves and their bearing upon the structure of the earth are treated. Seismic instruments and the applications of seismology to prospecting and engineering are briefly considered. (Alternate years. Offered 1940–41.)

12·87. Introduction to Geophysical Prospecting (B). This orientation course is designed to acquaint the student with the geophysical prospecting methods as a geological tool. The principles, possibilities and limitations of the methods are discussed, and the nature of the problem of interpreting the observational data is explained and illustrated.

12·91. Elements of Mining (B). Lectures, discussions, assigned reading to familiarize the student with mining history, terminology, and fundamentals of practice. Subjects include prospecting, exploration, drilling, shaft sinking, drifting, explosives, blasting, timbering, haulage, hoisting, ventilation, drainage, mining law, health and safety.

12·92. Mining Methods and Practice (B). A continuation of 12·91. Mining systems, costs, engineering and administration. Lectures, discussions and assigned read-

Geology Continued

ing, covering mining of metals and non-metallics by open-pit and underground methods, attention concentrated on adaptability, choice, and practical operation of representative methods of mining.

12·94. Mineral Economics (B). Economic aspects of mineral resources of the world, production and consumption. Effects of distribution, political control, monopolies, tariffs and cartels on availability of raw materials. Lectures, discussions and reading to give the student a broad outlook on the mineral industries. Attention directed to economic planning, self-sufficiency, nationalism, strategic minerals, over-production and secondary metals.

12·95. Mine Valuation (A). Methods of examination and principles of valuation of principal types of mineral properties. Lectures, class discussions, problems, to equip the student with theory of valuation and its practical application. Emphasis on sampling, sampling calculations, estimation of ore, costs, selling prices, markets, and profits, the interest rate, depletion and taxation.

12·96. Mineral Economics Seminar (A). Discussions of more advanced phases of mineral economics.

The following subjects are offered as General Studies. For description see Division of General Studies.

G9. Geology.

G10. Organic Evolution.

NAVAL ARCHITECTURE AND MARINE ENGINEERING

Subjects 13·00 to 13·99

13·01, 13·02. Naval Architecture (B). General theory of naval architecture; geometry of the ship; principles of flotation including displacement, stability and trim; buoyancy and stability in the damaged condition, subdivision for safety at sea; theory of waves; longitudinal strength; tonnage and freeboard. Rolling, pitching, heaving and yawing; steering and maneuvering; the resistance and powering of ships, influence of form and coefficients on resistance, models and model tanks; propulsion and propellers; methods of conducting power and speed trials; launching, grounding and docking.

13·021. Naval Architecture. The 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; buoyancy and stability in damaged condition, subdivision for safety at sea.

13·03, 13·04. Naval Architecture and Ship Design (A). These subjects deal with some of the problems in naval architecture and ship design which are more advanced than those given in the undergraduate course. Special attention is given to historical development, basic design of various types, structural design, stability in the damaged condition, subdivision, powering, analysis of performance, economics of design, general arrangement, cargo handling, launching, heating, ventilation, air conditioning, hull piping systems, etc. Both naval and merchant vessels are discussed. Paralleling the lectures, the student undertakes an original design of a merchant ship in the drafting room.

13·05. Navigation. Designed especially for students in Courses XIII and XIII-C. The following will be covered: use of the compass and log; plane, parallel and mid-latitude sailing; dead reckoning; departure; great circle charts and sailing; piloting; pilot charts; tides; currents; soundings; chart reading; aids to navigation; chronometer and sextant; equinoctial system; time (except siderial time); horizon system; correcting sextant altitudes; latitude observations; reduction to meridian; solution of the astronomical triangle by one of the commonly used methods; solution of sights; lines of position; time of morning, noon, and afternoon sights; navigator's day's work at sea; identification of stars and planets.

13·12T. Theory of Warship Design.*

13·13. Theory of Warship Design*

13·13T. Theory of Warship Design.* (Not offered 1940–41.)

13·14. Theory of Warship Design.*

13·15. Theory of Warship Design.*

13·16. Theory of Warship Design.*

13·16T. Theory of Warship Design.* (Not offered 1940–41.)

13·21T. Warship Design.*

13·22T. Warship Design.*

13·23. Warship Design.*

13·24. Warship Design.*

13·24T. Warship Design.* (Not offered 1940–41.)

13·25. Warship Design.*

13·25T. Warship Design.* (Not offered 1940–41.)

13·26. Warship Design.*

13·26T. Warship Design.* (Not offered 1940–41.)

13·29. Warship Design.**

13·30. Warship Design.**

13·34. Ship Construction. The structural design of steel cargo ships and their equipment. Details of steel construction, such as shell plating, framing systems, decks, bulkheads, double bottom tanks, and methods of fabrication and erection. Both riveted and welded construction are considered. The course also deals with deck auxiliaries, life-boat equipment, cargo handling gear, arrangement of quarters, ventilation and hull piping systems, joiner

*Open only to Naval Students in Course XIII-A.
**Open only to special students in Naval Construction.

Naval Architecture and Marine Engineering Continued

work and fire proof and fire resisting construction of passenger ships.

13·37. Merchant Shipbuilding.* A brief subject dealing with the design and construction of various types of merchant ships, especially those which might be used as naval auxiliaries in time of war. The rules of the classification societies for building and classing merchant vessels, and the governmental regulations applying to tonnage, freeboard, subdivision, stability, life-saving appliances, fire protection and inspection, are considered.

13·40. Yacht Architecture. A combined lecture and drafting room subject dealing with sailing and auxiliary yachts. In the lectures attention is called to the historical and technical developments of wooden boats. Illustrated by lantern slides and moving pictures. In the drafting room the student prepares the design of a wooden sailing yacht by fairing lines, making calculations and showing the method of construction and type of rig. The student is also given an opportunity to make a model of his design.

13·41. Ship Drawing. In this subject the student prepares the lines and curves of form of a merchant ship for definite trade requirements.

13·43, 13·45. Ship Design. (13·45 B). In these subjects each student continues the design which he began in 13·41. The following work is carried out in the drafting room: cross curves and curves of statical stability; drawing of midship section in accordance with the rules of the American Bureau of Shipping or Lloyd's Register of Shipping; inboard profile and deck plating plan; calculations for powering; subdivision, longitudinal and local hull strength, and launching; estimate of weights; diagrammatic plans for hull piping; layout of shell plating on prepared half model.

13·47. Ship Design.† Drawing-room exercises for students in marine transportation. Each student works up a design of a merchant ship, which includes the lines, dimensions, coefficients, displacement, freeboard, power and propeller requirements, and stability under various conditions of loading. He also draws a type midship section showing the principal scantlings of his design.

13·48. Model Making. The construction of a half model from the student's design. Such assistance will be given as will enable the student to compiete the work.

13·52. Marine Engineering. An introductory subject in marine engineering covering both steam and Diesel machinery; fuels, combustion, boilers, reciprocating engines, turbines, auxiliary machinery and steam power plant layouts. Diesel and oil engines, motorship auxiliaries; types of engines, fuel injection and combustion, valve gears, supercharging, oil engine fuels, and Diesel electric drive. Chapman, *The Marine Power Plant.*

13·54. Marine Engineering (B). Special topics in dynamics and stress analysis. The 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. The effects of superheat, increased pressure, vacuum; types of auxiliary drive and heat balance of the marine steam plant are studied. Critical speed, blade strength, design of reduction gears and pump laws are discussed.

13·56. Marine Engineering.† An advanced subject covering the 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; boilers, main engines, auxiliaries and auxiliary systems.

13·58. Marine Engineering.*

13·61. Marine Engineering Design (B). The design of various machinery parts in the drafting room; analysis of an engine with respect to torque diagram, stresses in various parts, bearing pressures, etc.; design of riveted and welded joints; the choice and relative advantages of different materials. *Marine Engineer's Handbook*, Sterling.

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.

13·64. Marine Engineering Design.*

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 transverse vibration of uniform beams; 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 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; non-linear systems; self-sustained oscillation.

13·75, 13·76. Advanced Marine Engineering (A). These subjects consist of lectures, conferences, and drafting, and deal with the basic design of the main propelling machinery and its auxiliaries in various types of ships. Calculations are made for the steam consumption of the various units of the power plant, and a machinery layout

*Open only to Naval Students in Course XIII-A.

†Open only to students in XIII-C who have had a year of practical experience with a steamship company, with nine months' service at sea.

Naval Architecture and Marine Engineering Continued

is made in the drafting room for a specified vessel. This work involves the basic design of boilers, propelling machinery, gears, condensers, auxiliaries, piping, shafting, propellers, etc. The necessary applications of the principles of heat balance, heat transmission, fuels, lubrication, and economy are studied. Special problems in heat stresses in piping, series feed-water heating, prediction of performance, trial analyses, propeller design, strength of various parts, balancing and vibration, are undertaken. Special attention is given to the study of the application of the Diesel engine and the comparison and selection of various types of propelling machinery and auxiliaries.

13·751. Marine Engineering.* (Not offered 1940–41.)

13·752. Marine Engineering.* (Not offered 1940–41.)

13·78. Propeller Theory and Experimental Research (A). A discussion of modern ideas of propeller action based on air-foil theory; cavitation; interactions of hull and propellers; various available methods of design.

13·81, 13·82. Ship Operation (B).† The engineering and economic aspects of ship operation, a study of the 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 and speed on operating expenses; turn-around and port expenses; cubic and deadweight 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. Numerous problems in both cargo and passenger ship operation are assigned to the student.

13·83. Port Facilities. A study of ports and port layouts, the handling and storage of ships' cargoes; piers, transit sheds, warehouses, railroad facilities, pier equipment; the design of the ship with reference to cargo handling, influence of turn-around on ship operation, longshore labor problems; marine passenger terminals. Special consideration is given to harbor and inland water transportation and the influence of the trends and developments in marine transportation on ports and port facilities.

13·90. Experimental Research (A). Designed to meet the needs of the graduate student who wishes to carry out a minor investigation in a particular field. Subject and hours arranged to fit individual requirements.

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†Open only to students in XIII-C who have had a year of practical experience with a steamship company, with nine months' service at sea.

BUSINESS AND ENGINEERING ADMINISTRATION

Subjects 15·00 to 15·99

15·01. The Field of Business Management. Lectures and discussions designed to describe the field of activity of the business manager, and the nature of scientific, engineering, economic and professional subjects which are essential to adequate academic preparation.

15·11, 15·12. Introduction to Business Management (B). Introduces the student to the functions and methods of business. The principal topics are: corporate organization, finance, accounting, production, marketing, with emphasis on the interrelations between these functions. Considers business problems in the order that they would be encountered were a new business to be launched: survey for a new venture; promotion, organization; personnel; operation; control; expansion or liquidation. (Not open to Course XV; may be taken as an elective in other Courses.)

15·20. Ocean Shipping Administration. Deals with the types of ocean services and traffic agencies and their organizations; rate and traffic agreements; ocean shipping documents; ocean rates and regulation; marine insurance; and admiralty law. Its purpose is to acquaint the student with the more important aspects of the administration of ocean shipping.

15·25. Industrial Traffic Management (A). A study of the organization and operation of an industrial traffic department. Deals with industrial aspects of freight classifications, rate structures, routes, carrier-shipper relations, common carrier liabilities, general and special services, national and state common carrier regulations and protective insurance. Considers the types of transportation agencies such as rail, water, air, motor truck, mail, parcel post and express. Seminar discussions are supplemented with classroom conferences conducted by traffic managers from representative industries.

15·41. Finance. Deals with the principles of financial organization and management. Following an introductory study of the modern business corporation, the student examines the instruments and agencies used in finance — corporate securities, investment banking and the exchanges, proceeding thereafter to the problems of internal financial control. Among the topics considered are: promotion, valuation, the financial plan, the sale of securities and the administration of income. Problems ofexpansion and the procedure during failure and reorganization conclude the subject. Specific cases illustrate the principles and afford an opportunity for individual analysis. Throughout the treatment emphasis is placed on the changing character of financial management, the growing demand for consideration of interests other than those of the control group, and the development of new relationships between business and government.

Business and Engineering Administration Continued

15·42. Financial Problems (B). Selected topics in the fields of corporate and personal finance. Case studies in internal financial administration of industry provide opportunity for applying to concrete situations the principles developed in 15·41. Problems in personal finance constitute the major part of the subject and include consideration of investment, insurance and taxation.

15·46. Financial Administration of Industry (A). Deals chiefly with the practical problems of internal financial management. Based upon the principles developed in 15·41, the subject proceeds with an analysis of the specific problems confronting business managers in the manufacturing, mercantile and public utility fields. Although the case method is largely used, other readings are also required. Primary attention is given to current financial operations; and attendant consideration to financial problems relating to taxation, consumer purchasing power and the availability of investment funds. Oral and written reports form an important part of the work.

15·50. Accounting. Familiarity with the use and interpretation of financial reports is an essential business tool. Since analysis depends upon a knowledge of constituent elements and their derivation, the subject begins with a brief consideration of double-entry bookkeeping. The major part of the term is devoted to a consideration of the problems inherent in the typical financial statements. The form and content of balance sheets and of profit and loss statements are considered; the problems of surplus, depreciation and valuation are studied. The subject concludes with an introduction to methods of statement analysis. So far as is possible, reports and accounting policies of actual companies form the basis for discussion. Throughout the course emphasis is placed upon interpretation of results. (Not open to students below the third year.)

15·51. Industrial Accounting (B). The application of accounting control to industry. Includes the principles of cost analysis as applied to problems of manufacturing, distribution and administration. Teaching material is drawn from a wide variety of business situations.

15·52. Accounting. This shorter subject has as its objective the introduction of the student to the elements of accounting. The preparation and structure of representative financial reports to stockholders and creditors are examined in order that the student may understand their use and significance.

15·55. Problems in Accounting Policy (A). A consideration of case problems involving accounting policy approached from the administrative viewpoint. The application of analytical methods to financial data is stressed. Discussion covers the nature and determination of income, asset valuation, presentation of net worth, consolidated statements.

15·58. Problems in Accounting Control (A). Examines the scope of the accounting function with emphasis upon the duties and responsibilities of the controller. Explores the principles underlying records systems and the extent to which various actual systems meet desired requirements. Periodic reports, budgets, costs, cash control, internal control, inter-company and branch control, machine accounting, taxes and other special problems, including the relation of the controller to stockholders and to public bodies, are considered.

15·61. The Law of Contracts (B). Covers the entire field of the law of contracts generally. Deals comprehensively with the rules applicable to the formation of contracts, their performance and discharge and also the rights of third parties in contracts. The rules applicable to special kinds of contracts such as agency, sales and negotiable instruments are treated incidentally but not comprehensively.

15·62. The Law of the Market (B). Deals with the rights and liabilities of buyers and sellers of goods and also the rules of law applicable to customary methods by which purchases and sales are financed. Covers fully the uniform law of sales and uniform law of negotiable instruments.

15·64. The Law of Business Organization (B). Deals with the legal problems arising out of the forms of organization through which commercial activities are carried on. The legal aspects of the formation, operation and termination of agencies, partnerships, corporations and unincorporated association are considered in detail.

15·70. Production. A basic treatment of the manufacturing process. Among the important topics covered are: 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. Classroom work is supplemented by plant visits and reports. One hundred industrial organizations in greater Boston coöperate in this plant visit work.

15·71. Production (B). The application of the principles of scientific management in production. Topics covered include: process research; operation analysis; standardization of materials, facilities and methods; production control; the design and installation of wage incentive systems and new product control. Students are given opportunity to investigate and report upon each of these activities as practiced by a group of coöperating manufacturing establishments to each of which a series of correlated plant visits are arranged. Classroom work is supplemented by plant visits.

15·72. Technique of Executive Control (B). A survey of the means by which the line executive deals with the working group. The student considers the nature of executive responsibilities and methods of control; devices for stimulating the desire of the employee to improve the quantity and quality of his work; ways of collaborating with other executives and functional specialists. Considerable time is given to a study of common executive difficulties with subordinates, associates and superiors.

15·73. Management Laboratory. Work Simplification and Time Study. Instruction in the technique of motion study, an essential tool of modern management extensively used for the simplification and standardization of manual work. Includes such topics as process charts,

micro-motion and principles of motion economy, proper work-place layout, labor-saving tools and equipment, assembly jigs, etc. Motion picture films of industrial operations are used as case material; instruction is given in labor relations involved in the introduction of work simplification; problems of employee training are considered; and the bearing of motion economy upon morale is discussed. Instruction in the use of the stop watch for rate setting includes such topics as selected times, leveling factors, fatigue study, allowances, base-rate evaluation.

15·75. Manufacturing Analysis (A). Deals with the formation of analytical sequences for the appraisal of management methods in a manufacturing establishment. Evaluates such factors as process, facilities, operating methods, organization, control structures, incentives. Analyzes the specific activities of such functions as purchasing, storage, traffic, research, design, inspection, salvage and maintenance. Students undertake analytical projects in several nearby companies who coöperate in making their productive operations available for first-hand study.

15·81. Marketing. For most commodities the cost of distribution exceeds the cost of production. Therefore this general subject deals with the broader social and economic aspects as well as the managerial problems involved in marketing operation. Includes such topics as product policy, selection of channels of distribution, brand policy, advertising and sales promotion, customer relationships and problems of price structure. Major emphasis is laid on the marketing of manufactured consumer goods, although some attention is given to the marketing of industrial goods and agricultural products. Instruction is based primarily on the problem method, supplemented by reading assignments and conferences with marketing executives.

15·82. Sales Management (B). Familiarizes the student with the operation of sales departments of manufacturing and service organizations. Among the problems considered are: product planning, market research, pricing, credits, sales promotion and advertising, organization of the sales department, selection, training, supervision and control of the sales force, and administrative control of sales operations, including budgets and selling costs. Class meetings are devoted largely to discussions of actual business situations. Several discussion sessions with marketing executives are scheduled throughout the term. Written reports of both detailed and memorandum character are assigned as are also laboratory problems requiring use of original sales records.

15·83. Marketing Research (B). Deals with the basic principles and techniques used in marketing research. Through experience with actual problems the student is trained to analyze a problem in its components, to secure the facts necessary for its solution, to interpret the data, and to prepare a suitable written report. An important portion of the work consists of an original study which is conducted by the class. As part of this investigation each student is expected to make a substantial number of field interviews.

15·85. Industrial Marketing (A). An advanced subject which deals with the problems involved in marketing goods to manufacturers and other industrial users. It covers such topics as buying methods and motives, distribution channels, formulation of marketing policies, marketing research, sales organization and control, compensation of salesmen, advertising and sales promotion, engineering service, control of marketing costs, product planning, pricing and terms of sale, and credit and collection policies. Special emphasis is laid on the coördination of methods to evolve logical and consistent marketing programs. Instruction is for the most part given through group discussions of specific problems of concerns engaged in this type of marketing. Each student interviews several marketing executives in an industrial company and prepares an analytical report on the marketing operations of the company.

15·86. Marketing of Consumer Goods (A). An advanced subject dealing with the problems faced by manufacturers of consumer goods in marketing their products. Discusses contemporary marketing problems from the standpoints of fundamental economics and practical circumstances. Representative topics are: pricing methods as affected by current legislation; resale-price maintenance; relationships with distributors; adaptation of products and packages to consumer demand; governmental control of marketing and the consumer movement. Contemporary marketing literature and current business problems are used as source material for group discussions.

15·88. Advertising (B). Deals with the underlying principles and technique of advertising, with particular emphasis on the viewpoint of the business man who uses advertising as a tool. The subject covers the advertising of both industrial and consumer goods.

15·92. Industrial Problems (B). Coördinates the previous subjects which the student has taken. With the collaboration of ninety operating executives, students survey the field of managerial activities as actually practiced by competent plant officials. Field interviews, committee conferences, classroom presentations and discussions form the basis of a term report on the acts of management which serves to record the day-to-day procedures of the operating executive, and to reflect the interdependence of marketing, finance, accounting, production, and labor, and the interrelations of the going business as a whole with government and the public.

15·94. Contemporary Problems Seminar (A). A symposium dealing with contemporary industrial and economic issues. Preparation includes assignments to current periodicals as well as text references. An initial period is devoted to general discussion of current assignment; subsequent periods are conducted as seminars with oral reports and general discussions. Objectives are the development of facility in the appraisal of current trends; stimulation of interest in business relationships with government, labor and the public; experience in discovering key factors influencing contemporary events. Representative topics have included: trends in public relations; government control of security issues and exchanges; current industrial price policies; unemployment compensation legislation; the consumer movement; the motor transportation issue in the United States. Guests (faculty members or industrialists) are invited to attend the two-hour sessions.

Business and Engineering Administration Continued

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. Hours and credit to be arranged. May include readings, conferences, laboratory and field work, and reports.

15·96. Administrative Theory and Practice (A). A seminar for the consideration of the initial problems confronting the business administrator whose responsibilities call for the determination as well as the execution of policy, and incorporate supervision over the major functions of the business. A method of approach to administrative problems is formulated. The techniques of negotiation, mediation and group deliberation are outlined. The relationships of the business administrator to subordinates, investors, vendors and customers, associates, the community, the government and the public, are examined. Administrative procedure in old and established organizations *vs.* newly organized companies is compared. Underlying principles leading to continuity of administrative tenure are reviewed. Administrative methods in political and military areas are differentiated from those used in industrial fields.

15·98, 15·99. Special Administrative Seminar (A). A graduate seminar for the analysis and discussion of administrative problems. Particular attention is given to the external aspects of administration and to the proper influence of personal talents upon administrative methods employed. The technique and points of view of prominent administrators will be studied and evaluated. Based upon readings and discussions the members will prepare both a group report on the functions and objectives, and individual reports on the technique of administration involved. Because of the type of work covered, admission to this subject is limited to mature graduate students who have had actual executive experience in business covering a substantial period of time. (For Sloan Fellows only.)

Thesis. To complete the requirements for graduation every student enrolled in the Department conducts an original investigation of a problem, preferably one of practical value to industry, in the field of management or engineering. The purpose of the thesis is threefold. It gives the student experience in applying the scientific method and specific research techniques to a typical business problem; it aids him in developing the ability to achieve constructive results on his own responsibility; it teaches him how to present his conclusions in convincing manner.

Graduate Thesis (A). Original research in the field of business administration. The purpose of such work is to ascertain the 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). Elementary dynamics of particles, fluids, and solid bodies, with applications to aeronautics.

16·03. Hydrodynamics and Its Application to Aeronautics (A). Selected advanced topics in continuation of 16·02, including the theory of flow potentials, the flow equations of Euler, the energy equations of Bernouilli and Kelvin, ideal two dimensional flow, theory of finite wings and wing combinations, instability of discontinuous layers, and boundary layer.

16·04. Hydrodynamics and Its Application to Aeronautics (A). Continuation of 16·03 with practical application of its theory and methods.

16·07, 16·08. Advanced Topics in Aeromechanics (A). A detailed study of several aeromechanic problems of practical importance which are too long and too difficult to be included in 16·03 and 16·04. Particular attention given to the mechanics of airplane spin and of wing and tail flutter, and of air flow at compression speeds to advanced phases of boundary layer phenomena as they affect burbling, also to the problem of sound reduction and vibration damping directed toward greater passenger comfort, and to similar problems as time allows.

16·10. Aerodynamics of Airplane Design. Application of aerodynamic theory to airplane design and aircraft propellers. Warner, *Airplane Design, Vol. I;* Weick, *Aircraft Propeller Design.*

16·11. Aerodynamics of Airplane Design (B). Performance problems and general theory of longitudinal, lateral and directional stability, controllability, and maneuverability of airplanes. In addition to the classroom work, each student receives flight demonstration of the airplane motions studied. (Students may omit this part of the subject.) Warner, *Airplane Design, Vol. I.*

16·14. Airplane Design Problems (B). Lectures, discussions and drafting-room exercises devoted largely to the choice of type of airplane to be used for a given service. Several problems are assigned, and each student makes a selection of type, executes a preliminary design, and estimates the airplane weight and performance. Warner and Johnson, *Aviation Handbook.*

16·17. Airplane Design Practice (B). Actual practice in design. Each student carries through the "layout" and calculations for a simple airplane. Niles and Newell, *Airplane Structures.*

Aeronautical Engineering Continued

16·18. Airplane Design Practice, Advanced (A). Students make a preliminary design of an airplane selected by the group. The development of the design is carried through the wind-tunnel test. The results are discussed, and the model is changed so as to give it satisfactory characteristics. In addition, special structural and detail design problems in connection with the design are carried through.

16·20. Theory of Structures. A subject covering outer forces, reactions, shears and bending moments, the use of influence lines, the three moment equation, torsion and bending on simple sections, the design of members subjected to flexure only, the analysis of trusses by algebraic and graphical methods and the design of simple columns. Niles and Newell, *Airplane Structures.*

16·21. Theory of Structures (B). Covers the analysis of fittings and allied details, the use of the generalized three moment equation, the fundamental concepts of various methods for determining deflection of beams and trusses and the fundamentals of the method of least work. Niles and Newell, *Airplane Structures.*

16·22. Aircraft Structures (B). Covers applications of the methods of least work and deflections to the analysis of indeterminate structures, the elements of the analysis of space framework, the use of methods of analysis currently employed in the design of all-metal aircraft and a consideration of the assumptions used in the determination of design load factors and load distributions specified for use on commercial airplanes. Niles and Newell, *Airplane Structures.*

16·23. Advanced Aircraft Structures (A). Covers the development of the fundamental relations in the theory of elasticity and illustrates their applicability to the analysis of aircraft structures by the study of stress concentrations around holes, the analysis of members subjected to torsion, the determination of shear centers, the evaluation of the effects of shear-lag, and the computation of stresses in stressed-skin structures of the types used in all-metal airplanes.

16·25. Advanced Aircraft Structures (A). The exact content of this subject varies somewhat from year to year as new methods of analysis become available for examination. Particular attention is paid to the investigation and development of methods for the analysis of all-metal airplanes and considerable time is spent on applications of the theory of elasticity to problems involving stiffened sheet in compression, plates under normal load and similar problems. Niles and Newell, *Airplane Structures.*

16·31. Airship Theory (A). A study of the aerodynamic and aerostatic forces which must be borne by an airship structure, including consideration of airship stability and control. A preliminary study is made of the properties of aerostatic gases and of the general theory of sustentation of lighter-than-air craft.

16·36. Airship Structures (A). Methods of stress analysis employed in the design of rigid airships, following a brief discussion of the general arrangement and design of the hull structure and of the external loading conditions.

16·41. Instrumentation (A). Instrument problems of mechanical engineering, aeronautics, and meteorology are studied from the standpoint of fundamental physical principles. A unified treatment applicable to a wide range of instruments is based on the general theory of one-dimensional systems with special emphasis on transient phases of the response to arbitrary forcing functions. In each case, tests from practice or the laboratory are compared with the theoretical results. Thermometers, pressure gages, engine indicators, vibration measuring instruments, magnetic compasses, and gyroscopic aircraft instruments are considered. Attention is given to the factors which control the practical errors of each instrument.

16·42. Aeronautical Instruments (A). A continuation of 16·41 directed particularly toward aeronautical instrument problems. Altimeters, rate of climb meters, airspeed meters, sonic altimeters, radio altimeters, radio aids to flight, and blind landing systems are studied. Hydrodynamical theory, acoustical theory, and electromagnetic wave theory are introduced where necessary. Attention will be given to special test instruments and automatic control equipment if time is available.

16·43. Instrumentation Laboratory (A). To be taken simultaneously with 16·41. Principles developed in 16·41 are applied to various types of instruments with special emphasis upon dynamic performance in each case. Laboratory exercises are devoted to the following subjects: transient and steady state behavior of one-dimensional systems, pressure gages, engine indicators, magnetic compasses, gyroscopic instruments, barometric altimeters, rate of climb meters, thermographs, hygrometers, and anemometers. A selection of experiments is allowed to suit the needs of students interested in particular fields.

16·44. Meteorological Instruments (B). Methods and instruments used to obtain and evaluate meteorological data. Lectures on the fundamental principles involved are accompanied by laboratory and field exercises. The student carries out calibrations of typical barographs, thermographs, meteorographs, and radiometeorographs. Wind velocity measurements are made with the theodolite and sounding balloons. Actual observations made with these instruments are plotted on various meteorological charts in a form suitable for synoptic or dynamic studies.

16·45. Special Problems in Aeronautical and Meteorological Instruments (A). Problems of interest to properly qualified individual students are studied in consultation with the instructor.

16·46. Vibration Measurements (A). Methods and instruments used to obtain and interpret data on mechanical vibrations. Lectures and laboratory exercises are devoted to consideration of the possibilities and limitations of mechanical, optical and electrical instruments for measuring vibrations. Electromagnetic, piezo-electric, carbon resistance and capacitative pickup units are studied. Cathode ray and electro-magnetic oscillographs are used for making visual observations and photographic records from internal combustion engines and other sources of vibration. The analysis of complex vibratory motions into

Aeronautical Engineering Continued

harmonic components by means of mechanical analyses is illustrated by laboratory exercises.

16·52. Aircraft Propeller Design (A). Theory and practice of propeller design including the study of propeller stresses. Classroom work is supplemented by actual design practice. Weick, *Aircraft Propeller Design.*

16·53. Advanced Airplane Engine Design (A). Advanced problems in the design of airplane engines, including drafting room layouts.

16·54. Advanced Airplane Engine Design (A). Continuation of 16·53, including the design of superchargers, reduction gears, etc.

16·60. Advanced Aeronautical Problems (A). Covers individual advanced work by properly qualified graduate students. Problems are selected in consultation with the instructor, and the hours are arranged to suit the individual case.

16·62. Aeronautical Laboratory (B). Lectures on the methods and equipment used in aeronautical research, and experience in the making of tests in the Institute wind tunnels.

16·63. Aeronautical Laboratory and Research Methods (B). A continuation of 16·62, with lectures on more advanced laboratory methods, and on free-flight testing, together with training in the application of these methods.

16·68. Aeronautical Seminar (A). Intended primarily for students conducting theses in aeronautics. Consists of a series of meetings with discussions of new publications and of current research work by both graduate students and members of the staff.

16·71. Airplane Shop Work. Shopwork and lectures on the handling of materials used in airplane construction, and on methods of fabrication including elementary work in airplane welding, and in fitting, design and fabrication, rib and spar making, wing covering, doping, et cetera, and an elementary study of the various airplane types, parts and designs. *The Airplane and Its Engine*, by Chatfield and Taylor.

16·72. Aircraft Production Methods. A selected group of factories, such as production machine shops, foundries, forges, mills, metal and wood working shops are visited and their basic processes studied in detail. Each visit is carefully outlined in advance and a definite report is required. A week is spent in Hartford, Connecticut, where a study is made of the methods of engine, propeller and aircraft production in the factories of the United Aircraft Manufacturing Corporation.

16·75. Construction Details of Aircraft (B). Drafting board problems and lectures dealing with the detail design of the airplane structure, and power plant installation.

16·81. Aeronautics (B). Aircraft and the general principles of flight.

16·811. Aeronautics (B). Similar to 16·81 but particularly adapted to the needs of Naval Constructors.

16·911. Synoptic Meteorology I (B). A simplified treatment, as non-mathematical as possible, of the fundamental physical laws which hold in the atmosphere, and their practical applicability to the usually observed meteorological phenomena. A brief discussion of weather maps and air mass analysis is included. Humphreys, *Physics of the Air.*

16·912. Synoptic Meteorology II (A). A discussion of North American air mass properties and of certain phenomena of especial significance to the forecaster, notably fog and tropical hurricanes.

16·913. Synoptic Meteorology III (A). The fundamental principles of weather analysis: the meteorological elements and their conservativism, air mass characteristics, stability and instability and their relation to the weather phenomena; the use of thermodynamical diagrams in analysis for forecasting; international classification of clouds and hydrometers; the formation and transformation of air masses; the analysis of the field of motion; and the relations between wind and atmospheric pressure.

16·914. Synoptic Meteorology IV (A). The principles of weather forecasting: frontogenesis, frontal characteristics, classification of fronts, structure and development of extratropical cyclones, isentropic analysis, practical rules and formulae for extrapolating the movement and development of pressure systems.

16·921. Meteorological Laboratory I (B). Decoding and plotting of the daily weather reports as transmitted by the Department of Commerce teletype. Analysis of weather maps and practice forecasting for selected stations.

16·922. Meteorological 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.

16·923. Meteorological Laboratory III (A). Synoptic weather map analysis and forecasting. Analysis of aerological diagrams. Three-dimensional upper air analysis with the aid of vertical cross-sections and surfaces of equal potential temperature (isentropic surfaces).

16·931. Dynamic Meteorology I (A). The thermodynamics of the atmosphere, including the theory of adiabatic and pseudo-adiabatic processes in the free atmosphere with special reference to the construction of the common aerological diagrams. Elementary dynamics of the atmosphere, including the equations of absolute and relative motion and a discussion of the relation between the fields of motion, mass and pressure with special emphasis on gradient wind conditions.

16·932. Dynamic Meteorology II (A). A brief discussion of frictional effects and turbulence in the atmosphere. Atmospheric radiation and the heat balance; structure and composition of the stratosphere with special reference to the ozone layer. The theory of the visual range, the formation of ice on aircraft, atmospheric electricity and atmospheric optics.

16·933. Dynamic Meteorology III (A). Advanced dynamics of the ideal fluid in absolute and relative motion

Aeronautical Engineering Continued

applied to an analysis of the structure of atmospheric flow. Stability of equilibrium and of linear and circular permanent flow, fundamentals of wave theory with application to cyclone waves.

16·934. Dynamic Meteorology IV (A). Application of fluid mechanics to the atmosphere, including the layer of frictional influence next to the ground. Energy transformations in the atmosphere, discussion of the creation and dissipation of circulation, and a qualitative discussion of the general circulation of the atmosphere.

16·941, 16·942. Meteorological Seminar (A). Weekly reviews and discussions, by staff members and students, of recent meteorological contributions published in current periodicals, and of original research.

BUILDING ENGINEERING AND CONSTRUCTION

Subjects 17·00 to 17·99

17·22. Building Construction. A study of the construction of Third-Class Buildings, with particular reference to the residence. The fundamentals of the assembly of various materials commonly used in such construction are discussed together with their proper relationship and the sequence in which they are ordinarily combined in the field. Improved details of construction and the use of new materials are introduced. The work is carried on by class discussions and by supervised basic problem analysis in the drafting room. *Departmental Notes.*

17·31. Building Construction. A study of Second-Class Buildings. This type of construction involves the combination 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, are studied in the same manner as in 17·22 *Departmental Notes.*

17·32. Building Construction. A study of the construction of First Class Buildings with special reference to those with reinforced concrete and structural steel frames. The relation of the frame to the exterior walls, the floor arches, the interior partitions, the mechanical equipment, the electrical services and the architectural balance are studied in the same way and in proper sequence, as in the previous courses in Building Construction. *Departmental Notes.*

17·40. Estimating and Job Management (B). A study of two of the important functions exercised by the builders, designed to give a knowledge of the basic units into which each estimate is divided, together with a breakdown of such units into man-hours and materials required. Includes lectures and discussions on job planning, contract relations, labor relations, safety in construction and the business aspects of contracting.

17·41, 17·42. Construction Problems (B). A continuation of previous courses in Building Construction. This has to do with job-planning, construction supervision and the methods of handling problems arising in every construction project but not covered by contract documents.

17·52. Structural Problems. The first part of this subject is intended to establish a connection by graphical and analytical methods between the study of applied mechanics and structural theory. The student is enabled by graphical analysis actually to see stress distribution and is thereby afforded a more visual concept of stress analysis. This procedure is applied to forces, homogeneous and non-homogeneous beams of wood and steel and reinforced concrete, trusses and masonry piers and arches. The latter part of the subject is an application of these studies to structural design in timber, including the 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). A study of the structural design of reinforced concrete building frames, including the development of the theory of design, consideration of specifications, design of solid and ribbed slabs, beam and girder frames, flat slab systems, columns and footings. Special consideration is given to economy in design. *Design of Reinforced Concrete Structures*, Peabody.

17·531. Structural Design (B). An abridgement of 17·53 with same classroom hours and preparation, but a shorter time devoted to drafting room problems.

17·54. Structural Design (B). A study of the design of structural steel building frames, including the design of typical floor-arch systems, rolled and built-up beams and girders, design of details, truss analysis, columns and foundation problems. Special attention is given to general steel framing in its relation to architectural details and the application of structural design to shoring and underpinning. *Steel Construction*, Voss and Varney.

17·541. Structural Design (B). An abridgement of 17·54 with same classroom hours and preparation, but a shorter time devoted to drafting room problems.

17·73T. Materials — Masonry. Begins with a study of the geological origin, sources and composition of masonry materials together with their conversion into usable building forms. Clays and clay products, cements and lime, concrete aggregates, composition and qualities of mortars, natural and cast stone, gypsum products and various masonry specialties are taken up from the standpoint of construction and engineering design. Class discussions are augmented by reports on assigned collateral reading. *Departmental Notes.*

Building Engineering and Construction Continued

17·74T. Materials — Wood and Metals. Mechanical and physical properties of wood are studied 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 are among other phases taken up. The work in metals begins with alloy diagrams and their interpretation, followed by consideration of the most important non-ferrous alloys, and a more detailed discussion of the ferrous metals, their properties and heat treatment. Supplementing this work is the chemistry of corrosion and welding theory and practice. Class discussions are augmented by reports on assigned collateral reading. *Wood Handbook*, *Chemistry of Engineering Materials*, Leighou; *Departmental Notes*.

17·75. Materials. Lectures and laboratory work for students in Architecture and City Planning. The work covers the same field as 17·73T. Laboratory exercises on the methods of making physical tests for the properties of the more common engineering materials, and a study of their behavior under stress are included.

17·76. Materials. This subject is a continuation of 17·75, and covers the same field as 17·74T.

17·77. Special Problems in Building Materials (A). Offered for graduate students whose previous training fits them to undertake research in connection with the physical behavior of building materials, and the effect of the physical and chemical properties of the constituents of the materials on this behavior.

GRAPHICS

Subjects D1 to D99

D11. Engineering Drawing and Descriptive Geometry. Instruction in the correct use of drafting instruments and materials. Practice in lettering. The theroy of projection drawing. Drawing in orthographic, isometric, oblique and perspective projection. A study of the fundamental concepts of descriptive geometry, including reference systems, representation of the point, line and plane: fundamental problems of position, of perpendicularity and of measurement. Especial emphasis is placed on the ability to visualize the problems, and the processes involved in their solution. A part of each exercise is devoted to a lecture. French, *Engineering Drawing*. *Notes on Descriptive Geometry*.

D12. Engineering Drawing and Descriptive Geometry. A continuation of D11 including practice in dimensioning, the making of dimensioned freehand sketches of machine parts and the accurate detail and assembly drawings from the sketches. Tracing in ink and pencil on cloth or paper of the finished drawings. A study of the various surfaces and solids, their sections, developments and intersections. Finally, the application of descriptive geometry to certain problems arising in engineering practice. A part of each exercise is devoted to a lecture. French, *Engineering Drawing*. *Notes on Descriptive Geometry*.

D13. Descriptive Geometry. Includes only the descriptive geometry part of D11 and D12. The subject is intended for transfer students who have been given credit for Engineering Drawing of the first year. *Notes on Descriptive Geometry*.

D14. Engineering Drawing. Includes only the engineering drawing part of D11 and D12. The subject is intended for transfer students who have been given credit for Descriptive Geometry of the first year. French, *Engineering Drawing*.

D21. Perspective. Fundamental phenomena of appearance, the general theory of conical projection and its application to perspective, the method of revolved plan upon which all shorter methods are based, curves and apparent distortion. The study of direct division, direct measurement, relations between lines and points in the vanishing-point diagram, method of perspective plan, and shadows. *Principles of Architectural Perspective*, Lawrence.

D31. Nomography. The nomographic method of solving equations in three or more variables and its application to scientific and engineering data. The subject matter includes a study of functional scales, network charts, simple nomographic relationships derived from plane geometry, the theory of determinants and their applications to nomograms, projective transformations, the design and construction of nomographic charts for engineering formulae.

ECONOMICS AND SOCIAL SCIENCE

SUBJECTS Ec1 TO Ec99

Ec11, Ec12. ECONOMIC PRINCIPLES. Elementary but comprehensive. Description of business and other modern economic institutions. Analysis of the forces which determine prices and of the manner in which production and personal incomes are determined by prices. Examination of leading current economic problems, especially those arising in connection with business cycles, foreign trade, labor organizations, monopolies, and the government control of private industry.

Ec111. ECONOMIC PRINCIPLES. Covers the same ground as Ec11 with additional time available for tutorial instruction in certain aspects of the subject.

Ec122. ECONOMIC PRINCIPLES. Covers the same ground as Ec12 with additional time available for tutorial instruction in certain aspects of the subject.

Ec15. PRINCIPLES OF ECONOMICS (B). A study of the fundamentals of production, business organization, prices and the price level, wages and employment, interest and profits, and a brief consideration of leading economic institutions and problems. Restricted to mature students for whom it is especially designed.

Ec17. ECONOMIC THEORY (A). A brief historical review showing the interdependent growth of theory and fact, followed by the general theory of equilibrium under price competition and price monopoly from which will be determined, under the given conditions, wages, rents and interest. Findings will be revalued under conditions which more closely approach reality.

Ec28. BUSINESS CYCLES (A). A study of the fluctuations in the different phases of business. In this is involved statistical interpretation, theories of the business cycle, studies of the intercausation of the different types of business changes, the interpretation and experimental tests of forecasting methods, the theory and practice of government control.

Ec32. STATISTICS. Includes charts and graphs, frequency distributions, averages, measures of dispersion, moments, simple index numbers, elementary time series analysis, linear correlation and the elements of small sample theory. The methods are applied principally to business and economic data.

Ec33. DESIGN OF EXPERIMENTS (B). Statistical principles applied to the design of certain industrial, biological and agricultural experiments. R. A. Fisher, *The Design of Experiments*.

Ec34. SPECIAL PROBLEMS IN INDUSTRIAL STATISTICS. Problems not considered in the statistical prerequisites of this subject are discussed. The topics will vary from year to year.

Ec35. INDUSTRIAL STATISTICS. Includes lectures, discussions and laboratory work in large-sample statistics, elementary small-sample theory, correlation and the analysis of variability. These methods will be applied to practical problems brought to the course by those attending and to problems analyzed at the Institute during the past several years.

Ec38. ENGINEERING AND INDUSTRIAL STATISTICS (A). Large-and small-sample theory and applications, industrial risk, analysis of variable quality, quality control programs. Applications include such products as textiles, radio tubes, electric lamps, other electrical equipment, steel, glass, fuels, building materials.

Ec40. MONEY AND BANKING. Credit instruments, commercial banks, trust companies, savings banks, different kinds of loans, securities for loans, credit statements, the bank statement, the money market, group and branch banking, the federal reserve system, credit control, and foreign exchange.

Ec45. MONETARY AND BANKING PROBLEMS (B). Presupposes a knowledge of the more elementary facts relating to banking in the United States. Topics to be discussed in conferences on recent and proposed changes in banking and monetary policy, including the insurance of deposits, limitations on scope of loans by banks, new types of banking institutions, devaluation of the dollar and inflation.

Ec47. INVESTMENT FINANCE (A). Investment securities, corporate promotion, business expansion, working capital requirements, business failure and corporate reorganization are examined from two points of view: that of the business executive and that of the investor. Accounting policy is examined from the point of view of the investor. Standards are also suggested which may be used to explain why the securities of some corporations sell on the basis of a yield higher than that offered by the securities of other enterprises in the same industry.

Ec48. INVESTMENT ANALYSIS (A). Deals with the investment characteristics of enterprises and with methods of analyzing their securities. Measurement of the risk and yield of the securities of enterprises in new industries and of established enterprises in expanding, stationary and dwindling industries. Corporate reports and their interpretation. Investment ratios and criticism of such ratios. Investment canons and their limitations. Financial institutions may be surveyed briefly with special reference to their current investment policies and problems.

Ec54. CORPORATIONS (B). Intended to meet the needs of those students whose professional interest may be in scientific or engineering fields, but who desire some knowledge of corporate organization and finance and the social and political problems of business. Among the topics considered are: legal relationships within the corporation, financial organization and management, the evolution of corporate structures, intercorporate relationships, trade associations, combinations, and government regulation of industry. (Not open to Course XV students.)

Economics and Social Science Continued

Ec57. Public Utilities (A). Following a brief study of the general principles of organization and finance applicable to public utility corporations, attention is given to some important economic and management problems such as: the organization and structure of utility systems, holding companies and intercorporate control, economic elements in the production and delivery of service, financial problems of management, and the relation of government to the industry.

Ec59. International Economic Relations (A). A study of the financial position of the United States, United Kingdom and other important commercial countries based upon an analysis of international payments. Consideration is given to the mechanism of exchange, international banking institutions and money markets, the financing of foreign trade, international short term and long term investments. Attention is devoted to the influence of international factors upon American business conditions and to the economic effects of nationalism as manifested in tariffs, raw material and exchange controls and other types of trade restriction.

Ec61. Labor Relations (B). A brief survey of the relations of employers and employees under present conditions of industry, with an analysis of the influences of economic and legislative factors upon these relations. Special attention will be given to issues of collective bargaining, to policies of unions, and to the role of the state in industrial relations.

Ec62. Personnel and Labor Problems (B). With the background acquired in Ec61, this subject is devoted primarily to a consideration of personnel and labor problems as they are encountered by employers. Among other things, the modifications of personnel policies arising from collective bargaining and legal regulations will be discussed.

Ec63, Ec64. Industrial Relations. A thorough review of the background and present nature of labor problems in American economic life. Among the topics considered are: the growth of the labor movement, policies of employers and unions, wages, hours, unemployment, legal aspects of labor problems, such as the regulation of collective bargaining, legislative standards for wages and hours, and social security. Throughout, the emphasis will be placed mainly upon the economic and social significance of the various topics considered.

Ec67. Labor Relations Seminar (A). Each student will investigate a particular topic in which he is interested and report to the class; the report will be followed by a general discussion. A wide latitude in the selection of subjects will be allowed: the problem may involve outside investigation or be largely library research; it may be in the general field of personnel relations, such as an investigation of written company labor policy, layoff policy, or wage policy; it may relate to organized labor, such as an investigation of trade agreements, the technique of collective bargaining; or the topic may be of a broader sociological or psychological nature, such as an investigation of the effects upon workers of unemployment, or an investigation of worker attitudes.

Ec68. Personnel Problems and Labor Relations (A). This subject is devoted to an intensive analysis of selected topics in personnel and labor relations. Stress is laid upon both the psychological and the economic aspects of the various problems considered. Emphasis is primarily upon the more fundamental factors underlying personnel problems, and upon their social and economic consequences, rather than on the specific administrative techniques which have been developed for handling them.

Ec72. American Government. The governmental process in the United States viewed historically and functionally. The development of the American system will be studied in relation to the changes that have taken place in political ideas both in this country and abroad. Attention will be given to the influence of the press, the radio and other factors affecting public opinion. Political phenomena will be correlated with economic changes and other social movements.

Ec78. Government Control of Industry (A). A study of the relationship of the state to economic activity. Attention will be centered on the United States, but comparison will be made with medieval guild control, the policies of mercantilism and with contemporary foreign systems. Topics include: instruments of control such as taxation and the administrative commission as developed in the United States, protection of consumers and wage earners, control of corporations, public utilities, security issues and exchanges, holding company regulation, trade associations, the anti-trust laws and the Federal Trade Commission.

Ec81. Human Problems in Industry (B). An introduction to the analysis of factors controlling the working relations of human beings. It presents the general features of human association and social organization applying to the problems of industrial life, both in industrial relations and in the connections between industry and the community. After a survey of instances of diverse economic adaptation, social structure, and community life, illustrating their mutual influences in primitive and modern societies, cases dealing with concrete situations in various industries and communities are examined. Methods for investigating and dealing with such situations are presented.

Ec83. Urban Sociology (B). Social origins; effect of environment on human life; social institutions; social change and social control; social characteristics of urban and rural communities; the relation of facilities for residence, commerce, government, education, and recreation; physical deterioration of the city as a by-product of social change; function of planning in the solution of social problems.

Ec84. Social and Economic Factors in City Planning (B). The social sciences in relation to the problems of city planning and housing. Subjects covered include: population growth and movement; rural-urban migrations and their relation to shifting industry; community costs for education and recreation; methods of assessment and taxation; fluctuation in land values; financing of public improvements.

Economics and Social Science Continued

Ec91, Ec92. Economics Seminar (A). Consideration of special social problems, or the study of economic problems of particular industries. Open to graduate students only.

Ec95, Ec96. Social Science Seminar (A). Reading, discussion, and case work designed to afford an introduction to the non-economic aspects of human behavior and human relations in the perspective of modern social and industrial conditions. Covers recent experimental developments in psychology, field study in social psychology and anthropology, and conceptual advances in sociology, and presents them in relation to the problems of personal and group adjustment in modern society. There are three divisions of the subject, each growing from the preceding. The first deals with the nature and development of the individual, the problems of motivation, and the nature of public opinion; the second deals with the problems of social organization and the analysis of social and emotional factors in present industrial and community life; the third reviews the growth of current institutions in capitalistic society and the changing concepts interpreting and justifying them. (Open to graduate students only.)

The following subjects are offered as General Studies. For description of subjects see Division of General Studies.

G71, G72. Introductory Psychology.

G73. Psychology in Industry.

G75. Human Relations.

G76. Human Relations.

G77. Social Institutions and Problems.

G78. Social Institutions and Labor Relations.

G79. Comparative Political Institutions.

G83. The Economics of War.

G85. Technology and Society.

ENGLISH AND HISTORY

Subjects E1 to E99

E1. English (Entrance).

E11. English Composition. Covers the principles of clear, accurate writing, with constant emphasis upon correctness and force of expression. Analysis of lectures, readings, and problems is used throughout the term as material for both oral and written work. Conferences with the instructor are held at frequent intervals. Oral work is an integral part of the course, each student presenting several short informal talks. Regular use of the library is required.

E12. English Composition. Three options are provided as follows:

A. Contemporary Literature. Reading of representative short stories, plays, and poems, and the writing of frequent short critical discussions of the reading. The main purpose of the option is the continuation of training in writing and the inculcation of good standards of taste based upon experience and judgment. Conferences and oral work as in E11.

B. The Post-War World. Material is drawn from contemporary world problems, these serving as a basis for training in the organization and presentation of facts and ideas. Conferences and oral work as in E11.

C. Scientific Writing and Thought. An introduction to scientific method and to scientific literature in the broadest sense. It is primarily a study of the mind of the scientist as he attacks his problems and presents them in written form. The student will be expected to apply the methods developed to numerous problems and to present the results of his work both orally and in writing. Conferences as in E11.

E21. Literature and History. Three options are offered, with oral and written work, outside reading, and conferences:

A. Growth of the Western World. Presents as a unit the history of Europe and America from 1750 to 1870. Military and political events are subordinated to the social, economic, scientific, and cultural developments of the period.

B. History of Thought. Traces the historical connection between present day ideas and the theories of the great thinkers in science, philosophy, government, and economics from 1200 to 1789.

C. Literature. Covers the same period of time in the field of literature as that covered in the option in history. Only men in the first rank are dealt with, and their works are studied with the object of showing their place in world literature.

E22. Literature and History. Three options are offered, with oral and written work, outside reading, and conferences:

A. Growth of the Western World. A continuation from 1870 to the present time of the E21 option of the same name.

B. History of Thought. A continuation from 1789 to the present time of the E21 option of the same name.

C. Drama. Presents the principles of drama together with the study of those principles in representative plays of different periods. Each class-section is given laboratory practice in presenting a play during the term.

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English and History Continued

E35. Reports. The preparation and presentation of business and engineering reports. Practice in the investigation of subjects, the arrangement of material and its presentation in report form. Subjects covered range from simple memoranda and business letters to longer, more comprehensive reports. Emphasis is placed both on written reports and on oral presentation before committees.

E42. Problem Analysis. The theory and practice of effective and convincing presentation of an architectural proposition to a non-professional audience. Consists almost entirely of group work.

The following subjects are offered as general studies. For description see Division of General Studies.

G1. History of Science.
G2. History of Science.
G7. Problems of Modern Philosophy.
G12. Biography in Science.
G19. Introduction to Latin American Problems and Institutions.
G21. History of Engineering.
G25. Social and Industrial History of Modern Europe. (Not 1940–41.)
G26. Social and Industrial History of the United States.
G27. Military History and Policy of the United States.
G31. Advanced Composition.
G32. Advanced Composition.
G34. American Literature.
G35. Contemporary English Literature. (Not 1940–41.)
G37. Contemporary European Literature.
G38. Public Speaking.
G39. Reading Seminar.
G40. The Bible as Literature. (Not 1940–41.)
G42. Shakespeare.
G61. Literature and the Fine Arts.
G62. History of Music.
G63. Introduction to Music.
G82. Introduction to International Relations.

GENERAL STUDIES

THIS section includes those subjects of a general and essentially non-vocational character which are offered for the purpose of giving the student an opportunity to broaden his education. They are designed to introduce him to fields of thought and interests outside of his chosen professional work.

Sixteen units of general study subjects are required, eight of which may be selected by the Department, others elected by the student. While each student is free to elect from among the subjects listed below such as appeal to his particular personal tastes and interests, he is advised to confine his choice to subjects within one of the four groups offered. A considerable variety of subjects is offered, grouped for convenience under the headings: History of Science and Thought; History of Civilization; Literature and Fine Arts; Social Science. The list may be modified or extended from year to year.

HISTORY OF SCIENCE AND THOUGHT

First Term

G1. History of Science.
G3. History of Mathematics.
G5. Descriptive Astronomy.
G7. Problems of Modern Philosophy.
G9. Geology.

Second Term

G2. History of Science.
G4. History of Mathematics.
G8. History of Philosophy.
G10. Organic Evolution.
G12. Biography in Science.

HISTORY OF CIVILIZATION

First Term

G19. Introduction to Latin American Problems and Institutions.
G21. History of Engineering.
G25. Social and Industrial History of Modern Europe. (Not 1940–41.)
G27. Military History and Policy of the United States.

Second Term

G20. French Civilization.
G22. Development of Transportation.
G24. Development of Community Planning.
G26. Social and Industrial History of the United States.
G27. Military History and Policy of the United States.
G28. Economic Geography.

LITERATURE AND FINE ARTS

First Term

G31. Advanced Composition.
G35. Contemporary English Literature. (Not 1940–41.)

General Studies Continued

G37. Contemporary European Literature.
G39. Reading Seminar.
G45. An Introduction to Architecture.
G51. French Literature.
G53. French Literature.
G57. Dante in English.
G61. Literature and the Fine Arts.
G63. Introduction to Music.
G65. Expressions of Graphic Arts.
G67. Design in Manufactured Products.

Second Term

G32. Advanced Composition.
G34. American Literature.
G38. Public Speaking.
G40. The Bible as Literature. (Not 1940–41.)
G42. Shakespeare.
G52. French Literature.
G54. French Literature.
G62. History of Music.
G64. Fine Arts.
G66. The Arts of the Book.
G68. Design in Manufactured Products.

SOCIAL SCIENCE

First Term

G71. Introductory Psychology.
G75. Human Relations.
G77. Social Institutions and Problems.
G79. Comparative Political Institutions.
G83. The Economics of War.
G85. Technology and Society.

Second Term

G72. Introductory Psychology.
G76. Human Relations.
G77. Social Institutions and Problems.
G78. Social Institutions and Labor Relations.
G82. Introduction to International Relations.
G86. Principles of Sanitary Science and Public Health.
G88. From Molecule to Man.

Summer

G73. Psychology in Industry.

G1. History of Science. The history of science from its beginnings. The Babylonians and Egyptians, the development and decline of Greek Science; the transmission of science into Western Europe; the science of the Renaissance. The subject centers around the physical and biological sciences, but attention is paid to technical arts and sciences. Emphasis is placed on the development of scientific spirit and method. Illustrated by lantern slides.

G2. History of Science. A continuation of G1 covering in some detail the history of the various sciences to the end of the eighteenth century. Nineteenth century science is studied along the two lines of its most important developments — geology, biology, and the theory of evolution; chemistry, physics, and the atomic nature of matter. Illustrated by lantern slides. (Either G1 or G2 may be taken independently.)

G3, G4. History of Mathematics. First term: History of mathematics traced from its beginnings through Egypt, Mesopotamia, Greece, Rome, the Arabic period, the Renaissance till the 18th century. Second term: Development of modern mathematics from Gauss to the present time. Lectures relate the history of mathematics to the general history of thought of the period and especially to the history of astronomy, physics, philosophy and technology. References: Sedgwick and Tyler, *History of Science;* D. E. Smith, *History of Mathematics;* F. Cajori, *History of Mathematics;* F. Klein, *Geschichte der Mathematik im 19 ten Jahrhundert I.*

G5. Descriptive Astronomy. A survey of the facts and theories relative to the solar system and the sidereal universe. Illustrated by slides. Baker, *Astronomy.*

G7. Problems of Modern Philosophy. The self and the will. Lectures and discussions, outside readings and reports.

G8. History of Philosophy. A general survey of modern philosophy from the time of Descartes.

G9. Geology. A consideration of the forces which are now modifying the earth and its inhabitants, and a history of the changes produced by these forces throughout the past, both upon the earth and its life. Shimer, *Introduction to Earth History.*

G10. Organic Evolution. A discussion of evolution, what it is and how it is shown in the organic world. There is especial reference to the evolution of man, his physical ancestry, his inherited impulses, and the development of his cultural environment. Shimer, *Evolution and Man.*

G12. Biography in Science. Offers training in the preparation and oral presentation of papers before organized groups, such as section meetings of a professional society. The papers are based on reading in the field of biography, chiefly of men of science. Not open to students below the fourth year.

G19. An Introduction to Latin American Problems and Institutions. The physical setting, racial backgrounds, colonial institutions, and modern economic, political, and social problems of Latin American republics.

G20. French Civilization. A series of lectures and outside readings in English on the evolution of French civilization as regards cities, forms of government, industries, arts and sciences, literature, education, and social institutions. Illustrated. No knowledge of French required.

G21. History of Engineering. The history of engineering in its relations to pure science and to man's social and economic life; the position and importance of engineering in the history of civilization. Illustrated.

General Studies Continued

G22. Development of Transportation. A series of thirty lectures on the history and development of transportation from the beginning down to the present day. It deals with land, water and air transportation, and includes, as transportation agencies, the railways, highways, ocean, coastwise and inland waters, and commercial airplanes. The influence of these means of transportation upon the industrial, economic and social development of the world forms the fundamental thesis of this subject.

G24. Development of Community Planning. A series of lectures and seminars on the development of community planning from the earliest times to the present. While primarily historical in character, the subject includes a consideration of the effect of changing social conditions on the scope and methods of comprehensive planning, and ends with a discussion of the contributions made by various professions in the solving of planning problems.

G25. Social and Industrial History of Modern Europe. A study of special topics showing some of the ways in which inventions, discoveries and theories have altered the course of social and industrial development in the recent past. Among the topics considered are the effect of inventions on the use of propaganda, the effect of inventions on modern war, the growth of the British Empire, the origins, remote and immediate, of the systems of party dictatorship in Italy, Germany and Russia. (Not offered 1940–41.)

G26. Social and Industrial History of the United States. This subject traces, by logical stages, the growth of a distinctive American civilization, emphasizing the non-political activities and interests of the people. The historical development of agriculture, commerce and industry will be studied in detail, along with such other topics as the rôle of invention, the social consequences of new modes of travel and transportation, the westward movement and the rise of cities, religious developments, the growth of the press.

G27. Military History and Policy of the United States. A course in American Military History. Some attention will be paid to the tactics of colonial and frontier warfare as well as those of the six important wars, but the emphasis will be placed on broad strategic considerations and on such problems as the development of mobilization, the influence of sea power, and the rise of such services as the Red Cross. Lectures, class discussions, papers.

G28. Economic Geography. Deals with the seas and the land masses of the world, with the geography of the human races, with the world's resources in mineral wealth and its resources of plant and animal origin; also with the distribution of commodities, with manufactured products, with the economic basis of world trade and with national control of raw materials.

G31. Advanced Composition. Further practice for students interested in writing as an art. The composition of larger prose units including short stories, essays, articles, and verse. The subjects attempted and the forms employed in the required weekly papers are determined by the student's preference. Weekly conferences.

G32. Advanced Composition. Continuation of G31.

G34. American Literature. American writers, particularly of the nineteenth and twentieth centuries, discussed with emphasis on their relation to contemporary life.

G35. Contemporary English Literature. Treats of a number of the most important English men of letters since 1890. (Not offered 1940–41.)

G37. Contemporary European Literature. An introductory study of some of the chief figures in European Literature of the past century and today.

G38. Public Speaking. Designed, through practice and criticism, to afford knowledge of the principles of public speaking and, in the process of doing so, to extend the range of the student's intellectual interests.

G39. Reading Seminar. Offers an opportunity to read good books under direction. The readings will be chosen from a selected list of the interesting and important works of the past and the present. Each student's selection, made with the advice of the instructor, will be given the unity of an interest in a period or a subject. There will be written critical reviews, oral presentations, and group discussions. The group will be limited to fifteen students.

G40. The Bible as Literature. A study of the historical background and the literary treatment of the material of the Old and New Testaments. (Not offered 1940–41.)

G42. Shakespeare. An analysis of representative plays with emphasis on the development of Shakespeare as a dramatist.

G45. An Introduction to Architecture. Designed to introduce non-architects to the principles of the subject including historical, aesthetic, and practical aspects. Illustrated lectures by a group of architects under the chairmanship of Dean MacCornack. Each student will be expected to submit a paper based on fairly wide reading.

G51, G52. French Literature. Outline of the history of French literature. Reading and interpretation, without translation, of illustrative specimens and some masterpieces complete: Chanson de Roland, medieval theatre, Villon, Montaigne, Rabelais, Corneille, Racine, Molière, Pascal, Voltaire, Rousseau, the Romantic School and subsequent movements. Braunschvig, *Notre Littérature Étudiée dans les Textes.* Vols. 1 and 2. Each term may be taken independently.

G53, G54. French Literature. Same as G51 and G52 with additional outside reading and written reports. Each term may be taken independently.

G57. Dante in English. A study of the Divine Comedy in English translation (bi-lingual text) with readings and lectures on the life and times of Dante.

G61. Literature and the Fine Arts. A study of what has recently been done in graphic arts and literature seen against the past so that the problems and products of our contemporaries may be judged.

General Studies Continued

G62. History of Music. Designed to offer to students an approach to the understanding of musical development. The subject matter, beginning with early forms, traces the evolution of the art through its various transitions to the twentieth century.

G63. Introduction to Music. No previous knowledge of music is required. Many musical illustrations are performed in the classroom. The lectures and textbook endeavor to give simply and clearly the knowledge needed by an intelligent listener. Moore, *Listening to Music.*

G64. Fine Arts. The required text (Helen Gardner, *Art Through the Ages*, Harcourt, Brace) is a history of the arts; but the lectures undertake a survey of the arts by topic, considering not only painting and sculpture but also the arts that come nearest to the usual interests of modern life, such as costume, furniture and furnishings, typography, camera art, etc. Visits to the Boston museums are required, and a paper is written, based upon observation of museum exhibits.

G65. Expressions of Graphic Art. A series of talks and demonstrations on the differing characteristics of expression in black and white, as indicated by sketching, drawing, lithographing, engraving, and so forth. These will be accompanied by actual exercises in drawing. Some acquaintance with freehand drawing is an essential prerequisite for admission to this subject. Enrollment is limited to thirty.

G66. The Arts of the Book. A study of paper, type, and printing plates, their history and their effective combination to produce appropriately designed printed material. Among the topics treated will be the history of fine printing, type nomenclature and specification, page and display layout, use and reproduction of illustration, modern typesetting and press work, estimation of printing costs, preparation of manuscript and seeing it through the press, bookbinding. Extensive use will be made of the Dard Hunter Paper Museum and of typographical exhibits. The student's assignment will be observation and written comment on fine printed production, or the actual design of such matter.

G67. Design in Manufactured Products. A series of lectures demonstrating the value of a sound knowledge of design in the creation of machine-made products. They will show how the adaptation of line and form to the limiting characteristics of material and of production may add the element of beauty to that of utility.

G68. Design in Manufactured Products. A continuation of G67 in which the student may apply his preparatory study to the solution of problems related to his major professional interest.

G71, G72. Introductory Psychology. A survey of the more important fields of psychology, with particular emphasis upon problems of personality and personal adjustment. Topics discussed will include: intelligence, learning, emotional behavior, motivation, the analysis of personality, clinical treatment of personality problems, and the psychology of suggestion and propaganda. A series of personality tests will be taken by members of the class to give the student knowledge of the techniques of psychological measurement as well as increased insight into the nature of his own personality. Films and class demonstrations of psychological phenomena will be utilized where possible.

G73. Psychology in Industry. A survey of such fields of psychology as the following: motivation, the analysis of personality, individual differences in skill and ability, and learning. Particular emphasis will be placed upon the use of data obtained from psychological research in industrial plants. Psychological techniques in employment selection, job analysis, the evaluation of the efficiency of the worker, accident prevention, and worker training will be treated in detail along with some of the broader problems of the relationship between worker and management.

G75. Human Relations. The fundamental object is to give students a realization of the necessity for good method in dealing with human relations, as well as a grounding in what constitutes good method. Such basic influences as aptitudes, habits, attention, understanding, desires, and prejudices are analyzed and applied to typical situations which arise in the course of employment. Illustrative problems taken from actual cases are studied, but always with the emphasis on that structural analysis which characterizes good method. Except by special permission of the instructor, only juniors and seniors may elect the subject.

G76. Human Relations. A continuation of G75 which applies the 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 are presented in the classroom; the person taking the part of the employee is brought in from industry and the technique of the students handling the situation is subsequently discussed, often by actual business men familiar with the original situation. Except by special permission of the instructor, only juniors and seniors may elect the subject.

G77. Social Institutions and Problems. A discussion of group activity within such social patterns as the family, the school and the state. Special stress is laid on the dominant role of the factory system in moulding contemporary social life. An analysis of the difficulties, conflicts, maladjustments, frustrations and breakdowns which are suffered by individuals, groups and communities if personal and social organization is not achieved. Field trips include: a penal colony, a home for the feeble minded, a public dispensary, a settlement house and a hospital for the insane.

G78. Social Institutions and Labor Relations. A presentation of the origin, growth and development of the corporation, the factory and trade union. An historical analysis of the activities of the state (through government departments, administrative agencies and the courts) and the community (through the family, the school, and the press) in selecting rules, techniques and ways of action for labor and industry in their conflicts and collaboration. (Not open to Course XV students.)

General Studies Continued

G79. Comparative Political Institutions. This subject deals with the various theories of government viewed historically and comparatively. The modern trends as evidenced by Fascism, Communism, Socialism and the changes in constitutional democratic government will be discussed in detail in relation to social and economic changes.

G82. Introduction to International Relations. The nature of contemporary international problems, including a survey of their historical background, and study of the past and present efforts to deal with them. Lectures, discussions, written and oral reports.

G83. The Economics of War. A study of the economic changes resulting from the adjustment of industry to the demands of war, and the impact of these changes on business stability, standards of living and methods of social control; the repercussion of various methods of financing the war, and the channels through which disturbances are communicated from one country to another. The study will be based upon the experience of previous wars and the trends observable in the present conflict.

G85. Technology and Society. The course deals with problems arising out of the influence of various kinds of technological and industrial activity upon the forms of social and community life. It examines characteristic examples of diverse types of productive economy at various stages of technological development, as they are to be found over the world today among primitive and civilized peoples. It deals with their effect upon family life, religion, political organization, class structure, social and racial conflict, and culture contact. Concrete problems in various communities are presented and methods for dealing with them examined. The course is open only to students who have some background of history, or sociology, or geography.

G86. Principles of Sanitary Science and Public Health. A consideration of the human body as a mechanism and the effect of the environment on its health, well-being, and proper functioning. The subject matter will include such items as infection and resistance, sources of infection, modes of disease transmission, air, water, milk, foods, sewage, refuse, housing, insects, and other factors in relation to disease, and the organized machinery for safeguarding the health of urban communities. The subject is designed for its cultural value and not for professional practice. Sedgwick's *Principles of Sanitary Science and Public Health*, Prescott and Horwood.

G88. From Molecule to Man. The nature and probable origin of life, its reproduction, the development of offspring, adaptations and mutations, effect of X-rays and other physical forces upon living matter, hormones, and other chemical regulators of birth, life, and death.

MATHEMATICS

Subjects M1 to M99

M1. Algebra, Entrance.

M3. Solid Geometry, Entrance.

M4. Trigonometry, Entrance.

M11. Calculus. An elementary presentation of the fundamental ideas of the calculus; differentiation and integration of algebraic functions; derivatives; differentials; maxima and minima; applications to simple problems in geometry and mechanics, such as the determination of velocity, acceleration, areas, volumes and pressure. A brief discussion of the analytic geometry of the straight line and the conic sections, and the plotting of the curves in rectangular coördinates.

M111. Calculus. An elementary subject adapted to the needs of students of Architecture.

M12. Calculus. Differentiation and graphical representation of trigonometric, inverse trigonometric, logarithmic and exponential functions, with applications to simple problems of geometry and mechanics, including related velocities, maxima and minima, simple harmonic motion, and curvatures; series.

M21. Calculus. Partial differentiation; integration of functions of one variable including use of tables; definite integrals; geometrical applications to areas and lengths of plane curves, volumes of solids; mechanical applications to work, pressure, centers of gravity and moments of inertia; double and triple integration with applications to areas, volumes, moments of inertia and centers of gravity. Woods and Bailey, *Elementary Calculus, Revised Edition.*

M22. Differential Equations. A treatment of ordinary differential equations including the principal types of first and second order equations, simultaneous equations, and linear equations with constant coefficients. The work is illustrated by numerous applications to geometry, chemistry, physics and mechanics. Phillips, *Differential Equations, Third Edition.*

M23. Algebra and Geometry. Determinants, matrices, theory of equations, quadratic forms, conics and quadrics, curvilinear coördinates, elements of analytic and differential geometry.

M24. Algebra and Geometry. A continuation of M23. (Not offered 1940–41.)

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 the theory of heat flow. Franklin, *Differential Equations for Electrical Engineers.*

M331, M332. Mathematical Theory of Statistics (B). A general treatment of the mathematical methods of statistics and their applications to scientific and engineering data. Includes systems of frequency curves and moments, theory of large and small sampling, precision of measurements, finite differences, simple, partial and multiple correlation, association, contingency, statistical estimation and general distribution theory. These methods will be developed from the practical viewpoint throughout the first term and mathematically in the second term. The work of both terms will be applied to data drawn from various fields of applied science, including engineering, biology, and physics. One hour per week will be devoted to a joint seminar with students in Ec33, Ec34, and Ec38, at which discussions of recent developments in statistical methods and industrial practice will be presented by instructors, students, and outside speakers.

M341, M342. Actuarial Mathematics. Includes readings, problems and discussions in advanced algebra, calculus of finite differences, compound interest, annuities certain and the construction of mortality tables.

M351, M352. Advanced Calculus for Engineers (A). Vector calculus with applications to geometry, kinematics, mechanics and hydromechanics. Partial differentiation. Fourier series and complex variables with applications to differential equations. Karman and Biot, *Mathematical Methods in Engineering.*

M36, M37. Advanced Calculus (A). Fundamental principles, 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. Woods, *Advanced Calculus, New edition.*

M381, M382. Theory of Functions (A). Arranged for students who desire a general subject in analysis somewhat more advanced than M36, M37. Among the topics discussed are series, infinite products, the Riemann integral, functions of a complex variable, contour integration, asymptotic expansions, Fourier series, differential equations, integral equations, and various transcendental functions of importance in the applications of mathematics. Attention is given to the logical derivation of the processes of analysis used in connection with these topics. Whittaker and Watson, *Modern Analysis.*

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 1940–41.)

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 on mapping. W. C. Graustein, *Differential Geometry* and L. P. Eisenhart, *Differential Geometry.*

M451, M452. Fourier Series and Integrals (A). This subject is devoted to the elementary theory of Fourier series and integrals as developed along modern lines. There will be a definite attempt to stress applications in practice and to develop the necessary analysis from the beginning. There are in existence mimeographed notes on topics of Fourier series which have been taken up in the past in M451, M452, and while the course is intended to be more elementary, it is recommended that use be made of these notes for more detailed material.

M471, M472. Seminar in Analytical Statistics (A). The subject will take up some of the techniques in the theory of probabilities and partitions of numbers and will apply them to problems in statistical mechanics, in particular to those concerning the equation of state. (Not offered 1940–41.)

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; the 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). The first term is devoted to the theory of measure and Lebesgue Integration. The second term deals with extensions and applications including Fourier series and Fourier integrals.

M561, M562. Functions of a Complex Variable (A). Among the topics discussed are complex integration, Cauchy's theorem, zeros, Jensen's theorem, Carleman's theorem, analytic continuation, the maximum-modulus theorem, conformal mapping, power-series, entire functions. The subject is based upon the first eight chapters of Titchmarsh, *Theory of Functions.* (Not offered 1940–41.)

M571, M572. Differential Equations (A). The physical problems which have given rise to the field of differential equations will be referred to constantly in motivating the various topics to be considered in this subject. Among these topics are various aspects of the linear differential equation including boundary value problems and the representation of an arbitrary function by Sturm-Liouville functions, the solution of certain of the more common equations by series and integrals, and the classification of equations by singular points. The relationship between integral and differential equations will be considered. The linear partial differential equation of the second order will be treated in detail and problems from potential theory, vibrations, heat flow, and other fields will be studied by methods including the integral equation

Mathematics Continued

and Fourier transform. *Ordinary Differential Equations* by Ince and a text on partial differential equations will be used.

M581, M582. Continuous Groups (A). A study of the 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 1940–41.)

M62. Modern Algebra (B). Polynomials, determinants, linear equations, linear transformation, matrices, bilinear, quadratic, and Hermitian forms, introduction to fields and algebras.

M631, M632. Modern Algebraic Theories (A). Designed to serve as a general introduction to the concepts and methods of modern abstract algebra, giving in particular a systematic development of field and matrix theory. The topics treated include: rings, polynomials, finite groups, algebraic extensions of a field, the Galois theory, cyclic fields, valued fields, elementary divisors and canonical forms of a matrix, symmetric and skew matrices, and algebras of matrices. Albert, *Modern Higher Algebra.*

M641, M642. Advanced Differential Geometry (A). This subject contains some of the modern developments in differential geometry, especially those involving tensor calculus, and is particularly useful for students who wish to do research work in this field.

M651, M652. Analytical Mechanics (A). Analytical dynamics of particles and rigid bodies is treated mainly by Lagrange's equations in generalized coördinates and Hamilton's canonical equations. Contact Transformation, the Hamilton-Jacobi theory, the theory of vibrations, and non-holonomic systems are among the topics discussed. (Not offered 1940–41.)

M661, M662. Algebra of Quantum Theory (A). An introduction to the non-commutative algebras employed by Dirac, Weyl, Heisenberg and others, including the theory of group characters. Slater's matrices, and homopolar valence. Lectures, problems and assigned reading. Familiarity with quantum theory is not prerequisite.

M671, M672. Partial Differential and Integral Equations (A). This subject has two objectives: first, to show how various types of physical problems lead to partial differential equations and to integral equations; second, to show the existing techniques for solving such equations. Partial differential equations are considered first and the Fourier technique is treated at some length, together with the various types of harmonics and special orthogonal functions which arise, and the Fourier integral. Among the equations treated are those which arise in potential theory, heat flow, wave propagation, etc. Next, integral equations are considered, the first step being to show how such equations arise in different types of physical problems. The available methods for solving such equations are then taken up, together with the various series solutions, characteristic functions, etc. The Laplace transformation is also considered. Integral equation methods are contrasted with differential equation methods wherever possible.

M682. Calculus of Variations (A). Extension of the theory of maxima and minima as begun in calculus. The 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.* (Not offered 1940–41.)

M691, M692. Characteristic Value Problems (A). Linear algebra, orthogonal functions, linear integral equations; the characteristic value problems of mathematical physics; applications of the calculus of variations; special functions defined by characteristic value problems. Courant-Hilbert, *Methoden der Mathematischen Physik.* (Not offered 1940–41.)

M73. Review of Mathematics. Review of algebra, plane and solid geometry, trigonometry, elementary calculus, differential equations.

M731, M732. Mechanics (B). Statics; frameworks and reciprocal force diagrams; least work and Castigliano's theorem; 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.

M75. Mathematics. Practical instruction in numerical, graphical and mechanical calculation and analysis necessary for the solution of problems in interior and exterior ballistics. (For U. S. Army Officers only.)

M76. Theory of Probability (A). Permutations and combinations. Elementary principles of the theory of probabilities. Bernoulli's Theorem. Bayes' Theorem. Distributive functions and continuous variables. Averages. Curve fitting. T. C. Fry, *Probability and Its Engineering Uses.*

M77. Vector Analysis (B). A treatment of the vector functions and operations required in theoretical work on electricity. Phillips, *Vector Analysis.*

M791, M792. Theoretical and Applied Elasticity (A). The fundamental mathematical theory of elasticity in three dimensions; elastic work of deformation, stress equations; stress functions; Mohr's stress diagram; bending of bars, plates, and tubes; instability; vibration of elastic systems; modern theory of strength; plasticity. Principles and methods used in practical engineering problems; principles of minimum energy and of virtual velocities; method of deflections, Ritz's method and the application of calculus of variations. Love, *Theory of Elasticity;* Föppl, *Drang und Zwang;* Timoshenko, *Theory of Elasticity.*

Mathematics Continued

M831, M832. Analysis (B). Advanced calculus for those already familiar with elementary technique who wish some knowledge of the logical development of the calculus as a mathematical science. The topics include the real and complex number system, limits, continuity, convergence, series, integration. Franklin, *A Treatise on Advanced Calculus.*

M841, M842. Analysis (B). A subject similar to M381, M382, designed for undergraduates in Pure Mathematics.

M851, M852. Advanced Calculus. Similar to M36, M37. Designed for undergraduates in Applied Mathematics and Industrial Statistics.

M90. Mathematical Reading (A). Designed to give the student an opportunity to read advanced mathematical treatises under the supervision of some member of the department. The treatise chosen and the time allowed will be determined by the needs in each particular case. This subject is for graduate students who may find it desirable to do advanced work not provided for in the regular courses. May be taken by undergraduates only under exceptional circumstances.

The following subjects are offered as General Studies. For description see Division of General Studies.

G3. History of Mathematics.

G4. History of Mathematics.

G8. History of Philosophy.

MILITARY SCIENCE AND TACTICS

Subjects MS1 to MS99

MS11. Military Science. (Required in all Courses.) Consists of nine weeks of infantry drill, three weeks of instruction in rifle marksmanship, and three weeks of lectures on elementary infantry subjects.

MS12. Military Science. (Required in all Courses.) Consists of ten weeks of infantry drill and ceremonies and five weeks of lectures on elementary subjects of military training.

MS21. Military Science. (Required in all Courses.) Consists of five weeks of map and aerial photograph reading, eight weeks of military fundamentals, and two weeks of field fortification. Opportunity is given the student to choose the unit in which he desires to continue his training. Those who do not report their choice of a unit by the beginning of the second term will be arbitrarily assigned to a unit.

MS221. Military Science. Coast Artillery. Elements of heavy artillery; fire control instruments; target characteristics; ammunition; aiming and laying of guns; service of the piece.

MS222. Military Science. Engineer Corps. Theoretical instruction in demolitions, sketching and military bridging; practical work in rigging, demolition, small caliber rifle firing, and combat principles of small units.

MS223. Military Science. Signal Corps. Tactical principles; 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 matériel and ammunition.

MS226. Military Science. Chemical Warfare Service. Weapons; chemical agents; chemical warfare drill and command.

MS31. Military Science, Advanced. Leadership. Students are given instruction in the duties and responsibilities of noncommissioned officers and junior officers in infantry drill; in the training of recruits; and in saber and command exercises.

MS311. Military Science. Coast Artillery, Advanced. Theory of position finding, fire control and gunnery for seacoast artillery. A study of the trajectory, dispersion, and determination and application of firing data.

MS312. Military Science. Engineer Corps, Advanced. Conferences and problems on the estimate of the situation and combat principles of small units, to include the infantry and engineer platoon; scouting and patrolling; weapons and musketry.

MS313. Military Science. Signal Corps, Advanced. Signal Corps tactics; message center operation; various types of codes and ciphers, and methods used in breaking them down; instruction in International Morse code.

MS314. Military Science. Ordnance Department, Advanced. Organization of Ordnance Department; property accounting; metals used in Ordnance construction; cannon construction.

MS316. Military Science. Chemical Warfare, Advanced. Chemical warfare agents; technique of chemical weapons; effect of weather on chemicals; combat principles of the infantry squad and platoon.

MS32. Military Science, Advanced. Leadership. Students are assigned to companies and are given instruction in the duties and responsibilities of company officers and noncommissioned officers.

MS321. Military Science. Coast Artillery, Advanced. Theory of position finding, gunnery, and fire control for anti-aircraft artillery.

Military Science and Tactics Continued

MS322. MILITARY SCIENCE. ENGINEER CORPS, ADVANCED. Conferences and problems on military bridging, demolitions and military roads.

MS323. MILITARY SCIENCE. SIGNAL CORPS, ADVANCED. Theoretical and applicatory instruction on all telephone and telegraph equipment in use by the Signal Corps; applicatory instruction on Signal Corps field radio sets; instruction in International Morse code; pistol and pistol equipment.

MS324. MILITARY SCIENCE. ORDNANCE DEPARTMENT, ADVANCED. Theory of recoil and design of recoil systems; principles of design and essential characteristics of fixed and mobile artillery, fire control equipment, small arms and automatic weapons.

MS326. MILITARY SCIENCE. CHEMICAL WARFARE, ADVANCED. Technique and tactical employment of chemical agents; tactical employment of chemical troops; combat principles of the infantry company and battalion; pistol marksmanship.

MS41. MILITARY SCIENCE, ADVANCED. Leadership. Students are assigned to companies and are given instruction in the duties and responsibilities of junior officers in infantry drill and in the training of men in the enlisted grades. Military law.

MS411A. MILITARY SCIENCE. COAST ARTILLERY, ADVANCED. Coast Artillery organization and matériel.

MS411B. MILITARY SCIENCE. COAST ARTILLERY, ADVANCED. Orientation, field engineering and combat orders.

MS412. MILITARY SCIENCE. ENGINEER CORPS, ADVANCED. Field fortifications and tactical problems, to include the battalion.

MS413. MILITARY SCIENCE. SIGNAL CORPS, ADVANCED. Instruction in methods of training men; emergency procurement and funds.

MS414. MILITARY SCIENCE. ORDNANCE DEPARTMENT. ADVANCED. Duties and problems of Ordnance officers in connection with the storage, issue and maintenance of Ordnance supplies.

MS416. MILITARY SCIENCE. CHEMICAL WARFARE, ADVANCED. Chemical estimate of the situation; solution of chemical warfare problems; combat principles of the infantry regiment; motor transportation.

MS42. MILITARY SCIENCE, ADVANCED. Leadership. Students are assigned to companies and are occupied primarily in imparting instruction and in the development of qualities of command and leadership in other students. Company administration. Regulations of the Officers' Reserve Corps.

MS421. MILITARY SCIENCE. COAST ARTILLERY, ADVANCED. Tactical employment of fixed, mobile, and antiaircraft artillery.

MS422. MILITARY SCIENCE. ENGINEER CORPS, ADVANCED. Instruction and problems applying the principles of field engineering.

MS423. MILITARY SCIENCE. SIGNAL CORPS, ADVANCED. Operation and maintenance of Signal Motor transport; operation and testing of a telephone plant.

MS424. MILITARY SCIENCE. ORDNANCE DEPARTMENT, ADVANCED. Ordnance supply and maintenance in combat operations.

MS426. MILITARY SCIENCE. CHEMICAL WARFARE, ADVANCED. Review of the tactical principles of the employment of chemical troops and chemical agents; tactical principles of the infantry brigade and division.

MODERN LANGUAGES

SEVERAL courses are offered in both French and German; one in Spanish, and one in Italian. Those in French and German are of Elementary, Intermediate and Advanced grade. In the Elementary and Intermediate subjects a careful foundation is laid for reading, writing and speaking the foreign language. Great care is taken to secure a good pronunciation, a mastery of the working essentials of grammar, a reasonable vocabulary for the expression of common ideas, training of the ear, and 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 organization of the country studied. Part of the work consists of assignments for written translation of articles from recent foreign journals selected by each student according to his individual interests and needs. Occasional illustrated lectures are given to supplement the class exercises and stimulate interest. The General Study subjects offer the student an opportunity to carry his study beyond the Intermediate grade.

The one-year elective courses in Elementary Spanish and Elementary Italian are parallel to the courses in Elementary French and German. They give a training in pronunciation, essentials of grammar, and reading of varied matter. On completion a student should be able to make intelligent contact with the foreign country, be able to read correspondence and translate reading matter of moderate difficulty. In all subjects the foreign language is used as far as practicable in the classroom.

In the designation of subjects, the grades Elementary and Intermediate correspond to the definitions of the Modern Language Association of America and the College Entrance Examination Board. Elementary French = French 2; Elementary German = German 2; Elementary Italian = Italian 2; Elementary Spanish = Spanish 2; Intermediate French = French 3; Intermediate German = German 3.

Modern Languages Continued

L11, L12. GERMAN, ELEMENTARY. The necessary foundation for the study of the German language for scientific and literary purposes. It will also enable students to fulfill the entrance requirements in Elementary German. It consists of training in pronunciation, elementary grammar, acquisition of useful vocabulary, reading of easy matter, some of which deals with science, and individual written translations from recent scientific works. Texts (subject to modification): Howe, *Elementary German;* Hagboldt: *Allerlei;* Malkowski: *Peter Krafft der Segelflieger;* Reuning, *Reise und Verkehr in Deutschland;* Wright: *German Science Reader.*

L21, L22. GERMAN, INTERMEDIATE. Includes a systematic review of grammar, miscellaneous prose and individual written translations from recent scientific works. The reading, scientific as well as literary, gradually becomes more difficult. At the end of the course students should be able 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. As far as practicable the exercises are conducted in German. Texts (subject to modification): Wesselhoeft, *German Prose Composition;* Kästner, *Das fliegende Klassenzimmer;* Curts, *Readings in Scientific and Technical German.*

L31T. GERMAN, INTERMEDIATE. Special subject required in Course V. Reading of selected texts of a varied nature, and individual assignments of articles in recent chemical journals.

L51, L52. FRENCH, ELEMENTARY. The necessary foundation for the study of the French language and literature, or for scientific studies; it also enables students to fulfill the entrance requirement in Elementary French. Consists of training in pronunciation, elementary grammar, acquisition of useful vocabulary and reading of easy matter, part of which deals with French institutions and the history of France, practice in spoken French; also individual written translations from recent scientific works. The last term will include the reading of some technical French. Texts (subject to modification): Fraser and Squair and Carnahan, *Standard French Grammar;* Hills and Dondo, *La France;* Zola, *L'Attaque du Moulin;* Alberse, *Chemical French Reader;* Daudet, *Tartarin de Tarascon;* and one short play.

L61, L62. FRENCH, INTERMEDIATE. Recitations partly conducted in French. A continuation of the study of grammar, pronunciation, and useful conversational forms; reading of matter dealing with French geography, history and industrial activity; some standard modern authors; reading of scientific French; individual written translations from recent scientific works. Texts (subject to modification); Bovée and Carnahan, *New French Review Grammar;* Williams, *Technical and Scientific French;* Maupassant, *Six Contes Choisis;* a selected play; Kullmer and Gerard, *Sketch Maps of France.*

L81, L82. SPANISH, ELEMENTARY. Pronunciation, elementary grammar, graded reading matter. Considerable practice in Spanish conversation. Texts (subject to modification): Hills, Ford, Rivera, *Brief Spanish Grammar for Colleges;* Castillo and Sparkman, *De Todo Un Poco* and *Sigamos Leyando;* Alarcón, *El Capitán Veneno;* the New York newspaper *La Prensa.* Individual assignments of collateral reading of selected fiction and drama.

L91, L92. ITALIAN, ELEMENTARY. Pronunciation, elementary grammar, easy reading matter, practice in conversational phrases useful for travel. Texts (subject to modification): Russo, *Elementary Italian Grammar;* Russo, *Nel Paese del Sole;* Capocelli, *L'Italia nel Passato e nel Presente;* Wilkins and Altrocchi, *Italian Short Stories.* (Not offered 1940–41.)

The following subjects are offered as General Studies. For description see Division of General Studies.

G20. FRENCH CIVILIZATION.
G51, G52. FRENCH LITERATURE.
G53, G54. FRENCH LITERATURE.
G57. DANTE IN ENGLISH.

HYGIENE

THE gymnasium of the Institute is located in the Walker Memorial building and affords ample accommodation for the training of classes in gymnastics.

The gymnasium is open to all students free of charge, and the instruction is especially arranged to fit individual needs. Bronze medals, known as the Cabot Medals for Improvement in Physical Development, are awarded to the five or six men showing the greatest physical improvement for the year. These medals were established by the late Samuel Cabot, for many years a member of the Corporation of the Institute.

The hangar building is equipped for boxing, wrestling and basket ball. This building is for competitive indoor sports and has seats for three hundred spectators. By using this building the Walker Gymnasium is left free for the regular gymnastics for which it was designed.

The new Athletic Field, built in 1939, gives an opportunity for track-team contests and interclass games. This field is provided with a quarter-mile running track, straightaway tracks for one hundred yard and two hundred twenty yard dashes, tennis courts, etc. It is under the direction of an Advisory Council on Athletics, composed of alumni and undergraduate students.

PT1, PT2. PHYSICAL TRAINING. All first-year men take two examinations during the first month, a complete physical examination at the Medical Department by a physician, and the other at Walker Memorial by the Physical Director, from which anthropometric charts are plotted. The class is then divided into sections for gymnastic exercise, each section having two hours a week for the last ten weeks of the first term and two hours a week for the first ten weeks of the second term, under the direction of the Physical Director. All first-year students are required to take these exercises. Regular exercises on the various athletic teams may be substituted for gymnastic work by consulting the Physical Director.

SUBJECTS OF INSTRUCTION TABULATED

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.

Some "B" subjects will not be credited to graduate students 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. To 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	1	I	2	—	2	Howard
1·01	Topographical Drawing	D12	2	1	I	0	4	0	Howard
1·02	Surveying	D12	3	S	VI	1	2	1	Howard
			2	S	VI-A				
			2	2	IX-B				
			4	1	IV-B, IV-C_1				
1·041	Surveying	D12	3	S	VII$_2$, XI	1	11	1	Howard
1·042	Surveying	D12	3	S	XVII	1	21	1	Howard
1·05	Surveying	1·00, 1·01	3	S	I	2	10	1	Howard
1·07	Geodetic Surveying	1·05, 1·13	4(B)	S	(Elective)	0	13	0	Shea
1·12	Astron. & Spherical Trig.	M4, 1·00	2	2	I	3	—	4	Shea
1·13	Geodesy	M22, 1·12	3	1	I	2	—	3	Howard
1·135	Int. Vibration Theory	M22	4(B)	1	(Elective)	3	—	2	Ruge
1·136	Vibration Problems	1·135	G(A)	2	(Elective	3	—	6	Ruge
1·138	Seismological Lab.	1·135 or *1·135*	4(B)	1 or 2	(Elective)		★		Ruge
1·141	Geodesy, Adv.	1·13	G(A)	1	(Elective)	2	—	4	Howard
1·142	Geodesy, Adv.	1·141	G(A)	2	(Elective)	3	—	6	Howard
1·16	Aerial Surveying	1·05	4(B)	2	(Elective)	2	—	2	Howard
1·18	Map Read. & Top. Draw.	D12	2	2	VII$_2$, XI	0	2	0	Howard
1·20	Rail. & High. Fieldwk.	*1·05*	3	S	I	1	4	0	Babcock
1·21	Rail. & High. Curves	M21; 1·00	2	2	I	2	—	2	Babcock
			3	1	I (40–41 only)				
1·22	Quantity Surveying	1·20 or 1·041	3	2	I, VII$_2$, XI	2	—	2	Babcock
			G	2	I (A.E.)				
1·25	Eng. Construction	1·22	4(B)	1	I, VII$_2$, XI	3	1	1	Breed
			G	S	I (A.E.)				
1·26	Railway Signalling	—	4(B)	2	(Elective)	2	—	3	Babcock
1·271	Transportation Eng.	1·21, 1·35	4(B)	1	(Elective I)	4	2	5	Babcock, Bone
1·272	Transportation Eng.	1·271	4(B)	2	(Elective I)	3	2	4	Babcock, Bone
1·273	Transportation Eng.	—	G(B)	2	I (A.E.)	4	—	5	Babcock, Bone
1·28	Railway Design	*1·272*	4(B)	2	(Elective)	0	5	0	Babcock
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
1·32	Des. of Harbor Works	1·48	G(A)	1	(Elective)	1	3	3	Reynolds
1·34	Municipal Eng.	—	5(B)	1	IV-B, IV.C_1	3	—	4	Bone
1·35	Roads & Pavements	1·21	3	2	I	2	—	1	Bone
1·371	High. Transport. Adv.	1·35	G(A)	1	(Elective)	2	—	4	Breed, Bone
1·372	High. Transport. Adv.	1·371	G(A)	2	(Elective)	2	—	4	Breed, Bone
1·38	Highway Design	*1·272*	4(B)	2	(Elective)	0	5	0	Bone
1·39	Graphic Statics	8·02	2	1	I	1	2	1	Mitsch

★ Time specially arranged.

Civil and Sanitary Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
1·40	Structures	2·04	3	2	I, XI	3	4	4	Fife
1·401	Structures	2·04	2	S	XVII	3	—	5	Fife
			3	2	VII_2, IX-B				
1·402	Structures	——	G	1	I (A.E.)	4	—	8	Fife
1·41	Structures	1·40	3(B)	1	XVII	3	—	6	Mirabelli
			4	1	I, VII_2, XI, XVII (40–41 only)				
1·411	Structures	1·402	G(B)	2	I(A.E.)	3	—	6	Fife
1·42T	Structures	1·41	4(B)	2	I, XI	3	—	6	Mitsch
1·421	Structures	1·41	4(B)	2	VII_2	2	—	4	Mitsch
1·422	Structures	1·41	3	2	XVII	3	—	6	Mitsch
			4	2	XVII (40–41 only)				
1·451	Structures	2·04	G	1	XIII-A	3	—	6	Fife
1·452	Structures	1·451	G	2	XIII-A	3	—	6	Fife
1·46	Structural Design	1·451	G	2	XIII-A	0	2	0	Mirabelli
1·47	Cement and Concrete	——	G	2	I (A.E.)	2	1	2	Carlson
1·48	Foundations	2·04	4(B)	1	I, XI, XVII	3	—	4	Taylor
1·491	Soil Mechanics	2·04	G(A)	1	I (A.E.)	3	—	6	Taylor
1·492	Soil Mechanics	1·491	G(A)	2	I (A.E.)	3	—	6	Taylor
1·493	Soil Mech. Lab.	*1·491* or *1·495*	G(A)	1	I (A.E.)	0	3	3	Taylor
1·495	Soil Mechanics	2·04	G(A)	1	(Elective)	5	—	10	Taylor
1·496	Soil Mechanics	1·491 or 1·495	G(A)	2	(Elective)	5	—	10	Taylor
1·501	Bridge Design	*1·41*	4(B)	1	I	0	8	0	Mirabelli
1·502T	Structural Design	1·501	4(B)	2	I	0	8	0	Mirabelli
1·51	Structural Theory Adv.	1·411	G(A)	S	I (A.E.)	3	—	6	Fife
1·52	Structural Design	1·41	4(B)	2	XI	0	3	0	Mirabelli
1·521	Structural Lab.	1·42	G(A)	1	(Elective)		★		Wilbur, Norris
1·522	Structural Lab.	1·42	G(A)	2	(Elective)		★		Wilbur, Norris
1·541	Reinf. Conc. Des. Adv.	1·42	G(A)	1	(Elective)	2	4	2	Mitsch
			G	S	I (A.E.)				
1·542	Reinf. Conc. Des. Adv.	1·541	G(A)	2	(Elective)	2	4	0	Peabody
1·551	Structural Design Adv.	*1·561*	G(A)	1	(Elective)	2	4	0	Wilbur
1·552	Structural Design Adv.	1·551	G(A)	2	(Elective)	2	4	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	—	6	Fife
1·571	Stat. Indet. Structures	1·42T or 1·421	G(A)	1	(Elective)	3	—	6	Wilbur
1·572	Stat. Indet. Structures	1·571	G(A)	2	(Elective)	3	—	6	Wilbur
1·58	Des. Reinf. Conc. Struct.	*1·40*	3	2	I, XI	2	4	0	Mitsch
1·59	Concrete Research	——	G(A)	1 or 2	(Elective)		★		Carlson
1·60	Hydrographic Survey	M12, *1·05* or *1·041*	3	S	I, VII_2, XI	1	4	0	Gifford
1·62	Hydraulics	2·01	3	2	I, VII_2, IX-B, XI	4	—	6	Russell
1·63	Hydraulics	2·01	4	1	XV_1	2	—	3	Russell
1·64	Hydraulics	2·01	4	1	VI, VI-A$(A)_{1,2}$	3	—	6	Russell
			4	2	VI-A$(B)_{1,2}$				
1·66	Hydraulics, Adv.	1·62	G(A)	1	(Elective)	2	—	6	Russell
1·681	Theory of Models	1·62	G(A)	1	I (A.E.)	2	—	4	Reynolds
1·682	River Hydraulic Lab.	1·62, *1·68*	G(A)	2	(Elective); I (A.E.)	0	9	0	Reynolds
1·69	River Engineering	1·62	G(A)	2	(Elective)	2	—	4	Reynolds
1·70	Hydrology	1·62	4(B)	1	(Elective I)	3	4	4	Gifford
			G	1	I (A.E.)				
1·701	Hydrology	——	4(B)	1	(Elective)	3	—	4	Gifford
1·71	Water Power Eng. & Flood Control	1·70, 1·41	4(B)	2	(Elective I)	3	4	3	Gifford
1·711	Water Power Eng. & Flood Control	1·62 or 1·64; 1·70 or 1·701	4(B)	2	(Elective)	3	—	3	Gifford

★ Time specially arranged.

Civil and Sanitary Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec.	Lab. Draw.	Prep.	Instructor in Charge
1·731	Water Power Eng. Adv.	1·42, 1·71, *1·851*	G(A)	1	(Elective)	3	—	6	Gifford
1·732	Water Power Eng. Adv.	1·731, *1·852*	G(A)	2	(Elective)	3	—	6	Gifford
1·75	Hydraulic & San. Eng.	1·62	4(B).	1	IV-C_2,VII_2,XI (Elec.I)	4	—	6	Camp
1·76	Sanitary Engineering	1·75	4(B).	2	IV-C_2 (Elective I)	2	—	3	Camp
1·78	Sanitary Engineering	1·75	4(B).	2	VII_2, XI	3	—	4	Camp
1·79	Sanitary Design	1·75	4(B).	2	(Elective I)	0	2	0	Camp
1·801	Hydraulic & San. Des.	*1·75*	4(B).	1	VII_2, XI (Elec. I)	0	3	0	Camp
1·802	Sanitary Design	*1·76* or *1·78*	4(B).	2	VII_2, XI	0	5	0	Camp
1·811	Sanitary Eng. Adv.	1·75	G(A)	1	(Elective)	3	—	6	Camp
1·812	Sanitary Eng. Adv.	1·811, 1·76	G(A),	2	(Elective)	3	—	6	Camp
1·821	Sanitary Eng. Lab.	*1·811*, 7·41	G(A)	1	(Elective)	6	4	2	Camp,Stein
1·822	Sanitary Eng. Lab.	*1·812*, 1·821, *7·29*	G(A)	2	(Elective)	0	4	2	Camp, Stein
1·851	Water Power Des. Adv.	*1·731*	G(A)	1	(Elective)	0	8	0	Gifford
1·852	Water Power Des. Adv.	1·851, *1·732*	G(A)	2	(Elective)	0	8	0	Gifford
1·881	Sanitary Design Adv.	*1·811*	G(A)	1	(Elective)	0	6	0	Camp
1·882	Sanitary Design Adv.	*1·812*	G(A)	2	(Elective)	0	6	0	Camp

MECHANICAL ENGINEERING—2·00–2·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec.	Lab. Draw.	Prep.	Instructor in Charge
2·00	Applied Mechanics	*D12*, *M21*, 8·02	2	1	I, II, VI, VI-B, IX-B, XIII, XIII-C, XV_1, XVI, XVII	3	—	5	L. S. Smith
2·01	Applied Mechanics	2·00	2	2	I, II, VI, IX-B, XIII, XIII-C, XV_1, XVI, XVII	3	—	5	L. S. Smith
			4	1	VI-B(b)				
2·011	Applied Mechanics	*M21*, *8·02*	2	2	VII_2, XI, XII_2	3	—	5	L. S. Smith
			3	1	III, X				
2·031	Struct. Mechanics, El.	M111	1	2	IV, IV-B, IV-C_1	3	—	6	Holmes
2·032	Structural Mechanics	2·031	2	1	IV, IV-B, IV-C_1	2	—	4	Holmes
2·033	Structural Mechanics	2·032	2	2	IV, IV-B, IV-C_1	2	—	4	Holmes
2·04	Applied Mechanics	2·01 or 2·011	3	1	I, II, VI, VI-C, VI-A(B)$_{1,2}$, IX-B, XIII, XIII-C, XV_1, XVI	3	—	5	L. S. Smith
			3	S	II-A, VI-A(A), XVII				
			4	S	VI-A(B)$_{1,3}$				
			4	2	VI-B(b)				
2·042	Applied Mechanics	2·011	3	1	VII_2, XI, XII_2	3	—	5	L. S. Smith
			3	2	III, X				
2·043	Applied Mechanics	——	3	1	XIII-A	3	—	5	L. S. Smith
2·05	Applied Mechanics	——	G	S	II (A.O.)	4	—	6	Holmes
2·06	Applied Mechanics	2·04	3	2	II, XIII	3	—	5	L. S. Smith
			3	1	II-A				
2·061	Applied Mechanics	2·043	3	2	XIII-A	3	—	6	L. S. Smith
2·07	Applied Mechanics	2·04	3	2	VI, VI-A(A)$_{1,2}$	3	—	5	Holmes
			4	2	VI-A(B)$_{1,2}$				
2·08	Applied Mechanics	2·04	4	1	II-A	4	—	8	Soderberg
2·081	Applied Mechanics	2·04	4(B).	1	$II_{1,2,4}$ XIII-A (Not 40–41)	3	—	5	Soderberg
2·082	Applied Mechanics	2·06	4(B).	2	$II_{1,2,4}$, II-A XIII-A (Not 40–41)	3	—	5	Soderberg
2·10	Ordnance Engineering	2·04	4(B).	1	(Elective)	3	—	3	Holmes
2·11	Industrial Plant Eng.	2·06	4(B).	2	(Elective)	3	—	3	Peabody
2·121	App. Photoelasticity	2·04	4(B).	1 or 2	(Elective)	1	2	2	Murray
2·125	Res. in Photoelasticity	2·121	G(A)	1 or 2	(Elective)		★		Murray
2·131	Dynamics of Engines	2·081	G(A)	1	(Elective)	2	—	4	Riley
2·132	Dyn. Aircraft Engines	2·131	G(A)	1	(Elective) (For Naval Officers only, XVI)	2	—	2	Riley

★Time specially arranged.

Mechanical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·151	Dynamics	—	G	1	II (T.E.)	2	—	4	Riley
2·152	Dynamics	—	G	2	II (T.E.)	2	—	4	Riley
2·201	Adv. Mech. & Th. Elast.	2·082	G(A)	1	(Elective)	3	—	9	Fuller
2·202	Adv. Mech. & Th. Elast.	2·201	G(A)	2	(Elective)	3	—	9	Fuller
2·203	Theory of Elasticity	2·05	G	S	II (A.O.)	2	—	4	Fuller
2·211	Adv. Mech. Eng. Prob.	2·082	G(A)	1	(Elective)	3	—	9	Soderberg
			G	1	XIII (N.E.) XIII-A (Not 40–41)				
2·212	Adv. Mech. Eng. Prob.	2·211	G(A)	2	(Elective)	3	—	9	Soderberg
			G	2	XIII (N.E.) XIII-A (Not 40–41)				
2·221	Plasticity	2·082	G(A)	1	(Elective)	3	—	6	MacGregor
2·222	Adv. Plasticity Prob.	2·221	G(A)	2	(Elective)	3	—	6	MacGregor
2·223	Plasticity Res.	*2·221*	G(A)	1 or 2	(Elective)		★		MacGregor
2·251	Fluid Mechanics	M22, 2·01	3	1	II, XIII	3	2	3	Hunsaker
2·252	Fluid Mechanics	2·251, 2·40	3	2	II	3	2	3	Hunsaker
2·253	Fluid Mechanics	M22, 2·01, *2·40*	3	1	II-A	5	2	5	Hunsaker
‡2·254	Fluid Mechanics	M22, 2·01	3	S	(Elective)	3	—	3	
‡2·255	Fluid Mechanics	2·254, 2·40	3	S	(Elective)	3	—	3	
2·271	Hydromechanics	2·252 or M73	4	1	XIII-A	3	—	6	Hunsaker
			G	1	II (T.E.)				
			G(A)	1	(Elective)				
‡2·272	App. Hydromechanics	2·271	G(A)	2	(Elective)	3	—	6	
			G	2	II (T.E.)				
‡2·273	Adv. Hydromech. Prob.	2·271	G(A)	1 or 2	(Elective)		★		
2·30	Engineering Metals	—	2	2	II	1	2	1	Kyle
			3	1	(Elective)				
2·31T	Engineering Materials	*2·30*	3	1	II	3	3	3	Kyle
2·311	Engineering Materials	—	4	2	XIII	3	3	3	Kyle
2·32	Engineering Metals	2·31 or 2·351	4	1	$II_{2,4}$	1	2	2	Kyle
			4	2	II_1				
2·33	Adv. Engineering Metals	2·31 or 2·32	4(B)	2	II_4	3	—	2	Kyle
2·331	Metal Processing	—	G	S	XIII-A	2	3	1	Kyle
2·332	Welding Eng., Adv.	2·32	4(B)	2	(Elective)	2	2	2	Kyle
2·34	Prop. of Metals under Stress	2·35, 2·37	G(A)	2	(Elective)	1	2	3	Lessells
2·35	Adv. Metals & Testing	2·31, 2·37	4(B)	1	II_4	2	2	4	Lessells
2·351	Materials of Eng.	*2·04*	3	1	II-A, XVI	2	—	2	Lessells
			3	2	(Elective)				
2·361	Adv. Str. of Materials	—	G(A)	S	(Elective)	4	1	4	Lessells
2·37	Test. Materials Lab.	2·04, 2·31 or 2·351	3	2	II, XVI	1	3	2	Cowdrey
			4	S	II-A				
2·371	Test. Materials Lab.	2·04 or 2·042	3	2	I, VI-A(A) XI	0	2	1	Cowdrey
			4	1	III, $VI\text{-}A(A)_3$, X, X-B				
			4	2	VI-A(B), XIII				
2·373	Test. Materials Lab.	2·04	3	1	XVII	0	5	3	Cowdrey
2·391	Dyn. Str. of Metals	2·082, 2·35, 2·37	G(A)	1	(Elective)		★		deForest
2·392	Dyn. Str. of Metals	2·391	G(A)	2	(Elective)		★		deForest
2·40	Heat Engineering	M21, 8·02	3	1	II, II-A, VI, IX-B, XIII, XIII-C, XVI	4	—	5	Svenson
			4	1	$VI\text{-}A(A)_{1,2}$				
			4	2	$VI\text{-}A(B)_{1,2}$				
2·402	Heat Engineering	—	3	1	XIII-A	4	2	7	Svenson
2·4[illegible]	Heat Engineering	M21, 8·02	3	1	XVII	3	—	5	Taft
2·411	Heat Engineering	M21, 8·02	4	1	I, XI	2	—	4	Taft
2·42	Heat Engineering	2·40	3	2	II, II-A, VI, IX-B, XIII, XIII-C, XVI	4	—	5	Svenson

★Time specially arranged. ‡Not offered in 1940–41.

Mechanical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec.	Lab. Draw.	Prep.	Instructor in Charge
2·421	Heat Engineering	2·41 or 2·411	4	2	I, XI	2	—	4	Taft
2·422	Heat Engineering	2·402	3	2	XIII-A	2	—	3	Svenson
2·43	Heat Engineering	2·40	4(B)	1	$II_{1,3}$	3	—	5	Svenson
			4	S	II-A				
2·44	Eng. Thermodyn. of Mixtures	2·42 or 2·421	G(A)	1	(Elective)	3	—	6	Moore
2·45	Eng. Thermodyn., Adv.	2·43, M36	G(A)	2	(Elective)	3	—	9	Keenan
			G	2	II (T.E.)				
2·451	Adv. Prob. in Eng. Thermodynamics	2·42, 2·252	G(A)	1 or 2	(Elective)		★		Keenan
2·461	Refrigeration, Adv.	2·43	G(A)	1	(Elective)	3	—	9	Svenson
2·462	Heat Transmission, Adv.	2·43	G(A)	2	(Elective)	3	—	9	Moore
2·50	Heat Measurements	8·04	3	2	III	1	2	1	Wilkes
2·501	Heat Measurements	8·04	3	1	IX-A	0	2	1	Wilkes
2·51	Heat Measurements	8·04	4(B)	1	II_3	1	2	3	Wilkes
			4	2	II-A				
2·53	Heat Measurements	2·50 or 2·501	G(A)	1	(Elective)		★		Wilkes
2·55	Power Plant Eng.	2·42 or 2·421	4(B)	1	$II_{1,3}$	3	—	3	Taft
2·551	Power Plant Eng.	2·42	4	2	II-A	3	—	5	Taft
2·56	Power Plant Eng.	2·55	4(B)	2	$II_{1,3}$	3	—	3	Taft
2·57	Power Plants, Adv.	2·56	G(A)	1	(Elective)	3	—	6	Holt
2·58	Heat Eng. in Ind. Plants.	2·42	4(B)	2	(Elective)	3	—	5	Taft
2·59	Torpedoes	—	G	1	II (T.E.)	2	—	4	Taft
2·60	Food Engineering	8·02	4	1	VII-B	2	—	2	Jones
2·601	Food Engineering	2·60	4	2	VII-B	3	—	3	Jones
2·621	Refrigeration Eng.	*2·43*	4(B)	1	II_3	3	—	3	Jones
2·622	Refrigeration Eng.	2·43	4(B)	2	II_3	3	—	5	Svenson
2·63	St. & Trans. of Foodstuffs	2·621	G(A)	1	(Elective)	3	—	6	Jones
2·64	Refrigeration Eng.	2·43	G(A)	2	(Elective)	3	—	6	Svenson
2·65	Mech. Eq. Bldgs. H. & V.	8·02	4	2	VII_2	3	1	3	Eames
2·651	Mech. Equip. of Bldgs.	—	4	1	IV	2	—	2	Moore
2·66	Heat., Vent. & Air Cond.	2·40 or 2·41	4(B)	1	II_3, XVII	3	—	5	Holt
2·671	Air Conditioning, Adv.	2·66	G(A)	1	(Elective)	3	—	6	Holt
2·672	Heat. & Vent. Design	2·671	G(A)	2	(Elective)	4	—	4	Holt
2·680	Engineering Lab.	2·40	3	2	II	0	4	4	Eames
			4	2	II-A				
2·682	Engineering Lab.	2·680	4(B)	1	II_1	0	3	3	Eames
2·683	Engineering Lab.	2·40	3	2	XIII	0	2	2	Eames
2·684	Engineering Lab.	2·683	4	2	XIII	0	2	2	Eames
2·685	Engineering Lab.	2·40	3	2	XIII-C	0	4	4	Eames
2·686	Engineering Lab.	2·40 or 2·41	4	1	VI, IX-B, XVI	0	3	3	Eames
2·687	Hydraulic Lab.	1·62	4	2	I, XI	0	2	2	Eames
2·688	Engineering Lab.	10·29	4	2	X	0	3	3	Eames
2·689	Mech. Eng. Equip.	—	G(B)	1	I (A.E.)	2	4	3	Riley, Eames
2·69	Refrig. & Air Con. Lab.	2·43, 2·66	4(B)	2	II_3	0	6	6	Jones, Holt
2·691	Refrigeration Lab.	2·43	4(B)	2	(Elective)	0	3	3	Jones
2·692	Refrig. & Air Con. Lab.	2·69	G(A)	2	(Elective)	0	6	6	Jones, Holt
2·70	Machine Drawing	D12	2	1	II	0	4	0	Sloane
2·701	Machine Drawing	D12	2	1	IX-B	0	6	0	Sloane
			3	1	XVI				
2·71	Th. & App. of Mechanisms	M75	G	1	II (A.O.)	6	—	8	Swett
2·72	Machine Design	—	4	2	XIII-A	3	—	6	Townsend
2·730	Machine Design	*2·01*, D12	2	2	II, XVI	1	2	1	Swett
2·731	Machine Design	2·04, 2·31T or 2·351, 2·730	3	2	II	2	2	1	Townsend
			3	1	II-A				

★ Time specially arranged.

Mechanical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·732	Machine Design	2·731	4(B)	1	$II_{1,4}$	2	2	2	Swett
2·733	Machine Design	2·731	4	2	II-A	2	3	3	Swett
2·734	Machine Design	2·731	4	1	(Elective)	1	2	1	Swett
2·74	Machine Design	2·04, 2·351 or 3·30	4	1	(Elective)	2	2	0	Townsend
2·751	Machine Design, Adv.	2·732	G(A)	1	(Elective)	3	5	2	Swett
2·752	Machine Design, Adv.	2·751	G(A)	2	(Elective)	3	5	2	Swett
2·761	Machine Design	——	G	1	II (T.E.)	2	4	2	Swett
2·762	Machine Design	——	G	2	II (T.E.)	1	2	2	Swett
2·77	Design of Prod. Mach.	2·732	4	2	II_1	2	2	2	Swett
2·79	Automotive Dynamics	2·791, 2·081	4(B)	2	II_2	2	—	2	E. S. Taylor
2·791	Automotives Engines	2·42, 2·06	4(B)	1	II_2	2	2	4	C. F. Taylor, Rogowski
2·792	Automotive Engines	2·791	4(B)	2	II_2	2	2	4	C. F. Taylor, Rogowski
2·793	Automotive Eng. Des.	*2·791* or *2·797*	4(B)	1	II_2	1	3	0	C. F. Taylor
2·794	Automotive Eng. Des.	2·793	4(B)	2	II_2	1	3	0	C. F. Taylor
2·795	Automotive Vehicles	——	4(B)	1	II_2	2	—	3	Fales
2·796	Automotive Vehicles	2·795	4(B)	2	II_2	3	—	5	Fales
2·797	Automotive Engines	2·42, 2·06	4(B)	1	(Elective)	2	—	2	C. F. Taylor
2·798	Automotive Engines	2·791 or 2·797	4(B)	2	(Elective)	2	—	2	C. F. Taylor
2·801	Auto. Eng. Prob., Adv.	——	G(A)	1	(Elective)		★		E. S. Taylor
2·802	Auto. Eng. Prob., Adv.	——	G(A)	2	(Elective)		★		E. S. Taylor
2·805	Diesel Engines	——	G(A)	1	XIII (N.E.) XIII-A (Not 40–41)	2	0	4	C. F. Taylor
2·806	Diesel Engines	2·805	G(A)	2	XIII (N.E.)	2	0	4	C. F. Taylor
2·82	Diesel Engine Design	2·081, 2·42	4(B)	2	II-A(a)	0	6	0	Riley
2·83	Steam Turbine Eng.	2·42	4(B)	2	II-A(b)	4	—	2	Keenan
2·851	Machine Tool Lab.	——	2	1	II, XIII	1	3	0	English
			3	S	XIII-A				
2·852	Machine Tool Practice	2·851	2	2	II, XIII	1	3	0	English
			3	S	XIII-A				
2·853	Machine Tool Lab.	——	2	1	VI	1	3	0	English
2·854	Machine Tool Lab.	——	2	1	XIII-C	1	2	0	English
			2	2	III, IX-B				
2·855	Machine Tool Lab.	——	2	2	VIII	0	2	0	English
2·871	Manufacturing Eng.	2·731 or *2·74*	4(B)	1 or 2	(Flective)	2	—	4	Buckingham
2·872	Prep. for Manufacturing	——	3(B)	1	$XVIII_1$	2	—	4	Buckingham
			4	2	(Elective)				
2·88	Metrology & Dimens. Eng. Stand.	——	G(A)	1	(Elective)	3	—	6	Buckingham
2·901	Prin. of Fabric Struct.	8·02	4(B)	1	(Elective)	3	—	6	Schwarz
2·902	Prin. of Fabric Struct.	2·901	4(B)	2	(Elective)	3	—	6	Schwarz
2·903	El. of Textile Manufact.	2·730	4(B)	1	(Elective)	3	—	6	Schwarz
2·904	Pr. of Textile Manufact.	2·903	4(B)	2	(Elective)	3	—	6	Schwarz
2·905	Textile Tech. Anal.	8·04	G(A)	1	(Elective)	3	—	5	Schwarz
2·906	Textile Tech. Anal.	2·905	G(A)	2	(Elective)	3	—	5	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 Research Lab.	*2·905*	G(A)	1	(Elective)	0	6	0	Schwarz
2·912	Textile Research Lab.	2·911	G(A)	2	(Elective)	0	6	0	Schwarz
2·92	Prin. Textile Anal.	——	——	S	(Elective)	3	5	2	Schwarz
2·951	Manufacturing Practice	——	3	S	II-A		40 h.p.w.		Townsend
2·952	Manufacturing Practice	——	3	2	II-A		40 h.p.w.		Townsend
2·953	Manufacturing Practice	——	4	1	II-A		40 h.p.w.		Townsend
2·954	Manufacturing Practice	——	G	S	II-A		40 h.p.w.		Townsend
2·96	Study and Research	——	G	S	II-A	0	6	0	Townsend

★ Time specially arranged.

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
3·00	Int. to Metallurgy	——	2	2	III	0	3	1	R. S. Williams
3·01	Non-Ferrous Met. I	3·00, 3·10	3	1	III	4	—	4	Hayward
3·02	Non-Ferrous Met. II	3·01	4	1	(Elective)	3	—	3	Hayward
3·03T	Non-Ferrous Met. III	3·02	4	1 or 2	(Elective)		★		Hayward
3·031	Met.: Copper, Lead	5·13, 3·10	4(B).	1	(Elective)	5	—	4	Hayward
3·04T	Metallurgical Lab.	——	3	1	III	0	5	0	Hayward
3·041	Electric Furnaces	8·04, 5·02	4(B).	1	(Elective)	1	2	2	Hayward
3·05	Metallurgy, General	3·02, 3·12T	4(B).	2	(Elective)	3	—	3	Hayward
3·06	Non-Fer. Metal., Adv.	3·031, 3·05	G(A)	1	(Elective)	2	0	6	Hayward
3·07	Metal. Com. Metals	5·02	4	2	(Elective)	3	—	3	Hayward
3·08	Gen. Metal., Adv.	3·05	G(A)	2	(Elective)	2	—	6	Hayward
3·09	Metal. Calc., Adv.	3·05	G(A)	2	(Elective)	2	—	6	Hayward
3·10	Metal. Plant Visits	——	3	S	III	0	3	1	Hayward
3·11	Production Metal	——	G	1	II (A.O.)	3	—	5	Waterhouse
3·12T	Met.: Iron & Steel	5·02, 3·10	3	2	III	4	—	3	Waterhouse
3·13T	Met.: Iron & Steel	——	4	2	XIII-A	2	—	1	Waterhouse
3·141	Met.: Iron & Steel	5·02	4	1	(Elective)	2	—	1	Waterhouse
3·15	Met.: Iron & Steel, Adv.	3·12T	G(A)	1	(Elective)		★		Waterhouse
3·16	Met.: Iron & Steel, Adv.	3·12T	G(A)	2	(Elective)		★		Waterhouse
3·17	Metal. Plant Design	3·02, 3·12T	G(A)	1	(Elective)	0	13	0	Waterhouse
3·18	Metal. Plant Design	3·01, 3·12T	G(A)	2	(Elective)	0	13	0	Waterhouse
3·19	Metallurgical Plants	3·01, 3·12T	4(B).	1 or 2	(Elective)	3	—	3	Waterhouse
3·20T	Metal. Thermodynamics	5·62	4(B).	1	III	4	—	5	Chipman
3·21T	Prin. of Steel Making	3·20T	4(B).	2	(Elective)	2	—	4	Chipman
3·22T	Fire Assaying	5·12, 12·01	3	2	(Elective)	1	4	1	Reed
3·23T	Fire Assaying, Adv.	3·22T	G(A)	1	(Elective)		★		Reed
3·24	Fire Assaying, Adv.	3·22T	G(A)	2	(Elective)		★		Reed
3·30	Metallography	8·04	3	2	$VIII_2$	2	2	1	Floe
			4	1	II_4				
			G	1	XIII-A				
3·31	Metallography	5·12, 8·04	3	1	III	2	3	2	Cohen
3·32	Metallography and Heat Treatment	3·31	3	2	III	2	4	4	Homerberg, Floe
3·33	App. of Metallography	3·30 or 3·32	4(B).	1	III_1	1	2	2	Homerberg, Cohen
			4	2	II_4				
3·34	Physical Metal, Adv.	3·33, 3·50	G(A)	1	(Elective)		★		Cohen
3·35	Physical Metal., Adv.	3·33, 3·50	G(A)	2	(Elective)		★		Cohen
3·36	Physical Metal.	——	G	1	II (A.O.)	4	—	6	Wulff
3·37	Physical Metal, Adv.	3·36	G	2	II (A.O.)	4	—	6	R. S. Williams Wulff
3·38	Physical Metal., Adv.	——	G	1	II (T.E.)	4	—	4	R. S. Williams
3·39	Physical Metal., Adv.	3·38	G	2	II (T.E.)	1	5	2	Homerberg
3·391	Properties of Metals	——	3	1	XIII-A	3	—	3	R. S. Williams, Homerberg
3·392	Properties of Metals	3·391	3	2	XIII-A	3	—	3	R. S. Williams, Homerberg
3·40	Cor. & Heat Res. Alloys	3·30 or 3·32	4(B).	1	(Elective)	2	—	4	R. S. Williams
3·41	Light Alloys	3·30 or 3·32	4(B).	2	(Elective)	2	—	4	R. S. Williams
3·42	Powder Metallurgy	3·30 or 3·32	4(B).	1	(Elective)	2	—	4	Wulff
3·422	Powder Metal. Lab.	3·42	4(B).	2	(Elective)	1	3	2	Wulff
3·43	Heat Treatment	3·30	G	1	II (T.E.)	1	2	2	Floe
3·50	X-Ray Metallography	M22, 3·30 or 3·31	4(B).	1	(Elective)	2	1	3	J. T. Norton
			4	2	II_4				
3·51	Physics of Metals	M22, 3·30 or 3·31 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
‡3·60	Ferromagnetism	——	G(A)	1	(Elective)	2	—	4	Bitter

★Time specially arranged. ‡ No offered in 1940–41.

Metallurgy Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
3·61	Atomic Arrangements in Alloys	——	G(A)	1	(Elective)	2	—	4	Bitter
3·62	Sp. Prob. in the Physics of Metals	——	G(A)	1 or 2	(Elective)		★		Bitter
3·70	Ceramics	5·02, 8·04	3	1	(Elective)	2	3	3	F. H. Norton
3·71	Optical Ceramics	8·04	4(B)	1	(Elective)	0	6	2	F. H. Norton
3·73	Fund. Ceramic Process	2·50, 3·70, 5·61	G(A)	1	(Elective)	3	4	4	F. H. Norton
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
3·78	Ceramic Mold. Proc.	——	——	S	(Elective)	1	1	0	F. H. Norton
3·81	Mineral Dressing I	12·01 or 12·031	3	1	III	2	2	2	Gaudin
3·82	Mineral Dressing II	3·81	3	2	III	2	2	2	Gaudin
3·83	Mineral Dressing Plant	3·82	4(B)	1	III_2	3	—	2	Locke
3·84	Mineral Dressing Prac.	3·83	4(B)	2	III_2	2	—	2	Locke
3·85T	Flotation	3·82	4(B)	1	III_2	3	—	3	Schuhmann
3·86T	Comminution	3·82	4(B)	2	III_2	2	—	3	Schuhmann
3·87	Quant. Mineragraphy	3·82	4(B)	1	III_2	4	—	0	Schuhmann
3·88	Ore Testing	3·82	4(B)	2	(Elective)	0	6	2	Schuhmann
3·89	Mineral Dressing Des.	3·84	G(A)	1 or 2	(Elective)		★		Locke
3·90	Mineral Dressing, Adv.	3·84	G(A)	1 or 2	(Elective)	2	—	4	Gaudin
3·91	Mineral Dressing Sem.	3·84	G(A)	1 or 2	(Elective)	1	—	2	Gaudin

ARCHITECTURE—4·00–4·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
4·021	Freehand Drawing	——	2	1	IV, IV-B, IV-C_1, VI-B(b)	0	4	0	W. H. Brown
			4	1	IV-C_2				
4·022	Freehand Drawing	4·021	2	2	IV, IV-B, IV-C_1 VI-B(b)	0	4	0	W. H. Brown
			4	2	IV-C_2				
4·031	Freehand Drawing	4·022	3	1	IV, IV-B, IV-C_1, VI-B(b)	0	4	0	W. H. Brown
			5	1	IV-C_2				
4·032	Freehand Drawing	4·031	3	2	IV, IV-B, IV-C_1	0	4	0	W. H. Brown
			5	2	IV-C_2				
4·041	Freehand Drawing	4·032	4	1	IV, IV-B, IV-C_1	0	4	0	W. H. Brown
4·042	Freehand Drawing	4·041	4	2	IV	0	4	0	W. H. Brown
4·051	Freehand Drawing	4·042	5(B)	1	IV	0	6	0	W. H. Brown
4·052	Freehand Drawing	4·051	5(B)	2	IV	0	6	0	W. H. Brown
4·053	Freehand Drawing	4·052	G(A)	1	IV	0	6	0	W. H. Brown
4·054	Freehand Drawing	4·053	G(A)	2	IV	0	6	0	W. H. Brown
4·06	Graphics	——	1	1	IV, IV-B, IV-C_1	0	6	0	Dean
4·071	Modeling	4·722	3	1	IV, IV-B, IV-C_1, VI-B(b)	0	3	0	Selmer-Larsen
4·072	Modeling	4·071	3	2	IV, IV-B, IV-C_1	0	3	0	Selmer-Larsen
4·081	Color, Comp. Th. & App.	4·732	4	1	IV, IV-B, IV-C_1, VI-B(b)	1	—	3	H. W. Gardner
			5	1	IV-C_2				
4·082	Color, Comp. Th. & App.	4·081	4	2	IV, IV-B, IV-C_1, VI-B(b)	1	—	3	H. W. Gardner
			5	2	IV-C_2				
4·091	Color, Comp. Th. & App.	4·082	5(B)	1	IV	1	—	4	Beckwith
4·092	Color, Comp. Th. & App.	4·091	5(B)	2	IV	1	—	4	Beckwith
4·11	Shades & Shadows	*4·06*	1	1	IV, IV-B, IV-C_1	0	2	2	H. W. Gardner
4·12	Perspective	*4·06* or *D12*	1	1	IV, IV-B, IV-C_1	0	4	3	Dean
4·312	Abstract Design	——	1	2	IV, IV-B, IV-C_1	0	10	5	H. W. Gardner

★ Time specially arranged.

Architecture Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
4·421	Architectural History	——	2	1	IV, IV-B, IV-C_1	3	1	5	Putnam
			3	1	VI-B(b)				
4·422	Architectural History	——	2	2	IV, IV-B, IV-C_1	3	1	5	Putnam
4·43	Architectural History	——	2	1	XVII	3	—	3	Putnam
4·461	Europ. Civilization & Art	4·422	3	1	IV, IV-B, IV-C_1	3	—	4	Seaver
4·462	Europ. Civilization & Art	4·461	3	2	IV, IV-B, IV-C_1	3	—	4	Seaver
4·471	Europ. Civilization & Art	4·462	4	1	IV, IV-B, IV-C_1	2	—	3	Seaver
4·472	Europ. Civilization & Art	4·471	4	2	IV, IV-B, IV-C_1	2	—	3	Seaver
4·481	Europ. Civilization & Art	4·472	5(B)	1	IV, IV-B, IV-C_1	2	—	3	Seaver
4·482	Europ. Civilization & Art	4·481	5(B)	2	IV, IV-B, IV-C_1	2	—	3	Seaver
4·491	Europ. Civilization & Art	4·482	G(A)	1	IV	2	—	4	Seaver
4·492	Europ. Civilization & Art	4·491	G(A)	2	IV	2	—	4	Seaver
4·50	Office Practice	——	5	S	IV-C		40 h.p.w.		F. J. Adams
4·51	Office Practice	4·50	5(B)	2	IV-C	0	30	0	F. J. Adams
4·52	Office Practice	4·51	G(A)	S	IV-C	0	30	0	F. J. Adams
4·53	Professional Relations	——	5(B)	1	IV	1	—	2	MacCornack, Clapp
4·541	Housing Seminar	——	G(A)	1	(Elective)	2	—	4	Burchard
4·542	Housing Seminar	——	G(A)	2	(Elective)	2	—	4	Burchard
4·60	Plan. & Housing Legis.	——	G(A)	1	IV-C	2	—	4	Shurtleff
4·611	Principles of Planning			S	(Elective)	2	—	2	F. J. Adams
4·612	Techniques of Planning			S	(Elective)	1	—	1	F. J. Adams
4·613	Planning Administration			S	(Elective)	1	—	1	Shurtleff
4·614	Planning Legislation			S	(Elective)	1	—	1	Shurtleff
4·62	Site Plan. & Const.	——	4	2	IV-B, IV-C	0	6	0	Eberlin
4·63	City Planning Admin.	——	G(A)	2	IV-C	2	—	4	Shurtleff
4·641	Prin. of City Planning	——	3	1	IV, IV-B, IV-C_1	2	—	2	Shurtleff
			4	1	IV-C_2				
4·642	Th. of Site Planning	4·641	4(B)	2	IV-B, IV-C	2	—	3	F. J. Adams
4·651	Th. & Prac. City Plan.	4·642	5(B)	1	IV-B, IV-C	3	—	3	F. J. Adams
4·652	Th. & Prac. City Plan.	4·651	5(B)	2	IV-B, IV-C	3	—	3	F. J. Adams
4·661	City Planning Research	4·652	G(A)	1	IV-C	2	—	4	F. J. Adams
4·662	City Planning Research	4·661	G(A)	2	IV-C	2	—	4	F. J. Adams
4·672	City Planning Design	4·741	4(B)	2	IV-B, IV-C_1	0	18	0	Hartzog
4·681	City Planning Design	4·672	5(B)	1	IV-B, IV-C_1	0	24	0	Hartzog
4·682	City Planning Design	4·681	5(B)	2	IV-B	0	12	0	F. J. Adams
4·683	City Planning Design	——	5(B)	1	IV-C_2	0	30	0	F. J. Adams
4·691	City Planning Design, Adv.	4·682	G(A)	1	IV-B, IV-C	0	30	0	F. J. Adams
4·692	City Planning Design, Adv.	4·691	G(A)	2	IV-B	0	30	0	F. J. Adams
4·694	City Planning Design, Adv.	4·691	G(A)	2	IV-C	0	6	0	F. J. Adams
4·711	Architectural Practice	——	1	1	IV, IV-B, IV-C_1	0	10	0	Bridge
4·712	Architectural Practice	——	1	2	IV, IV-B, IV-C_1	0	12	0	Bridge
4·721	Architectural Design II	——	2	1	IV, IV-B, IV-C_1	0	13	1	Beckwith
4·722	Architectural Design II	4·721	2	2	IV, IV-B, IV-C_1	0	13	1	Beckwith
4·731	Architectural Design III	4·722	3	1	IV, IV-B, IV-C_1	0	15	3	H. W. Gardner, Clapp
4·732	Architectural Design III	4·731	3	2	IV, IV-B, V-C_1	0	15	3	Clapp
4·741	Architectural Design IV	4·732	4	1	IV, IV-B, IV-C_1	0	24	1	Larsen
4·742	Architectural Design IV	4·741	4	2	IV	0	28	1	Larsen
4·751	Architectural Design V	4·742	5(B)	1	IV	0	29	0	Anderson
4·752	Architectural Design V	4·751	5(B)	2	IV	0	14	0	Anderson
4·761	Architectural Design VI	4·752	G(A)	1	IV	0	36	0	Anderson
4·762	Architectural Design VI	4·761	G(A)	2	IV	0	30	0	Anderson
4·78	Planning Principles	——	2	2	XVII	1	2	1	Clapp
4·811	Construction	2·031	3	1	IV, IV-B, IV-C_1	2	5	0	Gelotte
4·812	Construction	4·811	3	2	IV, IV-B, IV-C_1	2	5	0	Gelotte
4·93	General Science	——	2	1	IV, IV-B, IV-C_1	4	—	2	T. Davis
4·94	General Science	——	2	2	IV, IV-B, IV-C_1	4	—	2	Page
——	Thesis Research	——	G(A)	1 and 2	IV, IV-B, IV-C	0	6	0	Anderson, F. J. Adams

CHEMISTRY — 5·00–5·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
5·00	Chemistry, Entrance	—	—	S	—	3	3	5	A. R. Davis
5·01	Chemistry, General	—	1	1	All Courses except IV, IV-B and IV-C_1	4	3	4	Wareham
5·02	Chemistry, General	5·01	1	2	All Courses except IV, IV, -B and IV-C_1	4	3	4	Wareham
5·04	Chemistry	—	G	S	II(A.O.)	4	—	5	Wareham
5·061	Inorganic Chemistry	5·13	4(B)	1	V	2	—	3	Schumb
5·062	Inorganic Chemistry	5·061	4(B)	2	V	2	—	3	Schumb
5·071	Sem. Inorganic Chem.	5·062	G(A)	1	(Elective)	2	—	3	Schumb
5·072	Sem. Inorganic Chem.	5·071	G(A)	2	(Elective)	2	—	3	Schumb
5·08	Inorganic Lab., Adv.	5·13	G(A)	1 or 2	(Elective)	0	6	0	Young
5·10	Qualitative Analysis	5·02	2	S	V, X, XV_2	3	11	4	Hamilton
			2	1	(Elective)				
5·11	Qualitative Analysis	5·02	2	S	$VIII_2$	3	4	2	Simpson
			2	1	III, VII, VII-A, VII-B, $VIII_1$, IX-A, XI, XII				
5·12	Quantitative Analysis	5·10 or 5·11	2	1	V, $VIII_2$, X	3	4	2	Hamilton
			2	2	III, VII, VII-A, VII-B, IX-A, XI, XV_2				
5·13	Quantitative Analysis	5·12	2	2	V, X	2	3	2	Hamilton
5·14	Anal. Chemistry	5·12	2	2	V	3	—	2	Simpson
5·141	Anal. Chemistry	5·12, 8·04	3	1	V	1	3	1	Gibb
			3	2	VII-B				
5·16	Anal. Chemistry	5·13	4	2	X-A	1	3	1	Marvin
5·35	Applied Chemistry	5·02	3, 4	2	(Elective)	2	—	2	Marvin
5·41	Organic Chemistry I	5·12, 8·04	3	S	VII_1, VII-A, VII-B	4	—	3	Huntress
			3	1	V, VII_2, IX-A, X, XI, XV_2				
			4	1	$VIII_2$				
5·412	Org. Chemistry & Lab.	5·04	C	S	II(A.O.)	3	3	4	Ashdown
5·413	Org. Chemistry &Lab.	5·412	G	1	II(A.O.)	3	3	0	Ashdown
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	7	0	Ashdown
5·417	Quant. Org. Anal.	5·41 or *5·41*	3	2	V	0	4	0	A. F. Thompson
			G	1	(Elective)				
5·418	Organic Preparations	5·12, *5·41*	3	1	XI	0	6	0	Ashdown
			3	2	IX-A				
5·42	Organic Chemistry I	5·41	3	2	V, X	4	—	2	Huntress
5·424	Ident. of Org. Compounds	5·414	3	2	V	0	9	0	Ashdown
5·426	Ident. of Org. Compounds	5·416	3	2	X	0	5	0	Ashdown
5·428	Organic Chemistry Lab.	*5·41*	3	S	VII_1, VII-A, VII-B	0	10	0	Hockett
5·43	Powder, Explosives and War Agents	5·42	4(B)	2	(Elective)	2	—	2	T. L. Davis
5·51T	Functional Groups in Organic Chemistry	5·42	G(A)	1	(Elective)	3	—	6	Hockett
5·52T	Mechanism, Structure & Reactivity in Org. Chem.	5·42	G(A)	2	(Elective)	3	—	6	Morton
5·53T	Sp. Topics in Org. Chem.	5·42	G(A)	1	(Elective)	3	—	6	Morton
5·54T	Sp. Topics in Org. Chem.	5·42	G(A)	2	(Elective)	3	—	6	Morton
5·55	Ident. Organic Compounds	5·42, 5·414	G(A)	1	(Elective)	2	8	0	A. F. Thompson
5·56T	Structure in Org. Chem.	5·42	G(A)	2	(Elective)	2	—	4	T. L. Davis
5·581	Organic Lab., Adv.	5·42, 5·424	G(A)	1	(Elective)	1	5	1	Morton
5·582	Organic Lab., Adv.	5·581	G(A)	2	(Elective)	0	5	1	Morton
5·591	Recent Adv. in Org. Chem.	5·42	G	1	(Elective)	1	—	1	Huntress
5·592	Recent Adv. in Org. Chem.	5·42	G	2	(Elective)	1	—	1	Huntress
5·61	Physical Chem. I	M21, 8·03, 5·12	3	1	III, V, VII-A, $VIII_2$, X, XII_2, XV_2	4	—	4	Millard
5·611	Physical Chem. Lab. I	*5.61*	3	1	V, VII-A	0	4	0	Dietrichson

Chemistry Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec.	Lab. Lec.	Draw.	Prep.	Instructor in Charge
5·612	Physical Chem. Lab. I	*5·61*	3	1	III, X	0	2		0	Dietrichson
5·62	Physical Chem. II	5·61	3	2	III, V, VII-A, $VIII_2$, X, XII_2, XV_2	4	—		4	Millard
5·621	Physical Chem. Lab. II	5·611, *5·62*	3	2	V, VII-A	0	4		0	Dietrichson
5·622	Physical Chem. Lab. II	5·612, *5·62*	3	2	X	0	2		0	Dietrichson
5·63	Int. to Thermodynamics	5·62	4(B)	1	V	3	—		5	Sherrill
5·64	Int. to Rad. Chemistry	5·62 or 5·71	4(B)	2	V	2	—		3	Harris
5·642	Radiation Chemistry	8·04, 5·62 or 5·71	G(A)	2	(Elective)	2	—		4	Harris
5·66	Surface & Colloid Chem.	5·62 or 5·71	4(B)	2	V	2	—		3	Oncley
5·683	Physical Chem., Elem.	5·02, 8·02	2	1	II, XVI	2	—		2	Beattie
5·684	Physical Chem., Elem.	M21, 5·12, 8·04	3	1	VII_1, VII-B	3	—		3	Gillespie
			4	1	XI					
5·71	Physical Chem.	M21, 8·03, 5·13	G(A)	1	(Elective)	3	—		5	Sherrill
5·72	Physical Chem.	5·71	G(A)	2	(Elective)	3	—		5	Sherrill
5·741	Radiation Chem., Adv.	5·64 or 5·72	G(A)	1	(Elective)	2	—		4	Harris
5·742	Statistical Mech.	5·741	G(A)	2	(Elective)	2	—		4	Keyes
5·76	Thermodyn. & Chemistry	5·62	G(A)	1	(Elective)	3	—		6	Gillespie
5·77	Thermodyn. & Chemistry	5·76	G(A)	2	(Elective)	2	—		4	Beattie
5·79	Theory of Solutions	5·76	G(A)	2	(Elective)	2	—		4	Scatchard
5·82	Chem. Literature	5·41, 5·61, L31T	3	2	V	1	—		1	Huntress
5·83	History of Chemistry	5·41	4(B)	1	V	2	—		2	T. L. Davis
5·844	Eng. Chemistry	—	2	1	XVII	3	0		3	Marvin
5·911	Journal Meeting in Inorganic Chem.	—	G(A)	1	(Elective)	1	—		1	Schumb
5·912	Journal Meeting in Inorganic Chem.	—	G(A)	2	(Elective)	1	—		1	Schumb
5·921	Journal Meeting in Organic Chem.	—	G	1	(Elective)	1	—		1	Purves
5·922	Journal Meeting in Organic Chem.	—	G	2	(Elective)	1	—		1	Purves
5·931	Journal Meeting in Physical Chem.	—	G	1	(Elective)	1	—		1	Scatchard
5·932	Journal Meeting in Physical Chem.	—	G	2	(Elective)	1	—		1	Scatchard
5·941	Research Conf. in Organic Chem.	—	G	1	(Elective)	1	—		1	Morton
5·942	Research Conf. in Organic Chem.	—	G	2	(Elective)	1	—		1	Morton
5·943	Research Conf. in Physical Chem.	—	G	1	(Elective)	1	—		1	Scatchard
5·944	Research Conf. in Physical Chem.	—	G	2	(Elective)	1	—		1	Scatchard
5·945	Research Conf. in Inorganic Chem.	—	G	1	(Elective)	1	—		1	Schumb
5·946	Research Conf. in Inorganic Chem.	—	G	2	(Elective)	1	—		1	Schumb
5·98	Research	—	G(A)	1 or 2	(Elective)			★		Huntress
	Inorganic Chemistry									Schumb
	Organic Chemistry									Morton
	Physical Chemistry									Scatchard
	Thesis	—	4	1	V	0	16		0	Keyes
	Thesis	—	4	2	V	0	16		0	Keyes

★ Time specially arranged.

ELECTRICAL ENGINEERING — 6·00–6·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec.	Lab. Draw.	Prep.	Instructor in Charge
6.00	Elec. Eng. Prin.	*M22*, 8·03	2	2	VI, VI-B, VIII	4	—	6	Frazie
			3	2	VII-A				
6·01	Elec. Eng. Prin.	6·00	4	1	VII-A	4	—	6	Frazier
6·01T	Elec. Eng. Prin.	6·00	3	S	VI-A	5	—	7	Frazier
			3	1	VI, VI-B, VI-C				
6·02T	Elec. Eng. Prin.	6·01T	3	1	VI-A	5	—	7	Gray
			3	2	VI, VI-B, VI-C				
6·03	Elec. Eng. Prin.	6·01	4	1	VI, VI-B(a)	6	—	8	Lawrence
6·03T	Elec. Eng. Prin.	6·02T	3	2	VI-$A_{1,2}$	6	—	8	Lawrence
6·031	Elec. Eng. Prin.	6·01	4	S	VI-A(B)$_2$	4	—	6	Lawrence
			4	1	VI-C				
6·031T	Elec. Eng. Prin.	6·02T	3	2	VI-A(A)$_2$	3	—	4	Lawrence
6·04	Elec. Eng. Prin.	6·03	4(B)	S	VI-$A_{1,2}$	6	—	9	Lawrence
			4	2	VI				Woodruff
6·09	Int. to Elec. Eng.	—	2	1	VI, VI-B	2	—	0	Hazen
6·11	Elec. Eng. Prin.	6·00	3	1	VIII	4	—	6	Gray, Kingsley
6·211	App. Elec. in Industry	6·02	4(B)	1	(Elective)	3	—	6	Dawes
6·212	App. Elec. in Industry	6·03	4(B)	2	(Elective)	3	—	6	Dawes
6·221	Elec. Power Generation	2·42	4(B)	1	(Elective)	3	—	6	Mulligan
6·222	Elec. Power Generation	6·03	4(B)	2	(Elective)	3	—	6	Mulligan
6·241	Elec. Railways	6·77, *6·03*	4(B)	1	(Elective)	3	—	6	Balsbaugh
6·242	Elec. Railways	6·241	4(B)	2	(Elective)	3	—	6	Balsbaugh
6·251	Elec. Mach. Design	*6·03*	4(B)	1	(Elective)	3	—	6	Dwight
6·252	Elec. Mach. Design	6·03	4(B)	2	(Elective)	3	—	6	Dwight
6·26	Elec. Insulation	8·04	4(B)	1	(Elective)	3	—	6	von Hippel
6·27	Illum. Eng. Prin.	8·04	3	2	VI-B	2	3	4	Moon
			4	2	(Elective)				
6·271	Illum. Eng. Prin.	6·27	4(B)	1	VI-B	2	3	4	Moon
6·272	Illum. Eng. Prin.	6·271	4(B)	2	VI-B	2	3	4	Moon
6·281	Prin. Wire Com.	6·02	4(B)	1	(Elective)	3	—	6	C. E. Tucker
6·282	Prin. Radio Com.	6·02	4(B)	2	(Elective)	3	—	6	Barrow
6·30	Elec. Com. Prin.	*6·02*	3	2	VI-A_2, VI-C	3	—	6	Guillemin
6·31	Elec. Com. Prin.	6·30, 6·02	4(B)	S	VI-A(A)$_2$	3	—	5	Bowles
			4	1	VI-C, VI-A(B)$_2$				
6·32	Elec. Com. Prin.	6·30, 6·02	4(B)	2	VI-A_2, VI-C	4	—	8	Guillemin
6·331	Elec. Com. Lab.	6·02, *6·31*	4	1	VI-C	0	3	4	Fay
6·332	Elec. Com. Lab.	6·331	4	2	VI-C	0	4	4	Fay
6·333	Elec. Com. Lab.	6·02, *6·31*	4	1	VI-A(A)$_2$	0	6	6	Fay
			4	2	VI-A(B)$_2$				
6·34	Elec. Com. Lab.	—	4(B)	1 or 2	(Elective)		★		Fay
6·40	Elec. Eng. Elem.	*8·04*	3	1	I, II, XI, XVI	4	—	6	Hudson
			3	2	IX-B, XV_1, XVIII$_2$				
			4	S	II-A				
			4	1	X, X-B, XII$_2$, XIII				
			4	2	III_1				
			5	1	XIII-C				
6·42	Elec. Eng. Elem.	—	G	1	II(A.O.)	5	—	5	Huds
‡6·43	Electrical Eng.	—	4	1	XIII-A	3	—	5	
‡6·44	Electrical Eng.	—	G	1	XIII-A	3	—	5	
6·47	App. Elec. in Industry	6·40	4	1	II	2	2	4	Tucker, Dawes
6·48	Elec. Equip. Bldgs.	8·04	4	2	(Elective)	1	—	2	Hudson
6·501	Elec. Eng. Seminar	6·04 or 6·32	G(A)	1	VI	2	—	10	Woodruff
			G	S	VI-A(A)				
			G	S or 1	VI-A(B)				
6·502	Elec. Eng. Seminar	6·501	G(A)	2	VI, VI-A	2	—	2	Woodruff
6·511	Elec. Power Circuits	6·04	G(A)	1	(Elective)	3	—	7	Wildes
6·512	Elec. Power Circuits	6·04	G(A)	2	(Elective)	3	—	7	Wildes
6·513	Power System Stability	6·04	G(A)	1	(Elective)	3	1	6	Fitzgerald

★ Time specially arranged.

‡ Not offered 1940–41.

Electrical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
6·514	Power System Stability	6·04	G(A)	2	(Elective)	3	1	6	Fitzgerald
6·515	Power Systems Lab.	*6·511, 6·513, 6·514, 6·651* or *6·652*	G(A)	1 or 2	(Elective)		★		Fitzgerald
6·521	Alt. Cur. Machinery	6·04, M31	G(A)	1	(Elective)	3	—	7	Lyon, Kingsley
6·522	Alt. Cur. Machinery	6·04, M31	G(A)	2	(Elective)	3	—	7	Lyon, Kingsley
6·531	Power System Economics	6·04, Ec12	G(A)	1	(Elective)	3	—	7	Balsbaugh
6·532	Power System Economics	6·04, Ec12	G(A)	2	(Elective)	3	—	7	Balsbaugh
6·541	Electric Power Gen.	6·03, Ec12	G(A)	1	(Elective)	3	—	6	Mulligan
6·542	Electric Power Gen.	6·03, Ec12	G(A)	2	(Elective)	3	—	6	Mulligan
6·551	Railroad Elec. Trac.	6·03, Ec12	G(A)	1	(Elective)	3	—	6	Balsbaugh
6·552	Railroad Elec. Trac.	6·551	G(A)	2	(Elective)	3	—	6	Balsbaugh
6·561	Adv. Network Theory	6·32	G(A)	1	(Elective)	3	2	5	Guillemin
6·562	Adv. Network Theory	6·561	G(A)	2	(Elective)	3	—	7	Guillemin
6·571	Illum. Eng., Prin.	8·04, M22	G(A)	1	(Elective)	2	3	4	Moon
6·572	Illum. Eng., Prin.	6·571	G(A)	2	(Elective)	2	3	4	Moon
6·58	Trans. in Linear Systems	6·04 or 6·32, M31	G(A)	1 or 2	(Elective)	3	—	7	M. F. Gardner
6·586	Eng. App. of Static Field Theory	M22	G(A)	2	(Elective)	3	—	6	Moon
6·59	Communications Lab.	6·332 or 6·333	G(A)	1 or 2	(Elective)		★		Fay
6·60	Math. Anal. by Mech. Meth.	M22	G(A)	1	(Elective)	2	—	4	Caldwell
6·605	Dyn. Anal. of Automatic Control Systems	M22, 604	G(A)	1	(Elective)	3	—	6	G. S. Brown
6·606	Dyn. Anal. of Automatic Control Systems	6·605	G(A)	2	(Elective)	2	3	7	G. S. Brown
6·61	Gen. & Util. of Super Voltages	6·04	G(A)	2	(Elective)	3	—	6	Trump
6·62	Elec. Com. Prin.	6·32	G(A)	2	(Elective)	2	3	5	Bowles
6·621	Radio Lines, Ant. & Prop.	6·32	G(A)	1	(Elective)	3	—	6	Barrow
6·622	Radio Lines, Ant. & Prop.	6·621	G(A)	2	(Elective)	3	—	6	Barrow
6·627	Patents & Rel. to Sci. & Eng.	——	G(A)	1	(Elective)	2	—	4	Bowles
6·628	Patent Background of Elec. Com. in U.S.	6·627	G(A)	2	(Elective)	2	—	4	Bowles
6·631	Engineering Electronics	6·03	G(A)	1	(Elective)	3	—	7	Gray
6·632	Engineering Electronics	6·631	G(A)	2	(Elective)	2	3	5	Gray
6·64	App. of Atomic Phys. in Elec. Eng.	6·26	G(A)	2	(Elective)	3	--	6	von Hippel
6·651	Elec. Power Distribution	6·04	G(A)	1	(Elective)	3	--	6	Balsbaugh
6·652	Elec. Power Distribution	6·04	G(A)	2	(Elective)	3	--	6	Balsbaugh
6·661	Elec. Mach. Dev. Prin.	6·03	G(A)	1	(Elective)	3	1	6	Dwight
6·662	Elec. Mach. Dev. Prin.	6·03	G(A)	2	(Elective)	3	1	6	Dwight
6·671	Vibrations	M31; or M22 and 2·081	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
6·69	Sound in Elec. Com.	M31, 6·04 or 6·32 or 8·05	G(A)	2	(Flective)	2	3	5	Fay
6·73	Elec. Meas. Lab., Adv.	6·76, 6·04	G(A)	1 or 2	(Elective)		★		Bennett
6·74	Elec. Eng. Lab., Adv.	6·04, 6·79	G(A)	1 or 2	(Elective)		★		C. E. Tucker
6·75	Elec. Eng. Lab.	6·00	4	1	VII-A	1	2	4	Bennett
6·751	Elec. Eng. Lab.	6·00	3	1	VI-B	1	3	4	Bennett
6·75T	Elec. Eng. Lab.	6·00	3	S	VI-A(A)	1	3	5	Bennett
			3	1	VI, VI-C, VI-A(B)				
6·76	Elec. Eng. Lab.	6·75, 6·02	4	S	VI-A(B)$_{2,8}$				
6·76T	Elec. Eng. Lab.	6·75T, *6·02T*	3	2	VI, VI-B, VI-C, VI-A(A)	1	2	4	Bennett
			4	S	VI-A(B) (Not 40–41)				
6·77	Elec. Eng. Lab.	6·01	3	1	VI-A(B)	2	2	4	C. E. Tucker
			3	2	VI, VI-C, VI-A(A)				

★ Time specially arranged.

Electrical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
6·78	Elec. Eng. Lab.	6·77, *6·03*	4	1	VI, VI-A(A)$_{1,2}$	1	3	5	C. E. Tucker
			4	S	VI-A(B)$_{1,2}$				
6·781	Elec. Eng. Lab.	6·77, 6·03 or 6·031	4	S	VI-A (B)$_3$	1	2	4	C. E. Tucker
			4	1	VI-A(A)$_3$, VI-C				
6·79	Elec. Eng. Lab.	6·78, *6·04*	4	2	VI	1	2	4	C. E. Tucker
6·80	Elec. Eng. Lab.	6·00 or 6·40	4(B).	1 or 2	(Elective)		★		Tucker, Bennett
6·81	Elec. Eng. Lab.	*6·40*	4	2	III$_1$	1	1	2	Bennett
6·82	Elec. Eng. Lab.	6·11	3	1	VIII	0	2	3	C. E. Tucker
‡6·83	Elec. Eng. Lab.	——	4	2	XIII-A	0	3	5	
‡6·84	Elec. Eng. Lab.	——	G	2	XIII-A	0	3	5	
6·85	Elec. Eng. Lab.	*6·40*	4	1	IX-B, X, X-B, XII$_2$	0	2	3	C. E. Tucker
6·88	Elec. Eng. Lab.	6·42	G	2	II (A.O.)	0	3	6	C. E. Tucker
6·89	Elec. Eng. Lab.	*6·40*	3	1	I, XI	0	2	2	C. E. Tucker
			3	2	XV$_1$, XVI				
			4	S	II-A				
			4	1	XIII				
			5	1	XIII-C				
6·901	Manufacturing Prac.	——	3	1	VI-A(A)$_1$	40 h.p.w.			Timbie
			3	S	(B)$_1$				
6·902	Manufacturing Prac.	——	4	S	VI-A(A)$_1$	40 h.p.w.			Timbie
			3	2	(B)$_1$				
6·903	Manufacturing Prac.	——	4	2	VI-A(A)$_1$	40 h.p.w.			Timbie
			4	1	(B)$_1$				
6·904	Manufacturing Prac.	——	G	1	VI-A(A)$_1$	40 h.p.w.			Timbie
			G	S	(B)$_1$				
6·911	Public Utility Prac.	——	3	1	VI-A(A)$_2$	40 p.h.w.			Timbie
			3	S	(B)$_2$				
6·912	Public Utility Prac.	——	4	S	VI-A(A)$_2$	40 h.p.w.			Timbie
			3	2	(B)$_2$				
6·913	Public Utility Prac.	——	4	2	VI-A(A)$_2$	40 h.p.w.			Timbie
			4	1	(B)$_2$				
6·914	Public Utility Prac.	——	G	1	VI-A(A)$_2$	40 h.p.w.			Timbie
			G	S	(B)$_2$				
6·921	Public Utility Prac.	——	3	1	VI-A(A)$_2$	40 h.p.w.			Timbie
			3	S	(B)$_2$				
6·922	Public Utility Prac.	——	4	S	VI-A(A)$_2$	40 h.p.w.			Timbie
			3	2	(B)$_2$				
6·923	Public Utility Prac.	——	4	2	VI-A(A)$_2$	40 h.p.w.			Timbie
			4	1	(B)$_2$				
6·924	Public Utility Prac.	——	G	1	VI-A(A)$_2$	40 h.p.w.			Timbie
			G	S	(B)$_2$				
6·941	Communications Prac.	——	3	1	VI-A(A)$_3$	40 h.w.p.			Timbie
			3	S	(B)$_3$				
6·942	Communications Prac.	——	4	S	VI-A(A)$_3$	40 h.p.w.			Timbie
			3	2	(B)$_3$				
6·943	Communications Prac.	——	4	2	VI-A(A)$_3$	40 h.p.w.			Timbie
			4	1	(B)$_3$				
6·944	Communications Prac.	——	G	1	VI-A(A)$_3$	40 h.p.w.			Timbie
			G	S	(B)$_3$				
6·951	Electronic Apparatus Manufacturing Prac.	——	3	1	VI-A(A)$_3$	40 h.p.w.			Timbie
			3	S	(B)$_3$				
6·952	Electronic Apparatus Manufacturing Prac.	——	4	S	VI-A(A)$_3$	40 h.p.w.			Timbie
			3	2	(B)$_3$				
‡6·953	Electronic Apparatus Manufacturing Prac.	——	4	2	VI-A(A)$_3$	40 h.p.w.			Timbie
			4	1	(B)$_3$				
‡6·954	Electronic Apparatus Manufacturing Prac.	——	G	1	VI-A(A)$_3$	40 h.p.w.			Timbie
			G	S	(B)$_3$				

★ Time specially arranged.

‡Not offered 1940–41.

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
7·01	General Biology	——	2	1	VII, VII-A, VII-B, XI	2	3	2	Bunker
			3	1	IX-A				
7·03	Theoret. Biology	7·01, 7·06, 7·10	4(B)	2	VII_1	2	—	3	Blake
7·06	Botany	7·01	2	2	VII_1, VII-B	2	4	3	Jennison
7·08	Parasitology	7·10	3(B)	2	VII_1	2	—	4	Blake
7·09	Parasitology, Adv.	7·08	G(A)	2	(Elective)	0	4	4	Blake
7·10	Invertebrate Zoölogy	——	3	1	VII_1, VII-A	2	5	4	Blake
7·131	Adv. Histology	7·14	4(B)	1	(Elective)	1	3	2	Blake
7·132	Adv. Histology	7·131	G(A)	2	(Elective)	1	3	2	Blake
7·14	Comparative Anatomy	7·01	2	2	VII_1, VII-A, VII-B	2	6	2	Blake
7·17	Biol. Food Supplies	7·01	3	1	VII-B	3	—	2	Blake, Jennison
7·18	Tech. Aspects of Entom.	7·10	G(A)	1	(Elective)	2	—	3	Blake
7·20	Physiology	5·41, 7·14	3	2	VII_1, VII-A, VII-B	3	3	4	Bunker
7·201	Adv. Physiology	7·20, 7·80, 5·684	G(A)	2	(Elective)	3	4	3	Sizer
7·22	Personal Hyg. & Nut.	7·20	4(B)	1	VII_1, VII-B	2	—	2	Turner, Harris
7·23	Applied Nutrition	7·22	G(A)	2	(Elective)	2	1	4	Turner, Harris
7·24	Nutrition, Adv.	7·20, 7·22, 7·80	G(A)	1	(Elective)	3	4	2	Harris
7·28	Limnology	——	3	1	(Elective)	1	2	1	Jennison
7·29	Bacteriology	7·01	3	2	XI	2	4	2	Jennison
7·301	Bacteriolog	7·01	3	1	VII, VII-A, VII-B	2	4	4	Horwood
7·302	Bacteriolog	7·301	3(B)	2	VII, VII-B	2	4	3	Horwood
			4	2	(Elective)				
7·321	Bacteriology, Adv.	7·301, 7·80	G(A)	1	VII-A	3	—	4	Jennison
7·322	Bacteriology, Adv.	7·321	G(A)	2	(Elective)	1	4	2	Jennison
7·33	Plant Diseases	7·301	3	2	VII-B	1	—	2	Prescott
7·34	Limnological Field Work	7·01, 5·12	3	S	VII_2, XI	0	5	0	Jennison
7·35	Planktonology	7·06, 7·10	G(A)	1	(Elective)	2	—	3	Blake
7·36	Microbiology	7·302	4	1	VII_1	1	2	2	Prescott
7·361	Indust. Microbiology	7·302	4	1	VII-B	1	4	2	Prescott
7·362	Indust. Microbiology	7·361	4(B)	2	VII-B	1	3	4	Dunn
7·371	Indust. Microbiology, Adv.	7·362	G(A)	1	(Elective)	1	4	4	Dunn
7·372	Indust. Microbiology, Adv.	7·371	G(A)	2	(Elective)	1	3	4	Dunn
7·38	Germicides & Antiseptics	7·302	G(A)	2	(Elective)	1	3	4	Dunn
7·39	Bacteriology of Foods	7·302, 7·80	G(A)	2	(Elective)	1	3	2	Proctor
7·41	Chemistry of Water	5·12	3	1	VII, VII-B, XI	1	3	1	Jennison
7·411	Sanitary Biology	5·12, 8·04, 7·01	G(A)	1	(Elective)	3	6	4	Jennison
7·42	Chemistry of Foods	5·12	3	2	VII_1	1	4	1	R. S. Harris
7·50	Communicable Diseases	7·301	3(B)	1	$VII_{1,2}$	3	—	3	J. W. Williams
7·52	Industrial Hygiene	7·50	4(B)	2	VII, VII-B	3	2	3	Turner, Gould
7·53	Air Examination	8·04	3(B)	1	VII_2	1	1	2	Jennison
7·541	Public Health Admin.	7·302	4(B)	1	$VII_{1,2}$	2	—	3	Turner
7·542	Public Health Admin.	7·302	4(B)	2	$VII_{1,2}$	2	—	3	Turner
7·543	Health Dept. Practice	7·541	G(A)	1	(Elective)	4	—	6	Turner, Horwood
7·55	Pub. Health Bact. Meth.	——	——	S	(Elective)	2	4	2	J. W. Williams
7·551	Pub. Health Lab. Meth.	7·301	4(B)	1	VII_1	2	6	3	J. W. Williams
7·552	Immunological Meth.	7·301	4(B)	2	VII_1	1	5	1	J. W. Williams
7·56	Prin. of Sanitation	7·301	3, 4(B)	2	(Elective)	2	—	5	Horwood
7·57	Municipal Sanitation	7·301	3(B)	2	VII, VII-B	4	—	3	Horwood
7·58	Vital Statistics	7·301, 7·50	4(B)	1	$VII_{1,2}$	2	—	3	Horwood
7·59	Sanitation	7·302, 7·57	4(B)	1	VII_2	2	3	3	Horwood
7·591	Public Health Eng.	7·59	G(A)	1	(Elective)	4	7	7	Horwood
7·592	Public Health Eng.	7·591	G(A)	2	(Elective)	4	4	4	Horwood
7·601	Health Education	7·01	G(A)	1	(Elective)	2	1	4	Turner
7·602	Health Education	7·601	G(A)	2	(Elective)	1	2	4	Turner
7·603	Public Health Education	7·541, 7·50	G(A)	2	(Elective)	2	—	4	Turner
7·604	School Health Admin.	7·601	G(A)	2	(Elective)	2	—	4	Turner
7·63	Pub. Health Field Wk.	7·542	G(A)	1	(Elective)	2	—	4	Turner

Biology and Public Health Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
7·64	Public Health Prob.	7·542	G(A)	2	(Elective)	2	—	4	Turner
7·65	Health Hazards in Spec. Industries	7·52	G(A)	2	(Elective)	2	—	5	Horan
7·66	Epidemiology	7·302, 7·50	G(A)	1	(Elective)	2	—	6	Prescott
7·67	Functional Pathology	7·301, 7·20, 7·80	G(A)	1	(Elective)	3	—	4	J. W. Williams
7·68	Pathology	7·14, 7·552	G(A)	2	(Elective)	2	4	2	J. W. Williams
7·701	Tech. & Chem. of Food Supplies	5·41, *7·301*	3	1	VII-B	3	4	4	Proctor
7·702	Tech. & Chem. of Food Supplies	*7·302*	3	2	VII-B	2	2	4	Proctor
7·71	Food Technology	—	—.	S	(Elective)	2	4	2	Proctor
7·711	Tech. of Food Products	7·702	4(B).	1	VII-B	3	3	4	Proctor
7·712	Tech. of Food Products	7·711	4(B).	2	VII-B	2	3	4	Proctor
7·721	Adv. Food Technology	7·712	G(A)	1	(Elective)	1	3	2	Proctor
7·722	Adv. Food Technology	7·721	G(A)	2	(Elective)	1	3	2	Proctor
7·80	Biochemistry	5·41, 7·20	4(B).	1	VII_1, VII-A, VII-B	3	5	5	Bunker
7·802	Quant. Biochemistry	5·424, or 7·80	4(B).	2	(Elective)	1	4	1	Gould
7·81	Zymology	7·80	G(A)	1	VII-A	2	4	3	Sizer
7·82	Biochemistry, Adv.	7·80	G(A)	2	VII-A	2	4	3	Gould
7·831	Microbiol. Chem. Lab.	7·301, 7·36, 5·428	G(A)	1	(Elective)	0	5	1	Gould
7·832	Microbiol. Chem. Lab.	7·301, 7·36, 5·428	G(A)	2	(Elective)	0	5	1	Gould
7·84	Biophysics	6·75, 7·80, 8·09	4(B).	2	VII-A	2	4	3	Horton
7·91	Biological Engineering I	—	G(A)	1	VII-A	2	4	3	Horton
7·92	Biological Engineering II.	—	G(A)	2	VII-A	1	3	2	Horton
7·941	Research Problems	—	G(A)	1	(Elective)		★		Prescott
7·942	Research Problems	—	G(A)	2	(Elective)		★		Prescott

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	Livingston
8·01	Physics (Mechanics)	—	1	1	All Courses except IV, IV-B, and IV-C_1	4	2	5	Sears
8·012	Physics (College Transfer)	—	1	1	—	5	—	6	Boyce
8·02	Physics (Mech. and Heat)	8·01	1	2	All Courses except IV, IV-B, and IV-C_1	4	2	5	Sears
8·03	Physics (Electricity)	8·01, M12	2	1	All Courses except IV, IV-B, and IV-C_1	4	1	5	Page, Frank
8·034	Physics (College Transfer)	—	2	2	—	5	—	6	Sears
8·04	Physics (Elec. Optics & Modern Phys.)	8·03	2	2	All Courses except IV, IV-B, and IV-C_1	4	2	4	Page, Frank
8·05	Vibrations and Sound	8·04, M22	4(B).	1	VI-C, VI-A (A)$_3$	3	—	6	Morse
8·051	Sp. Problems in Acoustics	8·05	G(A)	1 or 2	(Elective)		★		Morse
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	Harrison
8·12	Experimental Physics	8·11	4(B).	2	VIII	2	—	4	Harrison
8·13	Undergrad. Colloquium	—	4(B).	2	VIII	2	—	2	Mueller
8·14	Production & Measurement of High Vacuum	8·201	4(B).	2	(Elective)	0	3	3	Lamar
8·15	Photography	8·04	3	2	VI-B(a)	2	—	1	Hardy
8·152	Adv. Photography	*8·15* or 8·161	–	2	(Elective)	0	3	2	Hardy
8·161	Optics	8·04	3	1	VI-B, VIII	3	—	6	Hardy
			4	1	VII-A				
8·162	Optical Measurements	*8·161*	3	1	VI-B, VIII	0	3	2	Hardy
			4	1	VII-A				
8·173	Color Measurements	8·04	4(B).	2	(Elective)	0	3	2	Hardy

★ Time specially arranged.

Physics Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
8·174	Motion Picture Photography	8·161	4(B)	1	(Elective)	1	—	3	Hardy
8·181	Optics, Seminar	8·161	G(A)	1	(Elective)	2	—	2	Hardy
8·182	Optics, Seminar	8·161	G(A)	2	(Elective)	2	—	2	Hardy
8·183	Sp. Problems in Optics	8·161	G(A)	1 or 2	(Elective)		★		Hardy
8·191	Microscopy and Photomicrography	——	4	2	(Elective)	2	—	0	Hardy
‡8·194	Adv. Physical Optics	8·161	G(A)	2	(Elective)	1	2	2	Hardy
8·201	Electronics	8·04, M22	3	2	VI-C, VI-A(A)$_3$, VIII	3	—	5	Nottingham
			4	2	VI-A(B)$_3$				
8·202	Electronic Lab.	*8·201*	3	2	VIII	0	3	2	Nottingham
8·21	Electronic Phen.	8·201, *8·212*, 8·511	G(A)	1	(Elective)	2	—	4	Nottingham
8·212	Experimental Electronics.	8·201, *8·21*, or *8·213*	G(A)	1	(Elective)	1	3	3	Nottingham
‡8·213	Advanced Electronics	M22, 8·201, 8·511 or 8·21	G(A)	1	(Elective)	3	—	9	Nottingham
‡8·214	Advanced Electronics	8·21	G(A)	2	(Elective)	3	—	9	Lamar
8·215	Sp. Prob. in Electronics	8·201	G(A)	1 or 2	(Elective)		★		Nottingham
8·26	Molecular Structure	8·311	G(A)	1	(Elective)	3	—	6	Mueller
8·27	X-Rays & Crys. Phys.	8·04, M22	4(B)	1	(Elective)	3	1	5	Warren
8·271	Adv. Physics of X-Rays	8·27	G(A)	2	(Elective)	2	—	4	Harvey
‡8·28	X-Ray Diffraction	8·27	G(A)	2	(Elective)	2	—	4	Warren
‡8·281	Crystal Chemistry	5·62 or 8·311	G(A)	2	(Elective)	2	—	4	Warren
‡8·29	Quantum Th. of the Solid State	8·11, 8·463	G(A)	2	(Elective)	3	—	6	Slater
8·30	Sp. Prob. in Crys. Phys.	8·27	G(A)	2	(Elective)		★		Warren
8·311	Atomic Structure	8·04	3	2	VIII	3	—	5	Allis
			4	2	VII-A				
8·312	Atomic Struct. Lab.	8·09, *8·311*	3	2	VIII	0	3	2	Stockbarger
			4	2	VII-A				
8·32	Line Spectra	8·311	G(A)	2	(Elective)	3	—	6	Albertson
8·341	Spectroscopy Sem.	8·32	G(A)	1	(Elective)	1	—	1	Harrison
8·342	Spectroscopy Sem.	8·32	G(A)	2	(Elective)	1	—	1	Harrison
8·343	Sp. Prob. in Spectros.	8·32	G(A)	1 or 2	(Elective)		★		Harrison
8·344	Prac. Spectroscopy	8·04	(B)	S	(Elective)	3	—	3	Harrison
8·345	Applied Spectroscopy	8·04	(B)	S	(Elective)	0	9	0	Harrison
8·346	Quant. Spectros. Anal.	8·04	(B)	S	(Elective)	1	—	1	Harrison
8·411	Nuclear Physics	8·311	4(B)	1	(Elective)	2	3	4	Evans
8·412	Nuclear Physics	8·411	4(B)	2	(Elective)	2	3	4	Evans
8·42	Sem. in Nuclear Phys.	8·411	G(A)	2	(Elective)	1	—	2	Van de Graaff
‡8·43	Th. of Nuclear Struct.	8·411, *8·521*	G(A)	2	(Elective)	2	—	6	Frank
8·441	Sp. Prob. in Nuclear Res.	8·311, 8·411	G(A)	1	(Elective)		★		Evans
8·442	Sp. Prob. in Nuclear Res.	8·441, 8·412	G(A)	2	(Elective)		★		Evans
8·461	Int. to Th. Physics I	8·04, M22	4(B)	1	VI-B(a), VIII	4	—	8	Vallarta
8·462	Int. to Th. Physics II	8·461	4(B)	2	VI-B(a), VIII	4	—	8	Vallarta
8·463	Int. to Th. Physics III	8·311, 8·461	G(A)	1	(Elective)	4	—	8	Frank
8·471	Hist. Dev. of Phys.	*8·461*	4(B)	1	VIII$_1$	3	—	6	Allis
‡8·481	Adv. Mechanics I	8·462 or 8·471	G(A)	1	(Elective)	3	—	9	Stratton
‡8·482	Adv. Mechanics II	8·481	G(A)	2	(Elective)	3	—	9	Stratton
8·491	Meth. of Theoret. Phys.	8·461, 8·462	G(A)	1	(Elective)	3	—	9	Morse
8·50	Heat & Thermodynamics	8·02, M22	3	1	VI-B(a), VI-C, VI-A(B)$_3$	3	—	4	Sears
			4	1	VI-B(b), VI-A(A)$_3$				
8·511	Thermodynamics and Statistical Mech.	8·02, M22	3	1	VIII$_1$	3	—	4	Slater
			4	1	XVIII$_{1,2}$				
8·512	Statistical Mechanics	8·511	G(A)	2	(Elective)	3	—	9	Allis
8·521	Quantum Mechanics	8·463	G(A)	2	(Elective)	3	—	9	Morse
8·54	Electromag. Theory	M77	4(B)	2	XVIII$_{1,2}$	3	—	6	Stratton

★ Time specially arranged. ‡ Not offered 1940–41.

Physics Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
8·56	Electromag. Wave Theory	8·491	G(A)	1	(Elective)	3	—	9	Stratton
‡8·57	Cosmic Rays High Energy Phenomena	8·463	G(A)	1	(Elective)	2	—	6	Vallarta
8·58	Th. of Relativity	8·462	G(A)	2	(Elective)	3	—	9	Vallarta
8·591	Theoret. Seminar	——	G(A)	1	(Elective)	1	—	1	Morse
8·592	Theoret. Seminar	——	G(A)	2	(Elective)	1	—	1	Morse
8·60	Sp. Prob. Theoret. Phys.	——	G(A)	1 or 2	(Elective)		★		Slater

CHEMICAL ENGINEERING — 10·00–10·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
10·11	Prob. of Chem. Eng.	5·02	2	1	X	1	—	0	Whitman
10·15	Thesis Reports	10·26	4	2	X	2	—	2	C. S. Robinson
10·17	Industrial Chemistry	5·41, 5·61	3	2	X, XV_2	3	—	2	Lewis
10·18	Industrial Chemistry	10·17, 5·62	4	1	X, X-B	4	—	6	Weber
10·201	Industrial Chemistry	5·41, 5·611	4	1	XV_2	4	—	4	Weber
10·203	Industrial Chemistry	*5·42, 5·62*	4	1	V	2	—	4	Weber
10·21	Industrial Chemistry	10·201, or 10·203, or 10·18	4(B)	2	V, X, XV_2	2	—	2	Lewis
10·25	Industrial Chemistry	5·42, 5·62	G(A)	1	(Elective)	5	—	7	Lewis
10·26	Industrial Chem. Lab.	*10·18*	4(B)	1	X, XV_2	2	3	1	Weber
			4	2	X-B				
‡10·27	Industrial Chem. Lab.	10·18	G(A)	1	(Elective)	2	6	0	C. E. Reed
10·28	Chemical Eng.	*5·61*	3	1	X, XV_2	4	—	6	C. S. Robinson
10·29	Chemical Eng.	10·28	3(B)	2	X, XV_2	4	—	5	C. S. Robinson
10·30	Eng. Equipment	*10·32*	4	2	X-B	4	—	1	Whitman
10·31	Chemical Eng.	10·17, 10·29	4(B)	1	X, X-B, XV_2	4	—	5	McAdams
10·311	Heat Transfer	——	G	1	XIII(N.E.)	3	—	3	McAdams
			4(B)	1	XIII-A (Not 40–41)				
10·32	Chemical Eng.	*10·31*	4(B)	1	X-B	4	—	5	McAdams
			4	2	X, XV_2				
10·33	Anal. Treat. of Chem. Eng. Processes	M22, 5·62	G(A)	1	(Elective)	3	—	6	Sherwood
10·38	Explosives Plant Eng.	5·412	G	1	II (A.O.)	5	—	3	C. S. Robinson
10·39	Th. Int. Ballistics	10·38	G	2	II (A.O.)	4	—	6	C. S. Robinson
10·40	Chem. Eng. Thermodyn.	5·62, 10·29	G(A)	1 or 2	(Elective)	3	—	6	Weber
10·41	Distillation	10·32	G(A)	2	(Elective)	3	—	5	C. E. Reed
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	Sherwood
10·50	Heat Transmission	10·31	G(A)	2	(Elective)	2	—	4	McAdams
			G	2	II (T.E.)				
10·52	Chemical Eng. II	10·32	G(A)	1	(Elective)	4	—	5	Sherwood
10·53	Chem. Eng. Design	10·81, 10·82, 10·83	G(A)	1	X-A	3	—	9	Whitman
10·54	Economic Balance	10·32	G(A)	1	(Elective)	5	—	7	Gilliland
10·55	Economic Balance	10·32	G(A)	2	(Elective)	3	—	6	Sherwood
10·61	Ind. Electrochemistry	5·62, 10·29	G(A)	2	(Elective)	2	—	4	Weber
10·62	App. Chem. Thermodyn.	5·62, 10·29	G(A)	2	(Elective)	3	—	6	Weber
10·63	Industrial Chemistry II	5·62	G(A)	2	(Elective)	3	—	6	Lewis
10·65	Catal. & High Pres. Proc.	5·62, 10·29	G(A)	2	(Elective)	3	—	6	Gilliland
10·661	Int. to Colloid Chem.	5·42, 5·62	G(A)	1	VII-A	2	—	4	Hauser
10·662	Colloid Chemistry	10·661	G(A)	2	VII-A	2	—	4	Hauser
10·663	Int. to Applied Colloid Chemistry	5·42, 5·62	G(A)	2	(Elective)	2	—	4	Hauser
10·672	Colloid Seminar	10·671	G(A)	2	(Elective)	2	—	4	Hauser
10·673	Colloid Chem. Lab.	10·63 or *10·661*	G(A)	1, 2	(Elective)	0	3	3	Hauser
10·674	Colloid Chem. Lab.	10·673	G(A)	1, 2	(Elective)	0	3	3	Hauser

★ Time specially arranged. ‡ Not offered 1940–41.

Chemical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec.	Lab. Lec.	Draw.	Prep.	Instructor in Charge
10·68	Corrosion	5·62	G(A)	1	(Elective)	2	—		4	Whitman
10·69	Plastics and Other High Polymeric Substances	——	G(A)	1	(Elective)	2	—		4	Hauser, C. E. Reed
10·70	Prin. of Combust.	Gen. Inorg. Chem.	G(A)	1	(Elective)	4	—		6	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	—		4	Hottel
10·81	Sch. Chem. Eng. Practice (Bangor Station)	10·32	G(A)	1, 2	X-A	0	12		0	Whitman
10·82	Sch. Chem. Eng. Practice (Parlin Station)	10·32	G(A)	1, 2	X-A	0	12		0	Whitman
10·83	Sch. Chem. Eng. Practice (Buffalo Station)	10·32	G(A)	1, 2	X-A	0	12		0	Whitman
10·84	Sch. Chem. Eng. Practice (Bangor Station)	10·31	4	2	X-B	0	12		0	Whitman
10·85	Sch. Chem. Eng. Practice (Parlin Station)	10·31	4	2	X-B	0	12		0	Whitman
10·86	Sch. Chem. Eng. Practice (Buffalo Station)	10·31	4	2	X-B	0	12		0	Whitman
10·90	Exp. Research Problem	5·42, 5·62	G(A)	1, 2	(Elective)		★			Gilliland
10·911	Research Conf.	5·42, 5·62	G(A)	1	(Elective)	1	—		2	McAdams
10·912	Research Conf.	10·911	G(A)	2	(Elective)	1	—		2	McAdams
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.	Lab. Lec.	Draw.	Prep.	Instructor in Charge
12·01	Mineralogy	5·02	2	1	III	2	6		2	Buerger
			3	1	IX-A, XII					
12·03	Theoretical Mineralogy	12·01	4(B).	2	(Elective)	2	3		1	Buerger
‡12·05	Mineral. Seminar	12·03, 12·15	G(A)	1	(Elective)	2	—		4	Buerger
12·06	Mineral. Research	——	G(A)	1	(Elective)		★			Buerger
12·15	Petrography	12·211	3	2	XII	2	6		2	Fairbairn
12·16	Chem. Petrology Seminar	——	G(A)	1	(Elective)	2	—		4	Fairbairn
12·17	Advanced Petrography	12·15	G(A)	2	(Elective)	0	4		0	Fairbairn
‡12·18	Struct. Petrol. Seminar	——	G(A)	2	(Elective)	2	—		4	Fairbairn
12·211	Optical Crystallog.	8·02	3	1	XII_1	2	3		2	Buerger
12·26	Structural Crystallog.	——	G(A)	2	(Elective)		★			Buerger
12·301	General Geology	——	2	1	XII	3	4		2	Shrock
12·302	General Geology	12·301	2	2	XII	3	4		2	Shrock, Shimer
12·321	App. Eng. Geology	——	3	1	I, IX-A	3	2		2	Mead
12·322	App. Eng. Geology	12·321	3	2	(Elective)	3	—		3	Mead
12·38	Geomorphology	12·31	4(B).	1	XII_1	3	—		6	Morris
12·40	Geology, Economic	12·01	3	2	XII	3	—		6	Newhouse
			4	2	III_2					
12·41	Econ. Geology Lab.	12·40	4(B).	1	(Elective)	0	8		0	Newhouse
12·42	App. Econ. Geology	12·40	4(B).	2	(Elective)	3	—		6	Newhouse, Mead
12·431	Econ. Geol. Lab., Adv.	12·41	G(A)	1	(Elective)	0	4		1	Newhouse
12·432	Econ. Geol. Lab., Adv.	12·41	G(A)	2	(Elective)	0	4		1	Newhouse
12·433	Econ. Geol. Sem., Adv.	12·40	G(A)	1	(Elective)	2	—		6	Newhouse
12·434	Econ. Geol. Sem., Adv.	12·40	G(A)	2	(Elective)	2	—		6	Newhouse
12·44	Econ. Geol. of Fuels	G9	4(B).	2	(Elective)	1	—		1	Whitehead
12·511	Paleontology	12·31 or G9	3	1	(Elective)	1	2		4	Shimer
12·512	Paleontology	12·511	3	2	(Elective)	1	3		5	Shimer

★ Time specially arranged. ‡ Not offered 1940–41.

Geology Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
12·52	Paleontology, Adv.	12·512	G(A)	1 or 2	(Elective)	1	3	3	Shimer
12·53	Index Fossils	12·511	G(A)	2	(Elective)	2	4	2	Shimer
12·54	Micropaleontology	12·512	G(A)	1	(Elective)	1	3	2	Shimer
12·55	Org. Evolution, Adv.	G10	G(A)	1 or 2	(Elective)	2	1	3	Shimer
12·581	Sedimentation	12·301	4(B)	1	XII_1	2	3	2	Shrock
12·582	Sedimentation	12·581	G(A)	2	(Elective)	2	3	2	Shrock
12·60	Glacial Geology	12·302	4(B)	2	(Elective)	2	3	6	Morris
‡12·62	Geological Climates Sem.	12·302	G(A)	2	(Elective)	2	—	5	Shimer
12·63	Physical Geol. Sem.	—	G(A)	1	(Elective)	2	—	5	Mead
12·64	Geology of N. America	12·302	G(A)	1	(Elective)	2	—	5	Shimer
12·66	Research	—	4(B)	1 or 2	(Elective)		★		Shimer
12·671	Problems in Geol. Seminar	12·302	G(A)	1	(Elective)	1	—	3	Morris and
12·672	Problems in Geol. Seminar	12·302	G(A)	2	(Elective)	1	—	3	Staff
12·70	Structural Geology	12·301 or 12·321	3(B)	1	XII	3	—	6	Mead
12·71	Structural Geology, Adv.	12·70	G(A)	2	(Elective)	3	—	6	Mead
12·79	Applied Eng. Geol.	12·321	G	2	I(A.E.)	3	—	3	Mead
12·80	Geology Coal & Petrol.	12·302 or G9	3(B)	2	(Elective)	4	—	3	Whitehead
12·81	Geology of Petrol., Adv.	12·80	G(A)	2	(Elective)	3	—	6	Whitehead
12·851	Th. Geophysics, Adv.	8·461	G(A)	1	(Elective)	3	—	6	Slichter
12·852	Th. Geophysics, Adv.	8·461	G(A)	2	(Elective)	3	—	6	Slichter
12·86	Seismology, Elem.	—	4(B)	2	(Elective)	2	—	2	Slichter
12·87	Intro. Geophysical Prospecting	—	4(B)	1	(Elective)	2	—	2	Slichter
12·91	Elements of Mining	—	4(B)	1	III_2, XII_2	4	—	4	Parks
12·92	Mining Meth. & Practice	12·91	4(B)	2	XII_2	5	—	4	Parks
12·94	Mineral Economics	—	4(B)	1	(Elective)	2	—	4	Parks
12·95	Mine Valuation	12·92	G(A)	2	(Elective)	3	—	8	Parks
12·96	Mineral Economics Seminar	—	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.	Lab. Prep.	Instructor in Charge
13·01	Naval Architecture	M21, 8·01	3(B)	1	XIII, XIII-A, XIII-C	3	—	5	Keith
13·02	Naval Architecture	13·01	3(B)	2	XIII, XIII-A	3	—	5	Keith
13·021	Naval Architecture	13·01	3	2	XIII-C	2	—	3	Chapman
13·03	Naval Arch. and Ship Des.	13·02, 13·45	G(A)	1	(Elective)		★		Keith
13·04	Naval Arch. and Ship Des.	13·03	G(A)	2	(Elective)		★		Keith
13·05	Navigation	M1, M4	3	1	(Elective)	2	—	2	Rossell
13·12T	Th. of Warship Des.	—	3	2	XIII-A	2	—	5	Rossell
13·13	Th. of Warship Des.	—	4	1	XIII-A	3	—	6	Keith
‡13·13T	Th. of Warship Des.	—	4	1	XIII-A	4	—	8	Keith
13·14	Th. of Warship Des.	—	4	2	XIII-A	3	—	8	Keith
13·15	Th. of Warship Des.	—	G	1	XIII-A	3	—	6	Rossell
‡13·15T	Th. of Warship Des.	—	G	1	XIII-A	3	—	5	Rossell
13·16	Th. of Warship Des.	—	G	2	XIII-A	3	—	6	Rossell, Keith
‡13·16T	Th. of Warship Des.	—	G	2	XIII-A	3	—	6	Rossell, Keith
13·21T	Warship Design	—	3	1	XIII-A	0	5	0	Keith
13·22T	Warship Design	—	3	2	XIII-A	0	5	0	Rossell
13·23	Warship Design	—	4	1	XIII-A	0	5	0	Rossell
13·24	Warship Design	—	4	2	XIII-A	0	5	0	Rossell
‡13·24T	Warship Design	—	4	2	XIII-A	0	5	0	Rossell
13·25	Warship Design	—	G	1	XIII-A	0	6	0	Rossell
‡13·25T	Warship Design	—	G	1	XIII-A	0	7	0	Rossell
13·26	Warship Design	—	G	2	XIII-A	0	6	0	Rossell
‡13·26T	Warship Design	—	G	2	XIII-A	0	6	0	Rossell
13·29	Warship Design	—	G	1	(Elective)	0	9	0	Rossell
13·30	Warship Design	—	G	2	(Elective)	0	9	0	Rossell

★ Time specially arranged. ‡ Not offered 1940–41.

Naval Architecture and Marine Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
13·34	Ship Construction	—	3	1	XIII, XIII-C	4	—	4	Owen, Burtner
			5	1	XIII-C				
13·37	Merchant Shipbuilding	—	4	2	XIII-A	2	—	2	Keith
13·40	Yacht Architecture	—	2	2	XIII	2	4	1	Owen
13·41	Ship Drawing	—	3	1	XIII	0	3	0	Owen
13·43	Ship Design	—	3	2	XIII	0	6	0	Owen
13·45	Ship Design	13·43	4(B)	1	XIII	2	8	1	Owen
†13·47	Ship Design	13·021, 13·52	5	2	XIII-C	0	6	0	Owen
13·48	Model Making	—	4	2	XIII-A	0	2	0	Owen
13·52	Marine Engineering	2·40	3	2	XIII, XIII-C	4	—	4	Burtner, Chapman
13·54	Marine Engineering	2·06, 13·52	4(B)	1	XIII	2	—	3	F. M. Lewis
13·55	Marine Engineering	2·42, 13·52	4	2	XIII	2	—	3	Burtner
†13·56	Marine Engineering	13·52	5	1	XIII-C	3	—	3	Chapman
13·58	Marine Engineering	—	4	1	XIII-A	3	—	4	Chapman
13·61	Marine Eng. Design	2·04, 2·40, 13·52	4(B)	1	XIII	1	6	1	Burtner, F. M. Lewis
13·62	Marine Eng. Design	13·61	4(B)	2	XIII	1	5	0	Burtner
13·64	Marine Eng. Design	13·58	4	2	XIII-A	0	3	0	Chapman
13·73	Mechanical Vibration	2·06	G(A)	1	(Elective)	3	—	6	F. M. Lewis
			G	1	II (T.E.), XIII (N.E.) XIII-A (Not 40–41)				
13·74	Mechanical Vibration	13·73	G(A)	2	(Elective)	3	—	6	F. M. Lewis
			G	2	II (T. E.)				
13·75	Adv. Marine Eng.	—	G(A)	1	(Elective)	3	4	8	Burtner
			G	1	XIII (N.E.)				
‡13·751	Marine Engineering	—	4	1	XIII-A	5	2	9	Chapman, Burtner
‡13·752	Marine Engineering	—	4	2	XIII-A	3	3	6	Burtner
13·76	Adv. Marine Eng.	—	G(A)	2	(Elective)	3	4	5	Burtner
			G	2	XIII (N.E.)				
13·78	Propeller Th. & Exp. Research	—	G(A)	2	(Elective)	2	—	4	F. M. Lewis
†13·81	Ship Operation	13·021, 13·52, 13·83	5(B)	1	XIII-C	3	—	5	Chapman
†13·82	Ship Operation	13·56, 13·81	5(B)	2	XIII-C	3	—	5	Chapman
13·83	Port Facilities	—	3	1	XIII-C	3	—	4	Chapman
13·90	Experimental Research	—	G(A)	1 or 2	(Elective)		★		F. M. Lewis

BUSINESS AND ENGINEERING ADMINISTRATION — 15·00–15·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
15·01	Field of Bus. Manage.	—	2	1	XV	1	—	0	Schell
15·11	Int. to Bus. Manage.	Ec12	4(B)	1	(Elective)	3	—	3	Fernstrom
15·12	Int. to Bus. Manage.	15·11	4(B)	2	(Elective)	3	—	3	Fernstrom
15·20	Ocean Ship Admin.	—	5	2	XIII-C	2	—	4	Fernstrom
15·25	Indust. Traf. Manage.	15·70	G(A)	1	(Elective)	3	—	6	Fernstrom
15·41	Finance	Ec12, 15·50	4	1	XV	3	—	6	Armstrong
15·42	Financial Problems	15·41	4(B)	2	(Elective)	3	—	6	Armstrong
15·46	Fin. Adm. of Industry	15·41 or Ec47	G(A)	2	(Elective)	3	—	6	D. S. Tucker
15·50	Accounting	Ec11	3	1	XV_1, $XVIII_3$	5	—	4	Porter, Robnett
			3	2	XV_2				
15·51	Indust. Accounting	15·50	4(B)	1	$XVIII_3$	5	—	4	Fiske, Robnett
				2	(Elective)				
15·52	Accounting	—	2	2	XIII-C	4	—	2	Porter, Robnett
			3	1	(Elective)				
			3	2	I				
			4	2	XVII				

† 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

★ Time specially arranged. ‡ Not offered 1940–41.

Business and Engineering Administration Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
15'55	Prob. in Account. Policy	15'50	G(A)	1	(Elective)	3	—	6	Fiske
15'58	Problems in Accounting Control	15'51	G(A)	2	(Elective)	3	—	6	Robnett
15'61	Law of Contracts	*Ec12*	G	1	XIII-A	3	—	6	Schaefer
			3(B).	1	XV				
15'62	Law of the Market	Ec12	4(B).	2	(Elective)	3	—	6	Schaefer
15'64	Law of Business Org.	Ec12	G(B).	2	VI-A(A)	3	—	6	Schaefer
15'70	Production	——	2	1	XV, XVIII$_3$	3	—	6	Fernstrom
15'71	Production	15'70	4(B).	1	(Elective)	3	—	6	Schell
15'72	Technique of Executive Control	15'70	4(B).	2	(Elective)	3	—	6	A. Williams
15'73	Management Lab.	15'11 or 15'70 or 2'731	4	1, 2	(Elective)	3	3	3	A. Williams
15'75	Manufact. Analysis	15'70	G(A)	1	(Elective)	3	—	6	Schell
15'81	Marketing	*Ec12*, Ec32	3	1	XV$_2$	3	—	6	Tallman
			3	2	XV$_1$				
15'82	Sales Management	15'81	4(B).	2	(Elective)	3	—	6	Cunningham
15'83	Marketing Research	15'81	4(B).	1	(Elective)	3	—	6	Cunningham
15'85	Indust. Marketing	15'81	G(A)	1	(Elective)	3	—	6	Cunningham
15'86	Marketing of Consumer Goods	15'81	G(A)	2	(Elective)	3	—	6	Cunningham
15'88	Advertising	15'81	G(B)	2	(Elective)	2	—	6	H. Bugbee
15'92	Industrial Problems	15'41, 15'61, 15'70, 15'81	4(B).	2	XV	2	—	6	Schell
15'94	Contemp. Prob. Seminar	15'41, 15'61, 15'70, 15'81	G(A)	2	(Elective)	3	—	6	Schell
15'95	Sp. Prob. in Management	——	G(A)	1 or 2	(Elective)		★		Schell
15'96	Adm. Theory and Practice	15'41, 15'61, 15'70, 15'81	G(A)	2	(Elective)	3	—	6	Schell
15'98	Sp. Admin. Seminar	——	G(A)	1	(Elective)	3	—	6	Fiske
15'99	Sp. Admin. Seminar	——	G(A)	2	(Elective)	3	—	6	Fiske
	Thesis	—	4	2	XV	0	10	0	Cunningham
	Graduate Thesis	——	G(A)	-	XV		★		Cunningham

AERONAUTICAL ENGINEERING — 16'00–16'99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
16'01	Intro. to Aero. Mech.	M22	3(B).	1	XVI	4	2	6	Rauscher
16'02	Intro. to Aero.Mech.	16'01	3(B).	2	XVI	4	2	4	Rauscher
16'03	Hydrodyn. and its Appl. to Aero.	16'02	G(A)	1	(Elective)	3	—	6	R. H. Smith
16'04	Hydrodyn. and its Appl. to Aero.	16'03	G(A)	2	(Elective)	3	—	6	R. H. Smith
16'07	Adv. Topics in Aeromechanics	16'02	G(A)	1	(Elective)	3	—	6	R. H. Smith
16'08	Adv. Topics in Aeromechanics	16'02	G(A)	2	(Elective)	3	—	6	R. H. Smith
16'10	Aerodyn. of Airpl. Des.	2'04, 8'04, 16'01, 16'71	3	2	XVI	3	—	3	Ober
16'11	Aerodyn. of Airpl. Des.	16'02, 16'10	4(B).	1	XVI	4	2	4	Koppen
16'14	Airpl. Design Prob.	16'11, 16'17	4(B).	2	(Elective)	2	4	6	Koppen
16'17	Airpl. Des. Practice	16'10, *16'11*	4(B).	1	XVI	0	8	0	Koppen
16'18	Adv. Airpl. Des. Prac.	16'14	G(A)	2	(Elective)	0	6	3	Koppen
16'20	Structures	2'04	3	2	XVI	3	—	5	Newell
16'21	Structures	16'20	4(B).	1	XVI	3	—	5	Newell
16'22	Aircraft Structures	16'21	4(B).	2	XVI	3	—	5	Newell
16'23	Adv. Aircraft Struct.	16'21	G(A)	1	(Elective)	2	—	4	Newell
16'25	Adv. Aircraft Struct.	16'17, 16'21	G(A)	2	(Elective)	3	—	6	Newell

★ Time specially arranged.

Aeronautical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
16·31	Airship Theory	16·02, 16·10	G(A)	1	(Elective)	2	—	3	R. H. Smith
16·36	Airship Structures	M22, 16·31	G(A)	2	(Elective)	2	—	4	R. H. Smith
16·41	Instrumentation	16·02 or 2·081	G(A)	1	(Elective)	3	—	9	Draper
			G	1	II (T.E.)				
16·42	Aeronautical Inst.	16·41	G(A)	2	(Elective)	3	—	9	Draper
16·43	Instrumentation Lab.	*16·41*	G(A)	1	(Elective)	0	3	6	Draper
			G	1	II (T.E.)				
16·44	Meteorological Inst.	*16·911*	G(B)	1	(Elective)	2	3	5	Draper
16·45	Sp. Prob. in Aero. & Met. Inst.	16·44 or 16·42	G(A)	1	(Elective)		★		Draper
16·46	Vibration Measure	16·41, 13·73 or 6·671 or 8·05	G(A)	2	(Elective)	2	3	6	Draper
			G	2	II (T.E.)				
16·52	Aircraft Prop. Design	16·11	G(A)	2	(Elective)	2	2	4	Ober
16·53	Adv. Airplane Eng. Des.	2·792	G(A)	1	(Elective)	1	4	3	E. S. Taylor
16·54	Adv. Airplane Eng. Des.	16·53	G(A)	2	(Elective)	1	4	3	E. S. Taylor
16·60	Adv. Aeron. Prob.	16·11 or 16·25 or 16·31 or 16·63	G(A)	1 or 2	(Elective)		★		Staff
16·62	Aeronautical Lab.	*16·11*	4(B)	1	XVI	2	2	3	Ober
16·63	Aero. Lab. & Res. Meth.	16·62	4(B)	2	(Elective)	2	2	2	Ober
16·68	Aeronautical Seminar	16·11	G(A)	2	(Elective)	2	—	2	Staff
16·71	Airplane Shopwork	——	3	S	XVI	0	8	2	Markham
16·72	Aircraft Product. Meth.	——	3	S	XVI	0	8	2	Markham
16·75	Constr. Details of Aircraft	16·11	4(B)	2	XVI	3	4	2	Koppen
16·81	Aeronautics	M21, 2·04	4(B)	1 or 2	(Elective)	3	—	1	Markham
16·811	Aeronautics	——	G(B)	1	XIII-A	3	—	1	Ober
16·911	Synoptic Meteorol. I	M12, 8·02	4(B)	1	(Elective)	3	—	4	Willett
16·912	Synoptic Meteorol. II	16·911, 16·921	G(A)	2	(Elective)	3	—	6	Willett
16·913	Synoptic Meteorol. III	16·911	G(A)	1	(Elective)	3	—	6	Petterssen
16·914	Synoptic Meteorol. IV.	16·913, 16·921, 16·931	G(A)	2	(Elective)	3	—	6	Petterssen
16·921	Meteorol. Lab. I.	*16·911*	4(B)	1	(Elective)	0	12	0	Petterssen
16·922	Meteorol. Lab. II	16·913, 16·921	4(B)	2	(Elective)	0	15	0	Petterssen
16·923	Meteorol. Lab. III	16·914, 16·922	G(A)	1	(Elective)	0	12	0	Willett
16·931	Dynamic Meteorol. I	8·02, M22	G(A)	1	(Elective)	5	—	10	Houghton
16·932	Dynamic Meteorol. II	8·04, 16·931	G(A)	2	(Elective)	4	—	8	Houghton
16·933	Dynamic Meteorol. III	*16·913, 16·931*	G(A)	1	(Elective)	3	—	6	Holmboe
16·934	Dynamic Meteorol. IV	16·933, *16·914*	G(A)	2	(Elective)	3	—	6	Holmboe
16·941	Meteorol. Seminar	*16·931*	G(A)	1	(Elective)	2	—	2	Petterssen
16·942	Meteorol. Seminar	16·941, *16·932*	G(A)	2	(Elective)	2	—	2	Petterssen

BUILDING ENGINEERING AND CONSTRUCTION — 17·00–17·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
17·22	Building Construction	D12	2	2	XVII	3	3	2	Dietz
17·31	Building Construction	17·22	3	1	XVII	3	3	2	Staley
17·32	Building Construction	17·31	3	2	XVII	3	3	2	Voss
17·40	Estimating & Job Manage.	17·32	4(B)	2	XVII	2	3	1	Voss
17·41	Construction Problems	17·32	4(B)	1	XVII (Elective)	0	4	0	Voss
17·42	Construction Problems	17·41	4(B)	2	XVII (Elective)	0	4	0	Voss
17·52	Structural Problems	2·04	3	2	XVII	3	4	3	Peabody
17·53	Structural Design	17·52	4(B)	1	XVII (Elective)	3	8	3	Peabody
17·531	Structural Design	17·52	4(B)	1	XVII (Elective)	3	4	3	Peabody
17·54	Structural Design	17·53	4(B)	2	XVII (Elective)	3	8	3	Peabody
17·541	Structural Design	17·531	4(B)	2	XVII (Elective)	3	4	3	Peabody

★ Time specially arranged.

Building Engineering and Construction Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
17·73T	Materials	5·844	3	1	XVII	3	—	2	Voss
17·74T	Materials	17·73T	3	2	XVII	6	—	4	Dietz
17·75	Materials	4·93, 4·94	3	1	IV, IV-B, IV-C_1	2	2	1	Voss
17·76	Materials	17·75	3	2	IV, IV-B, IV-C_1	4	—	1	Dietz
17·77	Sp. Prob. in Build. Mat.	——	G(A)	1 or 2	(Elective)		★		Staley

GRAPHICS — D1–D99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
D11	Engineering Drawing and Descriptive Geometry	M2, M3	1	1	All courses except IV, IV-B and IV-C_1	0	6	0	Rule
D12	Engineering Drawing and Descriptive Geometry	D11	1	2	All courses except IV, IV-B and IV-C_1	0	6	0	Rule
D13	Descriptive Geometry (College Transfer)	——	1	1 or 2	Transfer students with credit in Eng. Drawing but not in Desc. Geom.	0	6	0	Watts
D14	Engineering Drawing (College Transfer)	——	1	1 or 2	Transfer students with credit in Descriptive Geometry but not in Engineering Drawing	0	6	0	Goodrich
D21	Perspective	D12	2	1	VI-B (b)	2	0	2	Rule
D31	Nomography Charts	D12, M22	3	2	(Elective)	2	3	4	Watts

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	2	VI-B(b), XV, $XVIII_3$	3	—	3	D. S. Tucker
			3	1	I, II, II-A, III, V, VI, VI-A(B), VI-C, VII, VII-A, VII-B, VIII, IX-A, IX-B, X, XI, XII, XIII, XIII-C, XVII, $XVIII_{1,2}$				
			3	2	VI-B(a), XVI				
			4	1	IV, IV-B, IV-C_1, VI-A(A) (1940–41)				
Ec111	Economic Principles	E12	3	1	(Elective)	3	—	5	Maclaurin
Ec12	Economic Principles	Ec11	3	1	XV, $XVIII_3$	3	—	3	D. S. Tucker
			3	2	I, II, III, V, VI, VI-C, VII, VII-A, VII-B VIII, IX-A, IX-B, X, XI, XII, XIII, XIII-C, XVII, $XVIII_{1,2}$				
			4	2	IV, IV-B, IV-C_1, VI-A(B), VI-B, XVI				
			4	S	II-A				
			G	S	VI-A(A) (Not 40–41)				
Ec122	Economic Principles	Ec111	3	2	(Elective)	3	—	5	Maclaurin
Ec15	Principles of Economics	E12	4(B)	1	XIII-A	3	—	5	Armstrong
			4	2	XIII-A (Not 40–41)				
Ec17	Economic Theory	Ec12	G(A)	1	(Elective)	3	—	6	D. V. Brown
Ec28	Business Cycles	Ec12	G(A)	2	(Elective)	3	—	6	D. S. Tucker
Ec32	Statistics	M21	2	2	XV	3	—	3	H. A. Freeman
			3	2	XII_2				
Ec33	Design of Experiments	M331	4(B)	1	$XVIII_3$	3	—	6	H. A. Freeman
Ec34	Sp. Prob. in Industrial Statistics	Ec33	4	2	$XVIII_3$	4	—	2	H. A. Freeman Wadsworth

★ Time specially arranged.

Economics and Social Science Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
Ec35	Indust. Statistics	——	–	S	(Elective)	2	2	2	H. A. Freeman Wadsworth
Ec38	Eng. & Indust. Statistics.	M22	G(A)	2	(Elective)	3	—	6	H. A. Freeman
Ec40	Money & Banking	Ec11	3	2	XV	3	—	3	R. E. Freeman
Ec45	Monetary & Bank. Prob.	Ec12	4(B)	1	(Elective)	2	—	4	R. E. Freeman
Ec47	Investment Finance	Ec12	G(A)	1	(Elective)	3	—	6	D. S. Tucker
Ec48	Investment Analysis	Ec47 or 15'42	G(A)	2	(Elective)	3	—	6	D. S. Tucker
Ec54	Corporations	Ec12	5(B)	2	XIII-C	3	—	3	Armstrong
Ec57	Public Utilities	Ec12	G(A)	1	(Elective)	3	—	6	Armstrong
Ec59	Internat. Economic Relations	Ec12	G(A)	1	(Elective)	3	—	6	R. E. Freeman
Ec61	Labor Relations	Ec12	4(B)	1	XV	2	—	4	D. V. Brown
			5	1	XIII-C				
Ec62	Personnel & Labor Prob.	Ec61	4(B)	2	(Elective)	2	—	4	Livernash
Ec63	Industrial Relations	Ec12	4	1	(Elective)	3	—	5	D. V. Brown
Ec64	Industrial Relations	Ec63	4	2	(Elective)	3	—	5	Myers
Ec67	Labor Relations Seminar.	Ec61	G(A)	1	(Elective)	3	—	6	Livernash
Ec68	Personnel Probs. & Labor Relations	Ec61	G(A)	2	(Elective)	3	—	6	D. V. Brown
Ec72	American Government.	Ec12	3	2	(Elective)	3	—	6	Schaefer
Ec78	Gov't Control of Industry	Ec12	G(A)	2	(Elective)	3	—	6	Thresher
Ec81	Human Problems in Industry	Ec12	3, 4(B)	1	(Elective)	2	—	4	Arensberg
Ec83	Urban Sociology	Ec12	5(B)	1	IV-B, IV-C	2	—	4	Palmer
Ec84	Soc. Econ. Factors in City Planning	Ec83	5(B)	2	IV-B, IV-C	2	—	4	Palmer
Ec91	Economics Seminar	——	G(A)	1	(Elective)	3	—	6	R. E. Freeman
Ec92	Economics Seminar	——	G(A)	2	(Elective)	3	—	6	R. E. Freeman
Ec95	Social Science Seminar	——	G(A)	1	(Elective)	3	—	6	McGregor
Ec96	Social Science Seminar	——	G(A)	2	(Elective)	3	—	6	Arensberg

ENGLISH AND HISTORY — E1–E99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
E1	English (Entrance)	——	–	S	——	2	—	5	Copithorne
E11	English Composition	——	1	1	All courses	3	—	5	Eaton
E12	English Composition	E11	1	2	All courses	3	—	5	Greene
E21	Literature & History	——	2	1	All courses	3	—	5	A. T. Robinson
E22	Literature & History	——	2	2	All courses	3	—	5	A. T. Robinson
E35	Reports	E22	3	1	XV_1, XVII	2	—	4	Bartlett
			3	2	XV_2				
E42	Problem Analysis	——	3	2	IV, IV-B, $IV\text{-}C_1$	2	—	2	Greene

GENERAL STUDIES — G1–G99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
G1	History of Science	——	–	1	——	3	—	3	Woodbury
G2	History of Science	——	–	2	——	3	—	3	Woodbury
G3	History of Mathematics	——	–	1	——	3	—	3	Struik
G4	History of Mathematics	——	–	2	——	3	—	3	Struik
G5	Descriptive Astronomy	——	–	1	——	2	—	2	Goodwin
G7	Prob. of Modern Philos.	——	–	1	——	2	—	2	A. T. Robinson
G8	History of Philosophy	——	–	2	——	2	—	2	Wiener
G9	Geology	——	–	1	——	3	—	3	Shimer
G10	Organic Evolution	——	–	2	——	3	—	3	Shimer
G12	Biography in Science	——	3	2	VI-A(A)	3	—	3	Bartlett
			4	2	VI, VI-B, VI-C, VI-A(B)				

General Studies Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
G19	Int. to Latin Amer. Prob. & Inst.	—		1	—	2	—	4	R. G. Caldwell
G20	French Civilization	—		2	—	2	—	4	Langley
G21	Hist. of Engineering	—		1	—	2	—	2	Woodbury
G22	Dev. of Transportation	—		2	—	2	—	2	C. B. Breed
G24	Develop. Community Plan.	—		2	—	2	—	2	F. J. Adams
‡G25	Soc. & Ind. Hist. Mod. Europ.	—		1	—	3	—	3	Roberts
G26	Soc. & Ind. Hist. of U. S.	—		2	—	3	—	3	Bates
G27	Mil. Hist. & Policy of U.S.	—		1 or 2	—	3	—	3	Rutter
G28	Economic Geography	—	2	2	XIII-C	3	—	3	Prescott
G31	Advanced Composition	E22		1	—	2	—	2	Fassett
G32	Advanced Composition	—		2	—	3	—	3	Fassett
G34	American Literature	—		2	—	2	—	4	Eaton
‡G35	Contemp. English Lit.	—		1	—	3	—	3	Rogers
G37	Contemp. European Lit.	—		1	—	3	—	3	Rogers
G38	Public Speaking	—		2	—	3	—	3	Copithorne
G39	Reading Seminar	—		1	—	2	—	4	Chalmers
‡G40	The Bible as Literature	—		2	—	3	—	3	Rogers
G42	Shakespeare	—		2	—	3	—	3	Rogers
G45	Int. to Architecture	—		1	—	2	—	4	MacCornack
G51	French Literature	—		1	—	2	—	2	Langley
G52	French Literature	—		2	—	2	—	2	Langley
G53	French Literature	—		1	—	2	—	4	Langley
G54	French Literature	—		2	—	2	—	4	Langley
G57	Dante in English	—		1	—	2	—	2	Langley
G61	Literature & Fine Arts.	—		1	—	2	—	2	Greene
G62	History of Music	—		2	—	3	—	3	D. M. Fuller
G63	Introduction to Music	—		1	—	3	—	3	D. M. Fuller
G64	Fine Arts	—		2	—	2	—	2	H. L. Seaver
G65	Expressions of Graphic Art	—		1	—	2	—	2	Chamberlain
G66	The Arts of the Book	—		2	—	2	—	2	H. L. Seaver
G67	Des. Manuf. Products	—		1	—	3	—	3	Müller
G68	Des. Manuf. Products	—		2	—	3	—	3	Müller
G71	Introductory Psychology.	—		1	—	2	—	2	McGregor
G72	Introductory Psychology.	—		2	—	2	—	4	McGregor
G73	Psychology in Industry	—		S	—	2	—	2	McGregor
G75	Human Relations	—		1	—	3	—	3	Magoun
G76	Human Relations	—		2	—	3	—	3	Magoun
G77	Social Institutions & Problems	—		1 or 2	—	2	—	2	Palmer
G78	Social Institutions & Labor Relations	—		2	—	2	—	4	Palmer
G79	Comp. Pol. Institutions	—	4	1	II	3	—	5	Schaefer
G82	Intro. Internat. Relations	—		2	—	3	—	3	T. Smith
G83	The Economics of War	Ec11		1	—	2	—	4	R. E. Freeman
G85	Technology and Society	—		1	—	2	—	½	Arensberg
G86	Prin. San. Sci. & P. H.	—	4	2	IV-B, IV-C_1	2	—	2	Horwood
G88	From Molecule to Man	—		2	—	2	—	2	Bunker, Blake

‡ Not offered 1940–41.

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
L11	German, Elem.	—	-	1	(Elective)	3	—	5	Currier
L12	German, Elem.	L11	-	2	(Elective)	3	—	5	Currier
L21	German, Int.	L12, or Elem. Entrance German	-	1	(Elective)	3	—	5	Kurrelmeyer
L22	German, Int.	L21	-	2	(Elective)	3	—	5	Kurrelmeyer
L31T	German, Int.	L12, or Elem. Entrance German	3	1	V	2	—	3	Kurrelmeyer
L51	French, Elem.	—	-	1	(Elective)	3	—	5	Koch
L52	French, Elem.	L51	-	2	(Elective)	3	—	5	Koch
L61	French, Int.	L52 or Elem. Entrance French	-	1	(Elective)	3	—	5	Langley
L62	French, Int.	L61	-	2	(Elective)	3	—	5	Langley
L81	Spanish, Elem.	—	-	1	(Elective)	3	—	5	Koch
L82	Spanish, Elem.	L81	-	2	(Elective)	3	—	5	Koch
‡L91	Italian, Elem.	—	-	1	(Elective)	3	—	5	Langley
‡L92	Italian, Elem.	L91	-	2	(Elective)	3	—	5	Langley

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	—
M11	Calculus	M1, M3, M4	1	1	All courses except IV, IV-B and IV-C_1	3	—	6	Douglass
M111	Calculus	M1, M3, M4	1	1	IV, IV-B, IV-C_1	3	—	6	Gelotte
M12	Calculus	M11	1	2	All courses except IV, IV-B and IV-C_1	3	—	6	Douglass
M21	Calculus	M12	2	1	All courses except IV, IV-B, IV-C_1	3	—	6	Hitchcock
M22	Diff. Equations	M21	2	2	All except IV, IV-B, IV-C_1, VII_1, VII-B, XIII-C, XV_2	3	—	6	Zeldin
M23	Algebra & Geometry	M12	2	1	VI-B(a), XVIII	3	—	6	Struik
‡M24	Algebra & Geometry	M23	2	2	(Elective)	3	—	6	Struik
M31	Diff. Equations	M22	3	1	VI, VI-C, VI-A(B)	2	—	4	Franklin
			3	S	VI-A(A)				
M331	Math. Theory of Statistics	M22	3(B)	1	$XVIII_{2,3}$	3	—	6	Wadsworth H. A. Freeman
M332	Math. Theory of Statistics	M331	3(B)	2	$XVIII_3$	3	—	6	Wadsworth
M341	Actuarial Mathematics	M12	3	1	$XVIII_3$	3	—	6	Wadsworth H. A. Freeman
M342	Actuarial Mathematics	M12	3	2	$XVIII_3$	3	—	6	Wadsworth
M351	Adv. Calculus for Engineers	M22	G(A)	1	(Elective)	3	—	6	Franklin
M352	Adv. Calculus for Engineers	M351	G(A)	2	(Elective)	3	—	6	Franklin
M36	Calculus, Adv.	M22	G(A)	1	(Elective)	3	—	6	Douglass
			3	1	XIII-A				
M37	Calculus, Adv.	M36	G(A)	2	(Elective)	3	—	6	Douglass
			3	2	XIII-A				
M381	Theory of Functions	M22	G(A)	1	(Elective)	3	—	9	Cameron
M382	Theory of Functions	M381	G(A)	2	(Elective)	3	—	9	Cameron
‡M441	Projective Geometry	M22	3(B)	1	(Elective)	3	—	6	Struik
M442	Elem. Diff. Geometry	M22	4(B)	2	$XVIII_{1,2}$	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
‡M471	Sem. in Anal. Statistics	M451, M432	G(A)	1	(Elective)	3	—	9	Wiener
‡M472	Sem. in Anal. Statistics	M471	G(A)	2	(Elective)	3	—	9	Wiener

‡ Not offered 1940–41.

Mathematics Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
M54	Mathematical Lab.	M22	3(B)	2	$XVIII_2$	3	—	6	Douglass
M551	Funct. of Real Variable	M22	G(A)	1	(Elective)	3	—	9	Franklin
M552	Funct. of Real Variable	M551	G(A)	2	(Elective)	3	—	9	Franklin
‡M561	Functions of a Complex Variable	M22	G(A)	1	(Elective)	3	—	9	Martin
‡M562	Functions of a Complex Variable	M561	G(A)	2	(Elective)	3	—	9	Martin
M571	Diff. Equations	M22	G(A)	1	(Elective)	3	—	9	Levinson
M572	Diff. Equations	M571	G(A)	2	(Elective)	3	—	9	Levinson
‡M581	Continuous Groups	M22	G(A)	1	(Elective)	3	—	9	Zeldin
‡M582	Continuous Groups	M581	G(A)	2	(Elective)	3	—	9	Zeldin
M62	Modern Algebra	M22	3(B)	2	$XVIII_1$	3	—	6	Hitchcock
			2	2	$XVIII_3$				
M631	Modern Algebraic Theories	M22	G(A)	1	(Elective)	3	—	9	Clifford
M632	Modern Algebraic Theories	M631	G(A)	2	(Elective)	3	—	9	Clifford
M641	Adv. Diff. Geometry	M22	G(A)	1	(Elective)	3	—	9	Struik
M642	Adv. Diff. Geometry	M641	G(A)	2	(Elective)	3	—	9	Struik
‡M651	Analytical Mechanics	M22	G(A)	1	(Elective)	3	—	9	Crout
‡M652	Analytical Mechanics	M651	G(A)	2	(Elective)	3	—	9	Crout
M661	Algebra of Quantum Th.	M62	G(A)	1	(Elective)	3	—	9	Hitchcock
M662	Algebra of Quantum Th.	M661	G(A)	2	(Elective)	3	—	9	Hitchcock
M671	Partial Differential & Integral Equations	M22	G(A)	1	(Elective)	3	—	9	Crout
M672	Partial Differential & Integral Equations	M671	G(A)	2	(Elective)	3	—	9	Crout
‡M682	Calculus of Variations	M22	G(A)	2	(Elective)	3	—	9	Martin
‡M691	Characteristic Value Prob.	M22	G(A)	1	(Elective)	3	—	9	Franklin
‡M692	Characteristic Value Prob.	M691	G(A)	2	(Elective)	3	—	9	Franklin
M73	Review of Mathematics	——	3	S	XIII-A	20	—	0	Douglass
M731	Mechanics	M22	3(B)	1	XVIII	3	—	6	Crout
			4	1	XIII-A				
M732	Mechanics	M731	3(B)	2	XVIII	3	—	6	Crout
			4	2	XIII-A				
M75	Mathematics	——	G	S	II (A.O.)	5	—	7	Wadsworth
M76	Th. of Probability	M21	G(A)	2	(Elective)	3	—	9	Struik
M77	Vector Analysis	M22	2	2	$XVIII_{1,2}$	3	—	6	Hitchcock
			3(B)	2	VI-B(a), $VIII_1$				
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	$XVIII_1$	3	—	6	Franklin
M832	Analysis	M831	3(B)	2	$XVIII_1$	3	—	6	Franklin
M841	Analysis	M832	4(B)	1	$XVIII_1$	3	—	6	Cameron
M842	Analysis	M841	4(B)	2	$XVIII_1$	3	—	6	Cameron
M851	Adv. Calculus	M22	3	1	$XVIII_2$	3	—	6	Douglass
			4	1	$XVIII_3$				
M852	Adv. Calculus	M851	3	2	$XVIII_2$	3	—	6	Douglass
			4	2	$XVIII_3$				
M90	Math. Reading	——	G(A)	1 & 2	(Elective)		★		Phillips

★ Time specially arranged. ‡ Not offered 1940–41.

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	Johnson
MS12	Military Science	—	1	2	All courses	0	3	0	Johnson
MS21	Military Science	—	2	1	All courses	3	—	0	Irvine
MS221	Coast Artillery	—	2	2	All courses	3	—	0	Jackson
MS222	Engineer Corps	—	2	2	I, II, III, IV, VI, VII$_2$, IX-B, X, XI, XIII, XIII-C, XV$_1$, XVI, XVII	3	—	0	Wray
MS223	Signal Corps	—	2	2	VI, VI-B, VIII, IX-B, XV$_1$, XVI	3	—	0	Lawton
MS224	Ordnance Dept.	—	2	2	II, III, V, VIII, X, XV, XVI	3	—	0	Nisley
MS226	Chemical Warfare Ser.	—	2	2	V, VII, VII-A, VII-B, X, XV$_2$	3	—	0	Johnson
MS31	Military Science, Adv.	—	3	1	All courses	0	1	0	Jackson
MS311	Coast Artillery, Adv.	A basic course	3	1	All courses	2	—	1	Fisken
MS312	Engineer Corps, Adv.	A basic course	3	1	I, II, II-A ,III, IV, VI, VI-A, VII$_2$, IX-B, X, XI, XIII, XIII-C, XV$_1$, XVI, XVII	2	—	1	Wray
MS313	Signal Corps, Adv.	A basic course	3	1	VI, VI-A, VI-B, VI-C, VIII, IX-B, XV$_1$, XVI	2	—	1	Lawton
MS314	Ordnance Dept., Adv.	A basic course	3	1	II, III, V, VIII, X, XV, XVI	2	—	1	Nisley
MS316	Chemical Warfare Ser.	A basic course	3	1	V, VII, VII-A, VII-B, X, XV$_2$	2	—	1	Johnson
MS32	Military Science, Adv.	—	3	2	All courses	0	1	0	Jackson
MS321	Coast Artillery, Adv.	A basic course	3	2	All courses	2	—	1	Fisken
MS322	Engineer Corps, Adv.	A basic course	3	2	I, II, II-A, III, IV, VI, VI-A, VII$_2$, IX-B, X, XI, XIII, XIII-C, XV$_1$, XVI, XVII	2	—	1	Irvine
MS323	Signal Corps, Adv.	—	3	2	VI, VI-A, VI-B, VI-C, VIII, IX-B, XV$_1$, XVI	2	—	1	Lawton
MS324	Ordnance Dept., Adv.	A basic course	3	2	II, III, V, VIII, X, XV, XVI	2	—	1	Nisley
MS326	Chemical Warfare Ser. Adv.	A basic course	3	2	V, VII, VII-A, VII-B, X, XV$_2$	2	—	1	Johnson
MS41	Military Science, Adv.	MS31	4	1	All courses	0	1	0	Johnson
MS411A	Coast Artillery, Adv.	—	4 or 5	1	All courses	2	—	1	Jackson
MS411B	Coast Artillery	—	3, 4	1	All courses	2	—	2	Marsh
MS412	Engineer Corps, Adv.	—	4 or 5	1	I, II, II-A, III, IV, VI, VI-A, VII$_2$, IX-B, X, XI, XIII, XIII-C, XV$_1$, XVI, XVII	1	—	1	Irvine
MS413	Signal Corps, Adv.	—	4	1	VI, VI-A, VI-B, VI-C, VIII, IX-B, XV$_1$, XVI	1	—	1	Lawton
MS414	Ordnance Dept., Adv.	—	4	1	II, III, V, VIII, X, XV, XVI	1	—	1	Nisley
MS416	Chemical Warfare Ser. Adv.	—	4	1	V, VII, VII-A, VII-B, X, XV$_2$	1	—	1	Johnson
MS42	Military Science, Adv.	MS31, MS32	4	2	All courses	0	1	0	Johnson
MS421	Coast Artillery, Adv.	—	4	2	All courses	2	—	1	Marsh
MS422	Engineer Corps, Adv.	—	4	2	I, II, II-A, III, IV, VI, VI-A, VII$_2$, IX-B, X, XI, XIII, XIII-C, XV$_1$, XVI, XVII	1	—	1	Irvine

Military Science Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
MS423	Signal Corps, Adv.	—	4	2	VI, VI-A, VI-B, VI-C, VIII, IX-B, XV_1, XVI	1	—	1	Lawton
MS424	Ordnance Dept., Adv.	—	4	2	II, III, V, VIII, X, X-B, XV, XVI	1	—	1	Nisley
MS426	Chemical Warfare, Adv.	—	4	2	V, VII, VII-A, VII-B, X, X-B, XV_2	1	—	1	Johnson

HYGIENE

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
PT1	Physical Training	—	1	1 (last 10 w.)	All courses	0	1	0	McCarthy
PT2	Physical Training	—	1	2 (1st 10 w.)	All courses	0	1	0	McCarthy

APPENDICES

THE LOWELL INSTITUTE

LOWELL INSTITUTE LECTURES

The Lowell Institute offers courses of Free Lectures, open to the public, on selected subjects dealing with Science, History, Philosophy and the Fine Arts. The Lectures are given in the lecture hall of the Boston Public Library with entrance on Boylston Street, near Copley Square, Boston. Each request for programs or tickets should be accompanied by a stamped, self-addressed envelope and mailed to W. H. Lawrence, Curator of the Lowell Institute, Boston Public Library.

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JAMES HOLT, S.B.
Heating and Ventilating

RAYMOND DONALD DOUGLASS, PH.D.
Mathematics

FRANCIS WESTON SEARS, S.M.
Physics

ARTHUR LAWRENCE TOWNSEND, S.B.
Machine Design

TRUMAN STRETCHER GRAY, SC.D.
Electrical Measurements

JAYSON CLAIR BALSBAUCH, S.M.
Applied Electricity I

ALVIN SLOANE, B.S.
Mechanism Design

JOHN DONALD MITSCH, S.B.
Reinforced Concrete

ALBERT GEORGE DIETZ A.B., S.M.
Building Construction I

HOWARD RAYMOND STALEY, S.M.
Building Construction II

CARL LOUIS SVENSON, S.M.
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SUPPLEMENTARY COURSES

WILLIAM HENRY LAWRENCE, S.B.
Advanced Structural Design

DEAN PEABODY, JR., S.M.
Reinforced Concrete Design

CARLTON EVERETT TUCKER, S.B.
Telephone Transmission and Advanced Electrical Machinery Laboratory

GEORGE WRIGHT SWETT, S.B.
Alignment Charts

JAMES HOLT, S.B.
Power Plant Design, Heating and Ventilating, and Air Conditioning

ROBERT SEATON WILLIAMS, PH.D.
Metallurgy

GEORGE BARTHOLOMEW HAVEN, S.B.
Advanced Machine Design

IRVING HENRY COWDREY, S.B.
Advanced Testing Materials Laboratory

KARL DICKSON FERNSTROM, S.B.
Industrial Management

WALTER MAXWELL FIFE, S.M.
Water Power

RALPH GORTON HUDSON, S.B.
Electronics

THEODORE HOWARD TAFT, S.B.
Internal Combustion Engines

ARTHUR LAWRENCE TOWNSEND, S.B.
Alignment Charts

RAYMOND DONALD DOUGLASS, PH.D.
Applied Mathematics

CHARLES WILLIAM BERRY, S.B.
Refrigeration

ERNEST NAPOLEON GELOTTE, S.B.
Advanced Structural Design

ROSS MCDUFFEE CUNNINGHAM, M.B.A., D.C.S.
Marketing

ALBERT GEORGE DIETZ, A.B., S.M.
Estimating

TRUMAN STRETCHER GRAY, SC.D.
Advanced Electrical Laboratory

LYMAN MINER DAWES, S.B.
Applications of Electricity in Industry

JAMES EDWARD MULLIGAN, S.M.
Electric Power Generation

ALBERT ADAMS SCHAEFER, A.B., LL.B.
Business and Patent Law

HERBERT BRISTOL DWIGHT, D.SC.
Electrical Machine Design

WILMER LANIER BARROW, SC.D.
Principles of Radio Communications

CARL FREDERICK FLOE, SC.D.
Heat Treatment

RONALD HERBERT ROBNETT, S.B., M.B.A.
Accounting

JOHN HENRY HRONES, S.M.
Alignment Charts

APPENDIX A

STUDENT AID AND PRIZES

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 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 2140 men have borrowed more than $1,480,000 from the Technology Loan Fund; that, during 1940–41, approximately $90,000 and $100,000 will be 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 per 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.

FRESHMAN SCHOLARSHIPS

Approximately 200 Freshman Competitive awards covering part tuition for the first year are made annually to students entering from secondary schools. They are confined to students who make application to the Office of the Dean of Students before May 1 of the year in which they plan to enter.

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, are offered in Chicago, Cincinnati, Cleveland, Denver, Detroit, District of Columbia, Kansas City, Los Angeles, New York, Northern New Jersey, Philadelphia, Pittsburgh, Portland, Ore., San Francisco, St. Louis, Seattle, Schenectady, and Westchester County, New York. These are open to American citi-

zens 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 before May 1 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 before May 1 of the year in which the candidate plans to enter.

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, not later than May 1 of the year in which the applicant plans to enter the Institute. 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 '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."

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 not later than May 1 of the year in which the applicant plans to enter the Institute. Preference will be given to individuals who have, as of July 1, fulfilled all entrance requirements of the Institute with the further stipulation that no individual will be eligible to receive an East Bridgewater Scholarship until he has fulfilled all entrance requirements of the Institute.

FALL RIVER AND SWANSEA (1932). Established by the Institute through a bequest of Elizabeth R. Stevens, known as the Albert G. Boyden Fund. Five scholarships for the freshman year, three carrying stipends of full tuition and two carrying stipends of half tuition are annually offered to qualified applicants residing in Fall River or Swansea, Massachusetts. Application must be made to the Superintendent of Schools, either of Fall River or of Swansea, not later than May 1 of the year in which the applicant plans to enter the Institute. Preference will be given to individuals who have, as of July 1, fulfilled all entrance requirements of the Institute, with a further stipulation that no individual will be eligible to receive one of these scholarships 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.

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.

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 Freshman 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 not later than February 15 on blanks to be obtained at Room 3-108.

The scholarships or funds described are arranged in the alphabetical order of their names, the figures in parentheses being the dates of establishment:

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). Gift from Lucius Clapp to form a fund "to aid worthy students who may not be able to complete their studies without help."

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."

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."

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."

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."

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.

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."

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."

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."

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."

HEALTH EDUCATION (1928). Two scholarships carrying full tuition open to young women preparing themselves for professional work in Health Education have been established by the Institute. These scholarships are awarded before July 31 upon the basis of previous academic record, professional accomplishment in the field of health or of education, need, and likelihood of future contribution to Health Education. Application should be made directly to the Head of the Department of Biology and Public Health.

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 an M. I. T. scholarship for graduates of that school.

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 Coöperative Course in Electrical Engineering."

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."

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. Parmelee 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."

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 transfers 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."

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." Since the donor was an architect, this scholarship, in accordance with the wish of the Executor of the donor's estate, is given, if possible, to a Jewish student in the Department of Architecture.

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 FELLOWSHIPS AND SCHOLARSHIPS

GRADUATE scholarships are awarded only to students pursuing programs leading to higher degrees. Applications from new students must, therefore, be accompanied by an application for admission to the Graduate School, with the Department in which the student desires to major indicated. Except for Institute students, an official transcript of the applicant's college record and at least three letters addressed to the Dean by persons personally acquainted with his academic work are required. Both applications must be made on forms which may be obtained from the Secretary of the Committee on the Graduate School.

Awards to students who have not been in residence at least one term will be limited to the amount of full tuition ($600). Fellowships carrying stipends in excess of tuition are, in general, awarded only to students who have demonstrated their ability to carry on graduate study and research in residence.

In the award of graduate scholarships the Committee on the Graduate School considers first, the ability of the applicant to pursue advanced study and research; second, his pecuniary need. Scholarship awards become available in two installments, at the beginning of each of the two regular terms. Grants are not made unreservedly and their continuance from term to term is dependent on the recipient maintaining a satisfactory standard of scholarship. The recipient of a scholarship grant is expected to complete the period of study for which the grant is made. In case he discontinues his work before the end of such period, he will be expected to refund the amount received from the grant, unless released therefrom for satisfactory reasons by the Committee on the Graduate School.

Applications and credentials must be filed with the Secretary of the Committee on the Graduate School *on or before March 1.* This rule applies to renewal of previous grants as well as new applications. Late applications will receive consideration only if funds become available subsequent to the first allotment of awards. Announcement of awards will be made on April 1, and must be accepted or declined in writing not later than April 15.

ASSISTANTSHIPS AND TEACHING FELLOWSHIPS

Assistantships and Teaching Fellowships are staff appointments made upon recommendation of heads of Departments to whom applications should be addressed. They carry salaries from $1,000 to $1,200 for full time appointments and from $500 to $700 for half-time appointments, depending upon experience and length of service. Full time assistants are able to take approximately one-third time schedules of graduate study and research. Teaching fellows and half-time assistants may carry half-time schedules of graduate work. Staff appointments which include graduate study as a part of the program are in all cases contingent upon the applicant being admitted to the Graduate School for a course of study leading in the case of assistants to either the Master's or Doctor's degree, and in the case of teaching fellows to the Doctor's degree. Provision for meeting the tuition of staff members working for higher degrees is made by scholarship funds designated for this purpose. Applications for these scholarships and for admission to the Graduate School should be filed with the Secretary of the Graduate School at the same time application is made to the head of a department for a staff appointment. Applications for Assistantships and Teaching Fellowships should if possible be filed early in February. Graduate students on the staff may also apply for financial assistance from the Technology Loan Fund.

TRAVELING FELLOWSHIPS

A limited number of traveling fellowships are open to Institute graduates and to members of the instructing staff. Students planning to study abroad should consult the Dean of the Graduate School in regard to special privileges offered by universities and technical schools of various countries in coöperation with the Institute of International Education.

Holders of Institute Traveling Fellowships are expected to present to the Dean of the Graduate School on or before April 1 and October 1 of each year a full report of the progress of their work. This report should include not only a statement of the lectures and laboratory courses attended and special courses of reading and study pursued, but also an account of the progress of the research or other original investigation upon which they are engaged. Mention should also be made in the case of study abroad of the extent to which vacation time has been utilized in travel.

HONORARY FELLOWS

A student who is working for the degree of Doctor of Philosophy, Doctor of Science or Doctor of Public Health, either at the Institute or under an Institute Fellowship at another institution, may, as a mark of distinction, be appointed a "Fellow" upon the recommendation of the Faculty. A certificate of appointment bearing the seal of the Institute and signature of the President and of the Secretary of the Corporation will be issued to each Fellow upon the approval of his appointment by the Corporation. The appointment being honorary carries no stipend.

POST-DOCTORATE FELLOWSHIPS

ARTHUR D. LITTLE (1936). Two fellowships, established by the Institute in memory of Arthur D. Little of the Class of 1885, open to holders of the Doctorate who have shown outstanding ability in research in the field of Chemistry or Chemical Engineering. Stipend, $1,500 and facilities for research provided in the laboratories of the Institute.

FUNDS APPLICABLE TO FELLOWSHIPS AND GRADUATE SCHOLARSHIPS

AUSTIN (1899). Bequest of Edward Austin to assist needy meritorious students and teachers in payment for their studies. Approximately $16,000 to meet the tuition fees of full-time students and members of the Instructing Staff who are working toward the Master's or Doctor's degrees, and for special fellowships.

AUSTIN RESEARCH (1909). Open to candidates for the Doctor's degree who have shown exceptional ability in the field of research. Stipend, $1,000.

WILLIAM SUMNER BOLLES (1924). Founded by William P. Bolles, to establish and maintain either a fellowship, a traveling scholarship, or a resident scholarship, the recipient to have character, ability, and promise. Stipend, $1,200.

MALCOLM COTTON BROWN (1922). Established by Charles A. Brown and Caroline C. Brown in memory of their son Lieut. Malcolm Cotton Brown of the Class of 1919, for the purpose of stimulating advanced study and research in Physics. Open to a senior in high standing in the Course in Physics and available for study abroad as well as for graduate work at the Institute of Technology. (Not available 1940–41.)

F. W. CHANDLER TRAVELING SCHOLARSHIP IN CITY PLANNING (1940). For travel and study in the United States or a foreign country. To be awarded to a regular or special student in Course IV-B or IV-C, who has passed at least two years in the Course, one of which must have been in the fifth or sixth year. Offered annually, or as often as the Dean of Architecture considers desirable. The recipient will be selected by the Faculty of the School of Architecture, on the recommendation of the Head of the Course in City Planning, on the basis of his general performance. Character as well as capacity in all branches of his scholastic work will be considered in making the award. Stipend, $400.

COLLAMORE (1916). Bequest of Helen Collamore to aid women students in graduate courses. Available, $600.

CHARLES H. DALTON (1896). Founded by Charles H. Dalton for the payment of fees of American male students, graduates of the Institute, who may wish to pursue advanced chemical study and research especially applicable to textile industries. Stipend, $300.

FRANCES AND WILLIAM EMERSON FUND (1930). Awards not exceeding $600 to students in the School of Architecture, upon recommendation of the Dean of Architecture.

REBECCA R. JOSLIN (1924). Available for loans to students pursuing advanced work in Chemical Engineering. Any student receiving benefit from this fund is expected to abstain from the use of tobacco in any form.

WILFRED LEWIS (1930). Established by Wilfred Lewis as a fellowship in the Department of Mechanical Engineering. Stipend, $250.

ARTHUR D. LITTLE (1936). Two fellowships, established by the Institute in memory of Arthur D. Little of the Class of 1885, open to students pursuing courses leading to the Doctor's degree in the field of Chemistry or Chemical Engineering. Stipend, $1,000.

MOORE (1914). Gift of Mrs. F. Jewett Moore to assist some Institute graduate who wishes to continue studies in Europe, especially in Organic Chemistry. Preference will be shown to one who has distinguished himself in this subject while an undergraduate. Stipend, $1,500.

WILLARD B. PERKINS (1898). Bequest of Willard B. Perkins of the Class of 1872, the income available every fourth year for a traveling scholarship in Architecture. Stipend, $1,500. (Not available 1940–41.)

ELLEN H. RICHARDS MEMORIAL (1912). Established by subscription for the promotion of research in Sanitary Chemistry, the branch of science to the development of which Mrs. Richards so greatly contributed. The income is used for the award of fellowships to advanced students competent to pursue research in this field, for the employment of research assistants, and in such other ways as will best promote investigation in Sanitary Chemistry.

HENRY BROMFIELD ROGERS (1921). Founded by Anna Perkins Rogers for fellowships and scholarships for women graduates of the Institute or other colleges whose graduate work is carried on at the Institute. Available, $1,000.

ARTHUR ROTCH TRAVELING SCHOLARSHIP IN ARCHITECTURE. For travel and study abroad under the direction of the School of Architecture. Open to regular and special students who have passed at least two years in the School, one of which must have been in either the fifth or sixth year. The recipient will be selected by the Faculty of the School of Architecture, on the basis of his general performance. Character as well as capacity in all branches of his scholastic work will be considered in making the award. Stipend, $1,500.

RICHARD LEE RUSSEL (1904). Founded by Theodore E. Russel in memory of his brother Richard Lee Russel to assist some worthy student of high standing in the Department of Civil Engineering to continue his studies either as postgraduate or undergraduate. Stipend, $150.

HENRY SALTONSTALL (1901). Bequest of Henry Saltonstall to aid students, whether undergraduates or graduates, pursuing advanced courses. Stipend, $450.

JAMES SAVAGE (1873). Founded by James Savage for a graduate student of the Institute, or of some similar institution of equal standing, who wishes to engage in the advanced study of some branch or branches of knowledge taught in the Institute. Stipend, $500. (1940–41.)

SUSAN H. SWETT (1888). Founded by Susan H. Swett for a student specially fitted to pursue advanced study, holder to be a graduate of the Institute, or of some similar institution of equal standing and to be eligible for a second year's award. Stipend, $200. (1940–41.)

FRANK HALL THORP FELLOWSHIP IN INDUSTRIAL CHEMISTRY (1932). Established as a memorial to Professor Frank Hall Thorp, the income from $10,000 to be awarded on nomination by the Department of Chemical Engineering to a member of the graduating class of the Massachusetts Institute of Technology to enable him to pursue advanced study and research in the field of Industrial Chemistry. Stipend, $400.

LOUIS FRANCISCO VERGES (1924). Established by Caroline A. Verges for a meritorious student, either graduate doing research in the field of the sugar industry, or if there be no such candidate, for an undergraduate in the Department of Civil Engineering. Stipend, $400. (1940–41.)

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."

JONATHAN WHITNEY (1912). Established by Mrs. Frances B. Greene to aid students who need financial assistance in obtaining an education at the Institute. Income available for graduate students, $19,500.

SPECIAL FELLOWSHIPS AND GRADUATE SCHOLARSHIPS

1940–1941

MASSACHUSETTS INSTITUTE OF TECHNOLOGY FELLOWSHIPS. Six Fellowships open to full time students who have previously held Staff appointments as Teaching Fellows or Assistants, and whose work has progressed to the stage where by devoting one additional year primarily to research, they may hope to complete the requirements for the Doctor's degree. Stipend $1,000.

TRAVELING FELLOWSHIP IN ARCHITECTURE. For travel and study abroad under the direction of the School of Architecture. Open to regular and special students in the fifth or the graduate years of Courses IV or IV-B who have passed at least two years in the School, one of which must have been in the fifth or the graduate year. Stipend, $1,500.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERING OPEN HEARTH COMMITTEE FELLOWSHIP. For research in metallurgy. Stipend, $1,000.

DOW CHEMICAL COMPANY FLOTATION FELLOWSHIP. Established for the encouragement of graduate study and research in the field of Flotation. Stipend, $1,500.

DOW FELLOWSHIP. For research in biochemistry in Department of Biology and Public Health. Stipend $800.

DU PONT FELLOWSHIP. Gift of E. I. du Pont de Nemours and Company. Open to a graduate student to be nominated in alternate years by the Departments of Chemistry and Chemical Engineering, respectively. Available during 1940–41 to a student in Chemistry. Stipend, $750.

PAINT AND VARNISH PRODUCTION CLUB RESEARCH FELLOWSHIP. Gift of the National Federation of Paint and Varnish Production Clubs, for research on the technology of paint and varnish. Stipend, $750.

REVERE COPPER AND BRASS COMPANY FELLOWSHIP. For research in metallurgy. Available, $900.

ALFRED P. SLOAN FOUNDATION FELLOWSHIPS IN BUSINESS ADMINISTRATION AND ECONOMICS. For post-industrial graduate study in Departments of Business Administration and Economics and Social Science. Invitational to graduates of high scholastic standing in science and engineering, between twenty-five and thirty-five years of age, with at least five years of industrial experience of sufficient promise to merit the granting of a year's leave of absence by present employers. Stipends, up to $1,750 for single and up to $2,750 for married recipients.

TEXTILE GRADUATE SCHOLARSHIPS. Established by the Proprietors of the Locks and Canals of the Merrimack River and open to graduates of the Lowell Textile Institute. Available, $2,800.

PRIZES

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 theses may be entered and, if successful, duplicate medals will be awarded and the prize divided. Open only to candidates for the Bachelor's degree.

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.

TECHNOLOGY AWARDS (1936). Book prizes to secondary schools whose former students make an outstanding record in Calculus, Chemistry, Descriptive Geometry, English, and Physics during the Freshman year.

The following annual prizes are awarded to students of the School of Architecture:

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.

BOSTON SOCIETY OF ARCHITECTS (1892). Gift of the Society. Prize of $100 for the best design submitted by a present student of Harvard, Technology, or the Boston Architectural Club on one of the regular conjunctive programs.

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 1st, 2d, 3d, 4th and 5th 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.

The following annual prize is offered to students in the Department of 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.

The following annual prize is offered to students in the Department of 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.

APPENDIX B

DIRECTORY OF HONORARY SECRETARIES

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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 with 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, '94, Alabama Power Company, 600 North 18th Street.

Montgomery. Charles M. Smith, Jr., '25, Troy Laundry.

ARIZONA:

Phoenix. Charles F. Willis, '06, 520 Title and Trust Building.

CALIFORNIA:

Los Angeles. Robert S. Breyer, '10, Commercial Discount Company, 200 Roosevelt Building.

Kenneth C. Kingsley, '23, Thermodor Electric Mfg. Co., 5119 South Riverside Drive.

William H. Robinson, Jr., '24, General Electric Company, 205 Edison Building.

Charles H. Toll, Jr., '23, 5717 Santa Fe Avenue.

San Francisco. George R. Norton, '07, 770 Mission Street.

COLORADO:

Denver. Harold O. Bosworth, '02, Denver Fire Clay Company, 2301 Blake Street.

CONNECTICUT:

Bridgeport. Donald F. Carpenter, '22, Remington Arms Company.

Hartford. Thomas D. Green, '26, 38 Montclair Drive, West Hartford.

Naugatuck. Stuart M. Boyd, '18, 26 North Hoadley Street.

New Haven. Albert S. Redway, '23, Farrel-Birmingham Company, Ansonia.

Waterbury. Harold G. Manning, '12, The Post College Building, 24 Central Avenue.

DELAWARE:

Wilmington. Willis F. Harrington, '05, E. I. du Pont de Nemours & Co., du Pont Building.

DISTRICT OF COLUMBIA:

Washington. Henry D. Randall, Jr., '31, 119 South Chelsea Lane, Bethesda, Maryland.

FLORIDA:

Jacksonville. Horatio N. Parker, '94, Engineering Building, Main and Orange Streets.

Miami. B. Howard Brown, '30, 70 S. W. 27th Road.

Tampa. Harvey M. Mansfield, '83, Route 4, Box 42, West Tampa.

GEORGIA:

Atlanta. William E. Huger, '22, Courts & Co., 11 Marietta Street, N. W.

ILLINOIS:

Chicago. L. H. G. Bouscaren, '04, Stone and Webster, 33 South Clark Street.

Edward Pennell Brooks, '17, 18 East Hickory Street, Hinsdale.

Albert J. Browning, '22, United Wall Paper Factories, Inc., 3330 West Fillmore Street.

Charles W. Cristal, '23, Crocker Wheeler Manufacturing Company, 111 West Washington Street.

Edmund G. Farrand, '21, 1200 Old Colony Building.

Lonsdale Green, '87, 5639 Kenwood Avenue.

Philip W. Moore, '01, Poor & Co., 1310 Railway Exchange Building.

Ralph Sargent, '18, 140 South Dearborn Street.

William C. West, '11, Great Lakes Forge Company, 612 North Michigan Avenue.

Nelson C. Works, '17, Paine Webber & Co., 209 South LaSalle Street.

Rockford. Arthur B. Brand, '26, Earl M. Cummings, Advertising, Gas Electric Building.

INDIANA:

Fort Wayne. Frank J. Travers, '23, Lincoln National Life Insurance Company, 1300 Harrison Street.

Indianapolis. Howard S. Morse, '03, Indianapolis Water Company, 113 Monument Circle.

IOWA:

Des Moines. Harold C. Neumann, '17, Arthur Neumann & Bros., Inc., Hubbell Building.

Dubuque. Richard V. McKay, '06, McFadden Coffee & Spice Co., 145 West First Street.

KANSAS:

Topeka. John H. Ruckman, '10, 508 New England Building.

KENTUCKY:

Louisville. Frank D. Rash, '01, 55 Hill Road, "Castlewood."

LOUISIANA:

New Orleans. Theo. O. Hotard, '12, Orleans Parish School Board, 703 Carondelet Street.

MAINE:
Augusta. Willard Bates Purinton, '22, Purinton Brothers Company, 333 Water Street.
Bangor. Carl E. Danforth, '05, Arthur Chapin Company, 100 Broad Street.
Portland. William N. Todd, '04, 126 William Street.

MARYLAND:
Baltimore. Richard Mommers, '98, The American Sugar Refining Company, Key Highway, East Baltimore.

MASSACHUSETTS:
Fall River. Charles H. Warner, '89, 764 Rock Street.
Fitchburg. Andrew B. Sherman, '06, 18 Goodrich Street.
Great Barrington. Harold H. Lockey, '21, Prospect Street.
New Bedford. Clayton P. Hawes, '16, Hawes Electric Company, 592 Pleasant Street.
Worcester. Howard R. Stewart, '17, 5 Germain Street.

MICHIGAN:
Detroit. Allyne C. Litchfield, '17, United States Rubber Products, Inc., 6600 East Jefferson Avenue.

MINNESOTA:
Duluth. William C. Lounsbury, '03, Minnesota Power and Light Company.
Minneapolis. Charles W. Drew, '19, Rand Tower, Paine, Webber Company.
St. Paul. Winter Dean, '21, Nicols, Dean & Gregg.

MISSOURI:
Kansas City. C. Ellsworth Brown, '20, Burns & McDonnell Engineering Co., 107 West Linwood Boulevard.
St. Louis. Joyce R. Kelly, '17, Shell Oil Company, 1221 Locust Street.
Herbert C. DeStaebler, '21, Lambert Pharmacal Company, 2117 Franklin Ave.

MONTANA:
Butte. William A. Kemper, '04, 118 West Broadway.
Great Falls. Earl S. Bardwell, '06, 18 Smelter Hill.

NEBRASKA:
Omaha. Alfred H. Clarke, '15, Bemis Brothers Bag Company, 618 South Eleventh Street.

NEW HAMPSHIRE:
Concord. Leigh Spaulding Hall, '14, 31 South Main Street.

NEW JERSEY:
Bloomfield. William B. Coleman, '24, 21 Berkeley Heights Park.
Bound Brook. Benjamin W. Dow, '09, 567 Central Avenue.
Camden. Hal L. Bemis, '35, Campbell's Soup Company, Second and Market Streets.
Dover. Howard B. Allen, '18, New Jersey Power and Light Company, 9 West Blackwell Street.
East Orange. Harold McCready, '09, 130 South Munn Avenue.
Elizabeth. Richard W. Tryon, '25, 250 Canterbury Road, Westfield.
Englewood. Donald G. Fink, '33, 130 Grand Avenue.
Glen Ridge. Stewart C. Coey, '06, 39 Wildwood Terrace. Carole A. Clarke, '21, 215 Linden Avenue.
Hackensack. Ernest M. Loveland, '15, 123 Clarendon Place.
Jersey City. E. Curtis Plant, '24, 608 Pavonia Avenue.
Kearny. Robert V. Townend, '14, 101 Seeley Avenue, Arlington.
Manasquan. Munroe C. Hawes, '21, State Highway and Marcellus Avenue.
Maplewood. Gordon G. Holbrook, '10, 9 Beach Street.
Milburn. A. Raymond Brooks, '17, Wayside, Brantwood, Short Hills.
Montclair. Livingston P. Ferris, '11, 11 Bellevue Avenue, Upper Montclair.
Newark. Henry C. Colson, Jr., '09, 20 Mt. Pleasant Avenue.
Orange. Frank Maguire, '17, 201 Vose Avenue, South Orange.
Passaic. John F. Kelly, '98, 157 Prospect Street.
Paterson. Edmund J. Thimme, '23, 168 East 31st Street.
Plainfield. Geoffrey M. Rollason, '13, Aluminum Company of America, Garwood.
Red Bank. Richard S. Bicknell, '10, 21 Bergen Place.
Ridgewood. Herman A. Affel, '14, 827 Morningside Road.
Rutherford. Willard A. Emery, '21, 163 Ridge Road.
South Orange. Alfred I. Phillips, Jr., '10, 211 Lenox Avenue.
Summit. Winfield I. McNeill, '17, 165 Kent Place Boulevard.
Joseph P. Maxfield, '10, R. F. D. 1, Florham Park, Madison.
Teaneck. David J. McGrath, '12, 411 Maitland Avenue, West Englewood.
Trenton. James M. Ralston, '16, 175 West State Street
Westfield. Lyman L. Tremaine, '23, 560 Prospect Street
West Orange. A. Otterson Miller, '04, 62 Luddington Road.

NEW YORK:
Albany. Burt R. Rickards, '99, State Department of Health.
Binghamton. Irving K. Peck, '21, Binghamton Gas Company.
Buffalo. Whitworth Ferguson, '22, Ferguson Electric Construction Company, 204 Oak Street.
Marvine Gorham, '93, 420 Jackson Building.
Hudson. Robert A. Schmucker, '15, 545 Union Street.
Newburgh. Thomas C. Desmond, '09, 94 Broadway.
New York City. William J. Barrett, '16, Metropolitan Life Insurance Company.
Percy W. Carr, '18, Mutual Chemical Company of America, 270 Madison Avenue.
C. George Dandrow, '22, Johns-Manville Company, 22 East 40th Street.
Philip M. Dinkins, '18, American Cyanamid & Chemical Corp., 30 Rockefeller Plaza.
Charles P. Fiske, '14, General Motors Acceptance Corporation, 1775 Broadway.
George W. Gilman, '23, Bell Telephone Labs., 463 West Street.

Alfred T. Glassett, '20, W. G. Barney Corporation, 101 Park Avenue.
Page E. Golsan, '12, Ford Bacon and Davis, 39 Broadway.
Irving D. Jakobson, '21, Jakobson Shipyard, Inc., West End Avenue, Oyster Bay, L. I.
William T. Kniesner, '16, Room 3908, 60 East 42d Street.
Duncan R. Linsley, '22, First Boston Corporation, 100 Broadway.
William D. B. Motter, '05, Chile Exploration Company, 25 Broadway.
William H. Mueser, '22, Moran, Proctor, Freeman, and Mueser, 420 Lexington Avenue.
John J. Murphy, '23, Linde Air Products Company, 30 East 42d Street.
Raymond C. Rundlett, '22, Curtis Publishing Company, 60 East 42d Street.
Robert P. Shaw, '23, New York Museum of Science and Industry, R. C. A. Building, 30 Rockefeller Plaza.
Paul M. Wiswall, '09, General Foods Corporation, 250 Park Avenue.

Poughkeepsie. Marshall N. Waterman, '24, Central Hudson Gas & Electric Co., South Road Office.

Rochester. John F. Ancona, '03, 311 Hiram Sibley Building, 316 Alexander Street.

Schenectady. Ralph C. Robinson, '01, Vacuum Tube Department, Building 37, General Electric Company.

Syracuse. Frederick W. Barker, '12, First Trust & Deposit Co., 201 South Warren Street.

Utica and Rome. Richard A. Wilkins, '18, Revere Copper and Brass Company, Rome.

NORTH CAROLINA:

Charlotte. Beaumert Whitton, '33, Southeastern Construction Co., 218 West Second Street.

OHIO:

Akron. Ray P. Dinsmore, '14, 795 Merriman Road.

Cincinnati. Charles G. Merrell, '88, The William S. Merrell Company, Lockland P.O.

Cleveland. Charles H. Reed, '20, Forbes Varnish Company, 3800 West 143d Street.
Bruce T. Humphreville, '26, 16516 Invermere Avenue, S. E.

Columbus. Clarence E. Richards, '18, 400 South Front Street.

Dayton. Michael J. Gibbons, '06, 22 Oxford Avenue.

Toledo. Herbert A. Barnby, '23, Owens-Illinois Glass Company.

Youngstown. C. Snelling Robinson, '84, The Youngstown Sheet and Tube Company, Stambaugh Building.

OKLAHOMA:

Oklahoma City. Charles B. Stuart, '34, Taylor-Stuart Company, 453 American National Building.

Tulsa. William J. Sherry, '21, 841 Kennedy Building.

OREGON:

Portland. Ernest B. MacNaughton, '02, First National Bank.

PENNSYLVANIA:

Bethlehem. Charles H. Herty, Jr., '21, Bethlehem Steel Company.

Erie. John L. Parsons, '17, Hammermill Paper Company.

Harrisburg. Percy E. Tillson, '06, Bell Telephone Company of Pennsylvania, 210 Pine Street.

Lancaster. Charles K. Miller, '23, Armstrong Cork Company.

Philadelphia. F. Gurney Fine, Jr., '26, Lukens, Savage & Washburn, 132 South Fourth Street.
Greville Haslam, '15, Episcopal Academy, Overbrook.
Henry W. Jones, '26, Atlantic Refining Company, 260 South Broad Street.

Pittsburgh. Thomas Spooner, '09, Westinghouse Research Laboratories, East Pittsburgh.

Reading. Allyn C. Taylor, '06, 441 Penn Street.

Scranton. William L. Dennen, '17, Clarks Summit.

Wilkes-Barre. William M. Davidson, '27, The Bell Telephone Company of Pennsylvania, 222–228 South Main Street.

RHODE ISLAND:

Providence. Henry K. Sears, '96, 21 Oriole Avenue.

SOUTH CAROLINA:

Charleston. James F. Crist, '24, South Carolina Power Company.

TENNESSEE:

Chattanooga. Erwin Harsch, '20, Tennessee Valley Authority.

Knoxville. Albert S. Peet, '09, Knoxville Glove Company.

Memphis. Harry Webb, '09, P. O. Box 588.

Nashville. Thomas C. Keeling, '07, Nashville Machine & Supply Co., 123 Third Avenue, North.

TEXAS:

Dallas. Frank F. Bell, '10, Uvalde Construction Company, 920 Santa Fe Building.

El Paso. Charles I. Auer, '01, 1012 Park Road.

Fort Worth. Simon W. Freese, '21, 407 Capps Building.

Houston. George B. Forristall, '11, 703 Kirby Building.

San Antonio. Terrell Bartlett, '06, The Terrell Bartlett Engineers, Inc., 2607 Smith-Young Tower.

UTAH:

Salt Lake City. Bayard W. Mendenhall, '02, 28 South West Temple Street.

VERMONT:

Rutland. Birney C. Batcheller, '86, Wallingford.

VIRGINIA:

Lynchburg. John E. Jackson, '24, Appalachian Electric Power Company.

Norfolk. Charles W. Johnston, '05, 214 Broad Street, Portsmouth.

Richmond. Donald N. Frazier, '11, 1223 Mutual Building.

WASHINGTON:

Seattle. H. W. McCurdy, '22, 2929–16th Avenue, S.W.

Spokane. Edward E. Scofield, '19, Washington Water Power Company.

WEST VIRGINIA:

Charleston. Charles M. Cooper, '25, Elk View, R. F. D. No. 2.

WISCONSIN:
Milwaukee. Mitchell Mackie, '05, 207 East Michigan Street.

U. S. TERRITORIES AND DEPENDENCIES

CANAL ZONE:
Balboa Heights. Meade Bolton, '16, Box 23.

HAWAII:
Honolulu. William C. Furer, '06, Hawaiian Trust Building.

FOREIGN COUNTRIES

ARGENTINA:
Buenos Aires. Jose Carlos Bertino, '23, Central Naval, Florida 801.

AUSTRALIA:
Melbourne. Lionel H. Lemaire, '13, 47 Hopetown Road, Toorak S.E.2., Melbourne, Victoria.

BELGIUM:
Brussels. Charles L. Manneback, '21, 27 Rue de la Tourelle.

BRAZIL:
Rio de Janeiro. Alexandre H. Leal, '35, Carris Luze and Forca, Avenida Marechal Floriana 168.

CANADA:
Montreal, Que. A. D. Ross, '23, Canadian Comstock Company, 620 Cathcart Street.
St. John, N. B. H. Usher Miller, '09, P. O. Box 796.
Toronto, Ont. Denton Massey, '24, 34 Alexandra Wood.
Winnipeg, Man. Richard C. Huggard, '30, Huggard-Moncrieff, 612 Toronto General Trust Building, Portage Avenue.

CUBA:
Havana. Julio C. Ulloa, '33, E305, Vedado.

ENGLAND:
London. David A. Shepard, '26, Thames House, Millbank, London, S.W.1.

FRANCE:
Paris. Welles Bosworth, '89, Vaucresson (S et O).
George W. Bakeman, '13, The Rockefeller Foundation, 20 Rue de la Baume.

GERMANY:
Dresden. Heinz O. Vorlander, '30, The Deutsche Patentfeilen Fabrik, Radeberg Sa.
Neuss. Werner T. Schaurte, '14, Furtherstr. 24.26, Neuss, Rhein.

MEXICO:
Mexico City. George D. Camp, '16, Apartado 1005.

NORWAY:
Oslo. Harold R. Bjerke, '23, Osterhausgt 18.

PERU:
Lima. Melville W. Powers, '20, U. S. Naval Mission, Ministerio de la Marina.

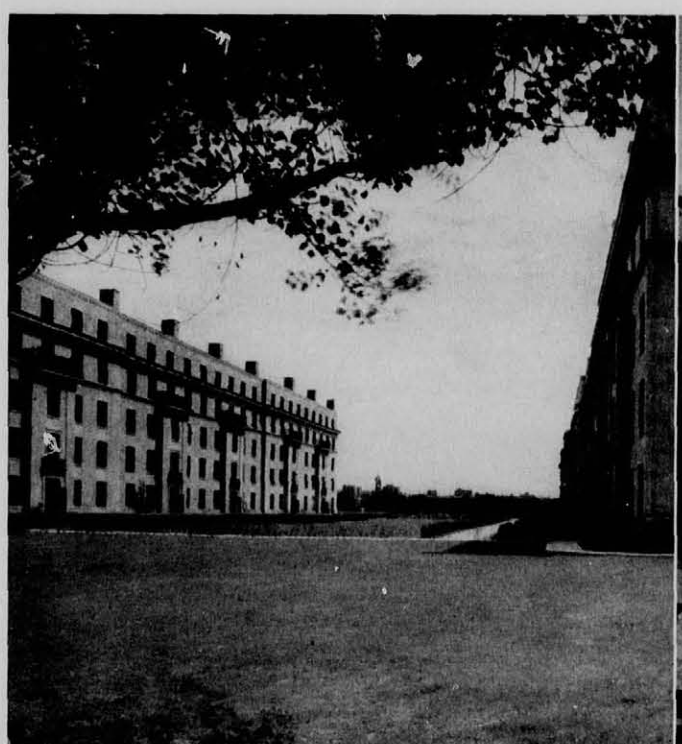
SALVADOR, C. A.:
San Salvador. Ernesto de Sola, '33, San Salvador.

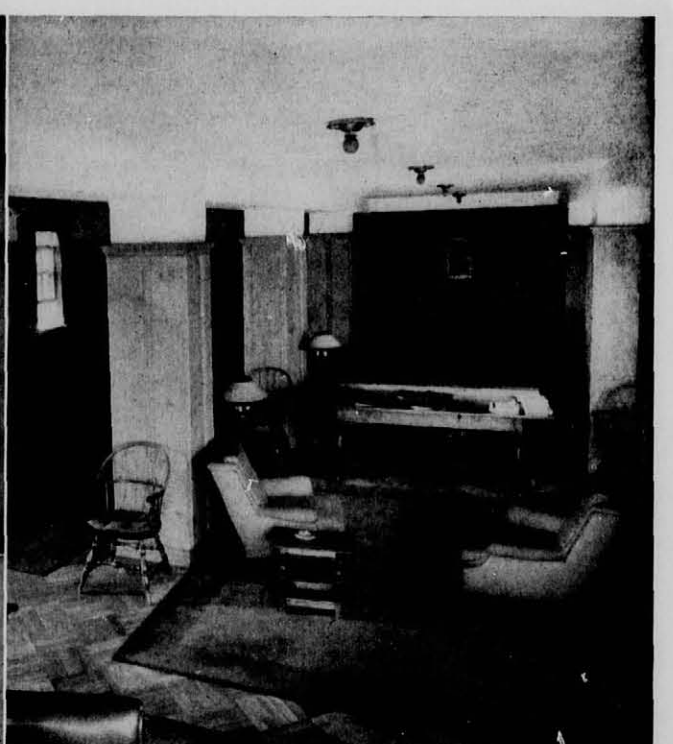
SOUTH AFRICA:
Johannesburg. Glen L. Bateman, '25, Box 1671.

SPAIN:
Barcelona. Casimiro Lana-Sarrate, '18, Lauria 122.

SWITZERLAND:
Zurich. Werner Schoop, '22, c/o Oelheizungs Ag. Flexflam, Spluegenstr. 11.

Above. *The Graduate House where approximately 400 advanced students live*
Below. *Views, exterior and interior, of the undergraduate dormitories. For views of the Senior House* *see next page*





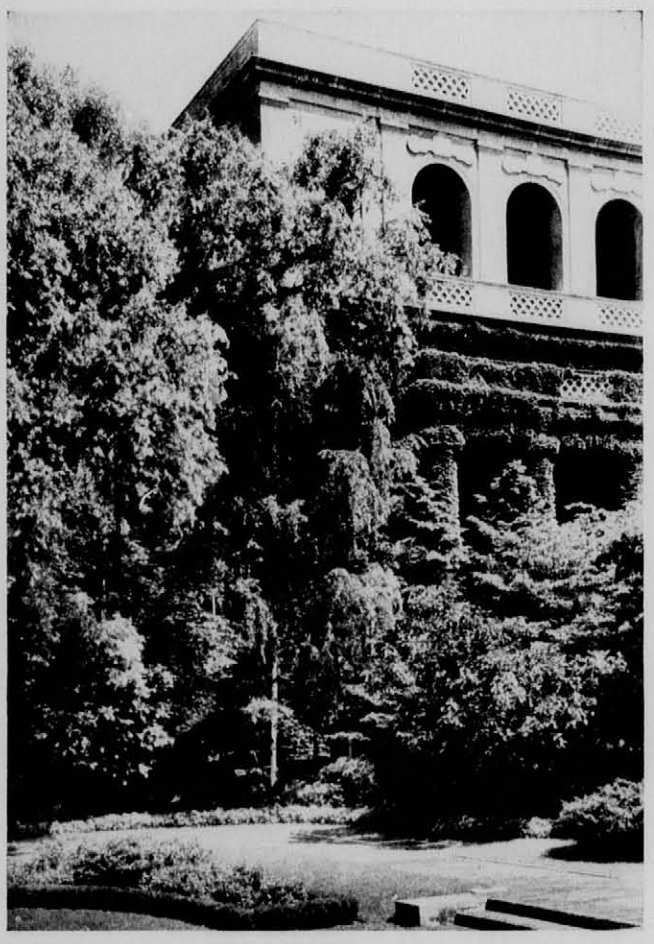




THE SENIOR HOUSE

AS THE adjacent pictures testify, the Senior House is admirably equipped for comfortable living. Separation of living quarters of graduates, seniors, and other undergraduates is based on the principle that the most natural cultural advance comes from social intercourse among men of different interests but of equivalent intellectual outlook and that their social development depends upon these contacts.







APPENDIX C

STUDENT HOUSING

APPENDIX C

STUDENT HOUSING

THE GRADUATE HOUSE

THE Graduate House, having a maximum capacity of 420 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 Dutch 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. Four 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 Dutch 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 of five dollars per resident per year 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, couch cover, 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 further provided with tables and studio couches. 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 rooms each day 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, Massachusetts.

Each student must file an application card, and if applying for double or triple suites the application must bear the names of the two or three men who

desire to occupy them. No application fees are required.

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 is granted to men already living in the House whose applications are filed on or before April fifteenth. Notices of assignments and leases will be forwarded to these applicants as soon as possible after April fifteenth and the leases, properly executed, must be returned to the manager within one month; otherwise the rooms may be reassigned.

Occupancy

Rooms leased for the Institute year may be occupied from the Monday before the opening of the fall term until the Saturday after commencement — about 38 weeks. Staff members in the Graduate House, who by virtue of their staff appointment are required to be in residence two weeks before the opening of the fall term, may occupy the assigned rooms for the additional week without charge. During the summer term, rooms are rented by the week.

Rentals, Payments, and Refunds

The rental of the single rooms and suites varies according to space, floor, exposure, and lavatory installation. These prices are clearly indicated on the floor plans.

Rentals for the academic year will be by formal lease bearing the signatures of applicants. Payments will be regularly due without notice — one-half before the beginning of the first term (about the end of September) and one-half before the beginning of the second term (about February 1). *No bills will be sent.*

Payments for rooms occupied during the summer terms are due in advance for each six weeks of occupancy. The summer rates are $4.00 to $8.00 per man per week, depending on the kind of accommodations desired.

The Dormitory Board extends the following privileges, subject to change without notice, in the cancellation of leases.

Leases may be cancelled without charge before September first upon written notice to the Manager.

Students who desire to move from the Graduate House 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 lease.

Students who apply for release, except as specified above, will be refunded a proportionate part of their payments, less $50, when and if another student can be secured to take over the remaining portion of the lease. This last arrangement can be made only with the consent of the Dormitory Board.

Leases are automatically cancelled 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 $1.00 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 8.00 a.m. to 12.00 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 a 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, 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 8.00 a.m. and midnight. Tele-

phone 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. Under the Compulsory Insurance Laws of the Commonwealth of Massachusetts, the owner of an automobile registered in this State must have a policy of liability insurance providing indemnity for or protection to himself and to any person responsible for the operation of the vehicle, and covering the same while operated in Massachusetts. The Commonwealth of Massachusetts has a reciprocal agreement with many of the other States whereby a *student* may operate a motor vehicle in Massachusetts during the *school year* on the registration of his home State, subject to the regulations as to insurance, etc., of that State. The owner of the registered vehicle *must* apply for a permit to operate the vehicle in Massachusetts under his non-resident registration after a period of thirty days. Applications are available at the Information Office, M. I. T.

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 194. 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, and the Oak Room, capacity 10, are used for small private luncheons or dinners. The Dutch Room, in the basement, will seat 140 persons for a banquet. It is available for the midday or the evening.

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 and maintenance of the building, the allotment of rooms and the enforcement of the terms of the lease.

For further information address the Manager of the Graduate House, Massachusetts Institute of Technology, Cambridge, Massachusetts.

SENIOR AND UNDERGRADUATE HOUSES

THE 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.

In addition to the Institute Dormitories (Senior and Undergraduate houses) accommodating 625 students, the Institute recognizes 25 national fraternities, whose houses are situated on private property in Cambridge, Boston, and Brookline. Local apartment and rooming houses are also available, but lack the advantages of residence in the Dormitories and fraternity houses, due to the more intimate contact of the latter with Technology life and activities.

Approximately 90 per cent of the fraternity men are pledged during, or prior to, the first week of the Freshman year and may assume residence at the fraternity house of their choice immediately, thereby releasing dormitory accommodations for those on the waiting list. Parents of students who anticipate fraternity affiliation for their son should, if possible, grant him permission to act on his own initiative, and should consider all available housing facilities before signing binding agreements. Fraternity contacts are encouraged prior to entrance, and under certain conditions Dormitory leases may be terminated to allow students to transfer from the Dormitories to a fraternity house (see following page).

The Senior House

Ware, Atkinson, Runkle, Holman, Nichols, and Crafts Halls — the Faculty Group — are reserved exclusively for members of the Senior Class. They have a capacity of 206 men.

A Library and Living Room are on the first floor of Crafts, and two lounge rooms are similarly located in Ware. A private dining room, with a maximum capacity of sixteen guests, is in the basement of Ware. The first-floor rooms in all of the other halls 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. A few of the suites are suitable for three men. All rooms are equipped for immediate occupancy. Many of the rooms have lavatory installation supplemented by adequate toilets and showers.

A member of the Institute Staff, who is familiar with the general aims and problems of Senior students, is resident house master and he, with the assistance of a student house committee, has supervision of the Senior House.

The Undergraduate Houses

Walcott, Bemis, Goodale, Munroe, Hayden and Wood — the Alumni Group — are reserved exclusively for undergraduate students. They have a capacity of 419 men. Most of the rooms are for single occupancy — some interconnecting — with a limited number of double and triple suites as noted on the floor plans. There are lavatory installations in all these rooms, supplemented by adequate toilets and showers on each floor of every hall.

The government of the Senior and Undergraduate houses is 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 whole question of discipline and maintenance of good order is in the hands of the students themselves. The student committee organizes and supervises all activities, athletic and social, and coöperates with all recognized undergraduate activities at the Institute. Application for residence in the dormitories implies the willingness to coöperate with the student government and contribute to its success.

A House Tax of five dollars per resident per year, included in the rental, is turned over to the committee for athletics, dances, dinners and a variety of social activities.

The Dormitory Board, referred to above, is responsible for general regulations, sanitation, service and maintenance, the allotment of rooms and the enforcement of the terms of the lease. Friendly relations between the Board and the student committee have been maintained to such a degree that disciplinary action seldom has been found necessary.

Equipment

Single Rooms. Special bed or couch, all hair innerspring mattress with cover, pillow, couch cover, blankets, chiffonier, desk and chair, study chair, bookcase, rug, draperies, desk lamp, wastebasket, and interconnecting telephone. Bed linen and towels are furnished, and regularly replaced, by porters who make up and clean the rooms each day.

Double and Triple Rooms. These rooms are furnished in a manner similar to the single rooms, but in addition have study tables and wardrobes where necessary. As the rooms are *fully equipped for occupancy*, additions by the students to the standard equipment are permitted only upon agreement with the manager of the dormitories.

Service. 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.

Application for Rooms

Applications for the Senior House and for the Undergraduate Houses should be made to D. L. Rhind, Bursar. The following single rooms are reserved for students entering the first year:

Bemis: 101, 104, 105, 108, 111, 113, 201, 204, 205, 208, 211, 213, 301, 304, 305, 308, 311, 313, 401, 404, 405, 408, 411, 413, 501, 504, 505, 508, 511, 513.

Goodale: 103, 105, 110, 112, 203, 205, 210, 212, 303, 305, 310, 312, 403, 405, 410, 412, 503, 505, 510, 512.

Walcott: 101, 104, 111, 114, 201, 204, 207, 210, 213, 301, 304, 307, 310, 313, 401, 404, 407, 410, 413, 501, 504, 507, 510, 513.

Munroe: 201, 204, 210, 213, 301, 304, 310, 313, 401, 404, 410, 413, 501, 504, 510, 513.

Hayden: 101, 104, 107, 110, 113, 201, 204, 207, 210, 213, 301, 304, 307, 310, 313, 401, 404, 407, 410, 413, 501, 504, 507, 510, 513.

Wood: 101, 104, 107, 110, 113, 201, 204, 207, 210, 213, 301, 304, 307, 310, 313, 401, 404, 407, 410, 413, 501, 504, 507, 510, 513.

Applications for double and triple suites must bear the signatures of the two or three men who desire to occupy them. No application fees are required.

Allotment of Rooms

Seniors, Juniors, Sophomores. 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 specifically reserved for entering first-year students, is granted to men already living in the houses whose applications are filed on or before March 15. Notices of assignments and leases will be forwarded to these applicants as soon as possible after March 15 and the leases, properly executed, must be returned to the Cashier's Office, Room 10–180, within one month; otherwise the rooms will be reassigned. The Dormitory Board reserves the right to assign a registered student from the waiting list to a vacancy in a double or triple suite.

First-Year Students. Rooms will be assigned in order of date of application and leases will be forwarded about August 15 to applicants whose admission as first year students has been approved by the Director of Admissions. Leases must be returned to the Cashier's Office, 10-180, properly executed, by September 15; otherwise the rooms will be reassigned. Unsuccessful applicants will be notified and their names kept on the waiting list in order of the date of application. They should report to the Cashier's Office, 10-180, on Registration Day to inquire about possible assignment to rooms released by cancellation, or withdrawal. All vacancies will be filled in order from this first-year waiting list.

Occupancy

Rooms leased for the Institute year may be occupied from the Monday before the opening of the fall term until the Saturday preceding commencement — about 37 weeks. Residents of the Senior House may retain their rooms without charge until the Saturday after Commencement. During the summer term, rooms are rented by the week.

Rentals, Payments, and Refunds

The rental of the single rooms and suites varies according to space, floor, exposure, and lavatory installation. These prices are clearly indicated on the floor plans. (See pages 255–260.)

Rentals for academic year will be by formal lease bearing the signatures of applicants, as well as of their parents or guardians. Payments will be regularly due *without* notice — one-half before the beginning of the first term (about the end of September) and one-half before the beginning of the second term (about February 1). *No bills will be sent.*

Payments for rooms occupied during the summer terms are due in advance for each six weeks of occupancy. The summer rates are, Undergraduate Houses, $4.00 per man per week.

The Dormitory Board extends the following privileges in the cancellation of lease. These privileges are subject to change without notice.

Leases may be cancelled without charge before September 1 upon written notice to the Bursar.

Students who desire to move to recognized fraternity houses will be refunded a proportionate part of their payments, less $10, up to noon of the Wednesday following Registration Day of the first term, provided authorized representatives of the fraternities request such transfer.

Other students who desire to move from the Dormitories 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 immediately secured to take over the remaining portion of the lease, and provided the application for release is filed prior to noon of the Wednesday following Registration Day of the first term.

Students who apply for release, except as specified above, will be refunded a proportionate part of their

payments, less $50, when and if another student can be secured to take over the remaining portion of the lease. This last arrangement can be made only with the consent of the Dormitory Board.

Leases are automatically cancelled upon the withdrawal of a student from the Institute or 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 Dormitory Office on the first floor of Munroe Hall. A deposit of $1.00 for the two is required, but this is refunded upon surrender of the keys.

Dormitory Office. Located on the first floor of Munroe with a clerk in attendance from 7.00 a.m. to 11.00 p.m. All necessary information may be obtained there. The office of the manager of the dormitories is adjacent to the Dormitory Office.

Burton Room. Adjoining the Dormitory Office in Munroe is a large, comfortably furnished common room known as the Burton Room. Women are not allowed in the dormitories except on special occasions, but they are permitted to visit the Burton Room at any time when the Office is open.

A library of non-technical books is maintained for the use of dormitory occupants in connection with the library in the near-by Walker Memorial.

Mail and Express. Packages and mail matter for students living in the dormitories should be addressed as follows: *Massachusetts Institute of Technology Dormitories, Cambridge, Massachusetts.* Individual post office lock boxes are provided and are located at the Dormitory Office.

Telephone Service. Persons calling the dormitories from outside should ring KIRkland 5300. Through a system of intramural telephone service, the Office is enabled easily to call any occupant. Telephone pay stations for out-going calls are located at the Office and at other points in the dormitories.

Laundry and Valet Service. The Institute operates a laundry and valet agency, and students are enabled to secure such service through the Dormitory Office at greatly reduced prices.

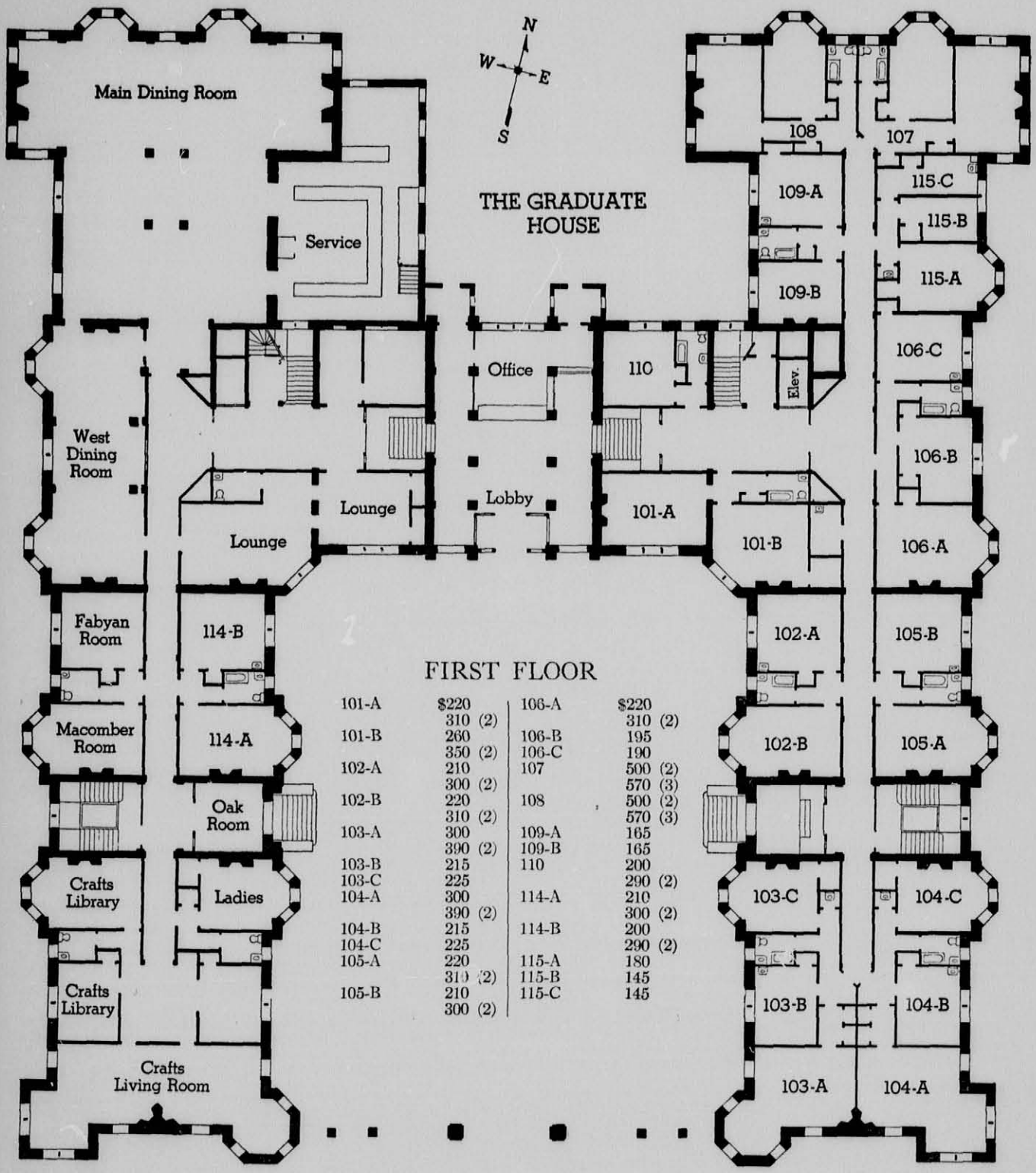
Storage. Ample facilities for storage are provided in the basement of the halls without charge. Trunks are not permitted in the rooms.

Automobile Regulations and Parking. Under the Compulsory Insurance Laws of the Commonwealth of Massachusetts, the owner of an automobile registered in this State must have a policy of liability insurance providing indemnity for or protection to himself and to any person responsible for the operation of the vehicle, and covering the same while operated in Massachusetts. The policy must provide a limit of not less than $5,000 for injury or death of any one person and not less than $10,000 on account of any one accident resulting in the injury to or death of more than one person. The Commonwealth of Massachusetts has a reciprocal agreement with many of the other States whereby a *student* may operate a motor vehicle in Massachusetts during the *school year* on the registration of his home State, subject to the regulations as to insurance, etc., of that State. The owner of the registered vehicle *must* apply for a permit to operate the vehicle in Massachusetts under his non-resident registration after a period of thirty days. Applications are available at the Information Office, M. I. T.

Outdoor parking of properly registered automobiles is permitted on the Institute grounds at the risk of the owner.

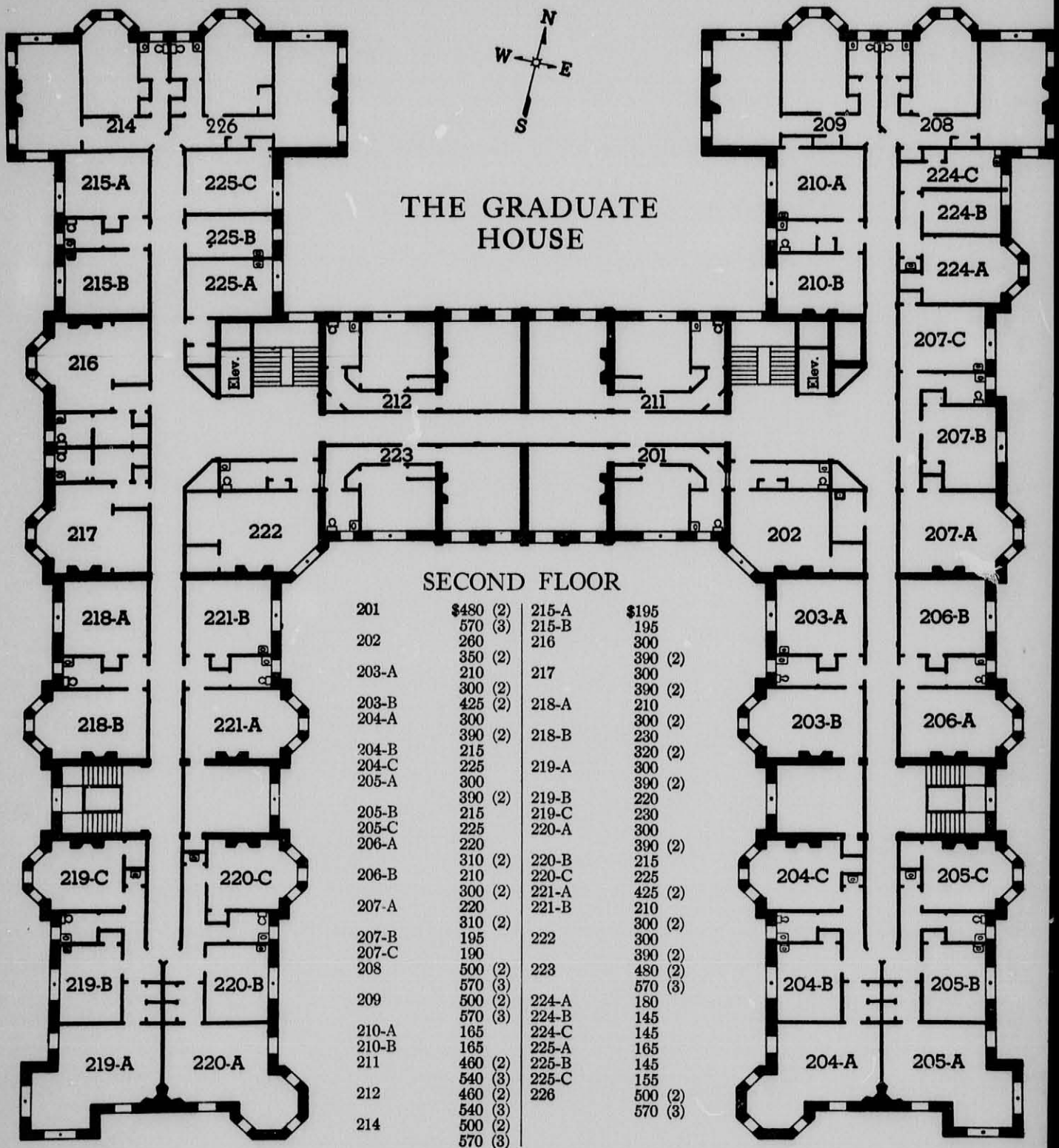
Dining Service. Dining facilities are in the Walker Memorial, headquarters of student activities, adjacent to the Dormitories. Either cafeteria or table service is available. No board by the day or week is furnished, and no student is required to use this service. Because of the low cost and the excellent facilities, however, about 2,000 meals a day are served. During the academic year the student dining service operates seven days a week.

Building Service. The dormitory buildings are of first class construction and are fireproof. Rooms are cleaned by use of vacuum cleaners; mazda lamps are furnished; and each room is provided with extra electrical outlets. Steam heat is available throughout the Institute year, day and night. The house service is directly in charge of the manager of the dormitories and is maintained by experienced porters. A representative of the Institute is on the premises day and night. *For further information address the Bursar, Massachusetts Institute of Technology, Cambridge, Mass.*

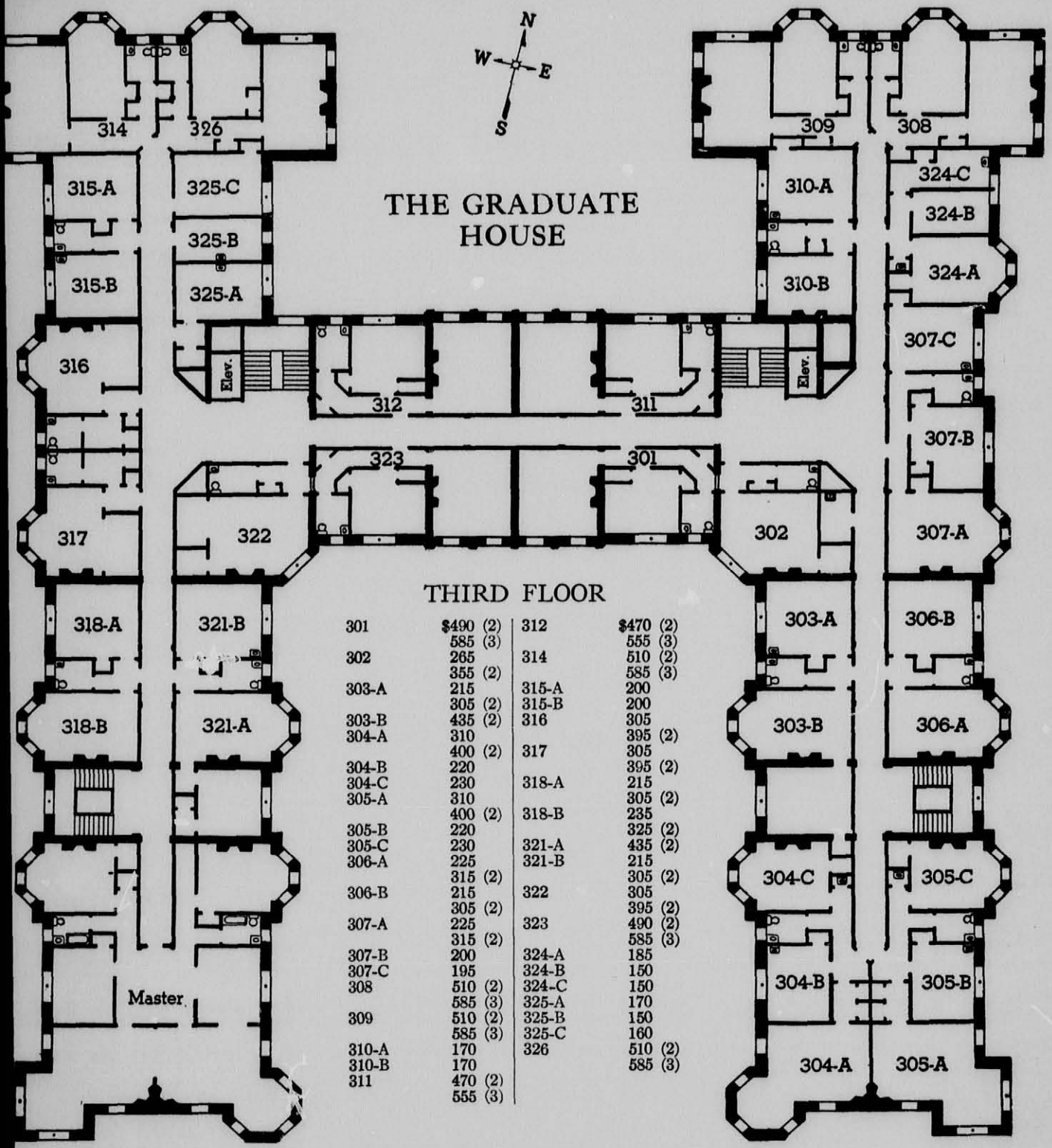


FIRST FLOOR

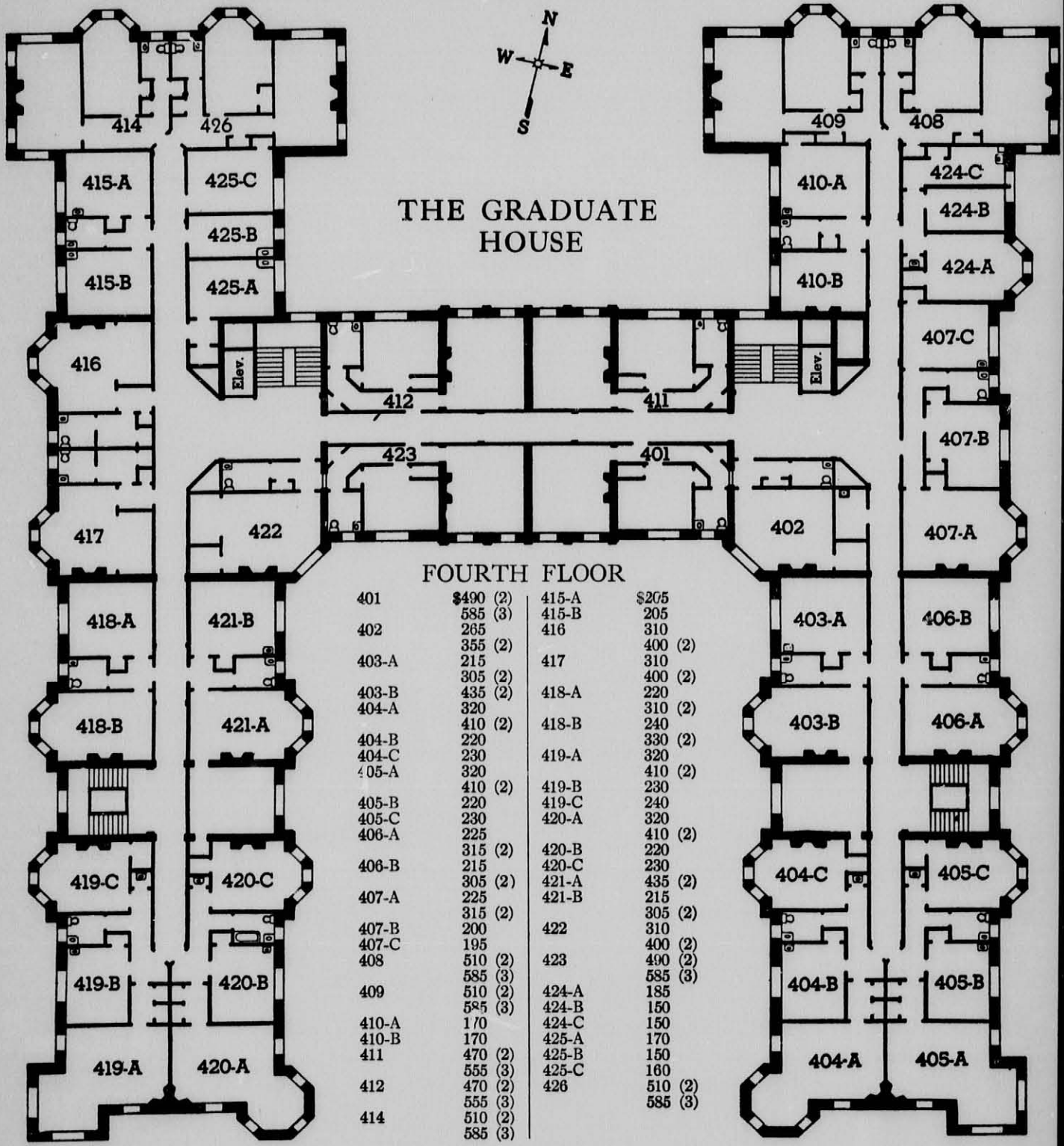
101-A	$220	106-A	$220
	310 (2)		310 (2)
101-B	260	106-B	195
	350 (2)	106-C	190
102-A	210	107	500 (2)
	300 (2)		570 (3)
102-B	220	108	500 (2)
	310 (2)		570 (3)
103-A	300	109-A	165
	390 (2)	109-B	165
103-B	215	110	200
103-C	225		290 (2)
104-A	300	114-A	210
	390 (2)		300 (2)
104-B	215	114-B	200
104-C	225		290 (2)
105-A	220	115-A	180
	310 (2)	115-B	145
105-B	210	115-C	145
	300 (2)		



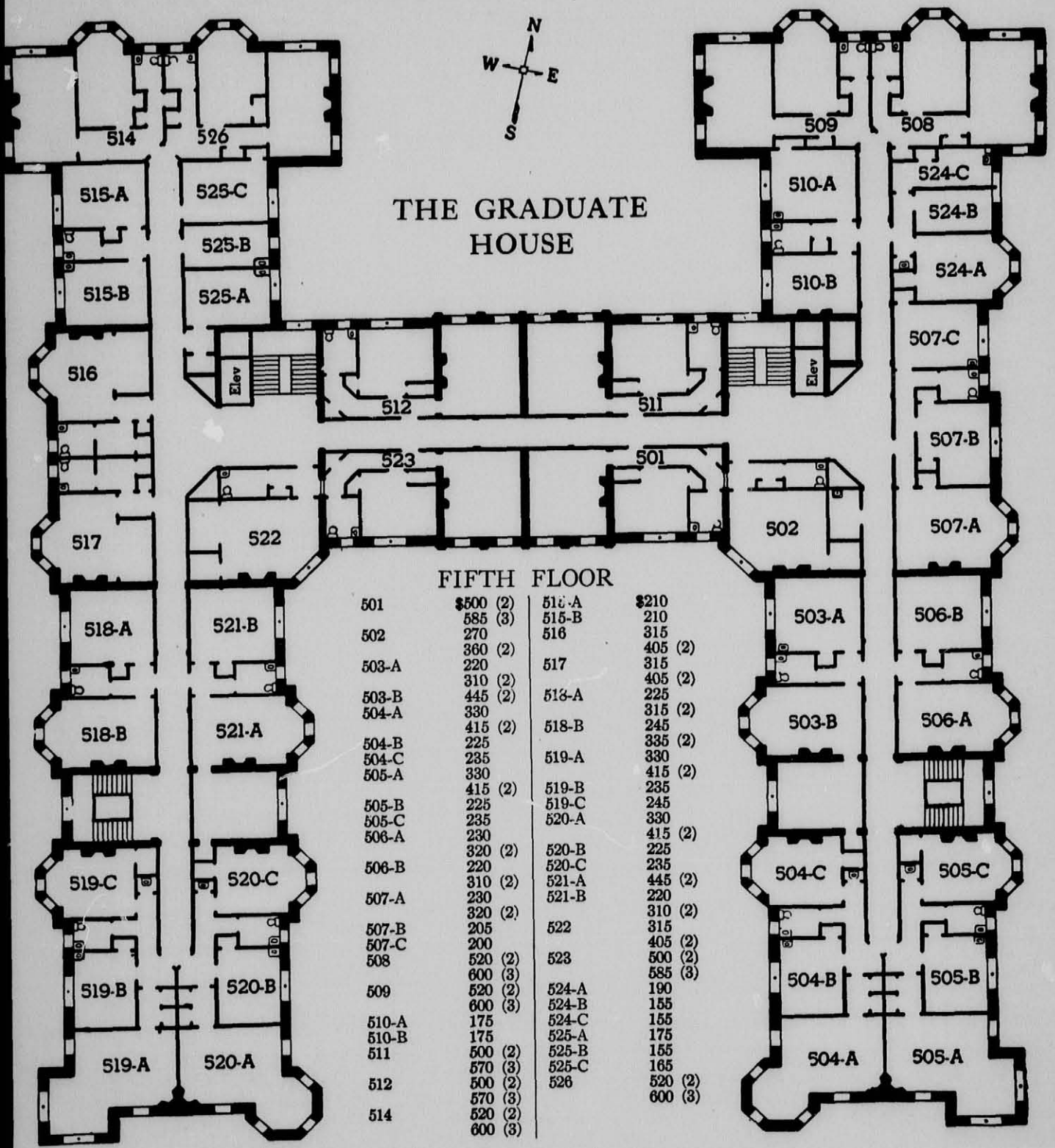
201	$480	(2)	215-A	$195	
	570	(3)	215-B	195	
202	260		216	300	
	350	(2)		390	(2)
203-A	210		217	300	
	300	(2)		390	(2)
203-B	425	(2)	218-A	210	
204-A	300			300	(2)
	390	(2)	218-B	230	
204-B	215			320	(2)
204-C	225		219-A	300	
205-A	300			390	(2)
	390	(2)	219-B	220	
205-B	215		219-C	230	
205-C	225		220-A	300	
206-A	220			390	(2)
	310	(2)	220-B	215	
206-B	210		220-C	225	
	300	(2)	221-A	425	(2)
207-A	220		221-B	210	
	310	(2)		300	(2)
207-B	195		222	300	
207-C	190			390	(2)
208	500	(2)	223	480	(2)
	570	(3)		570	(3)
209	500	(2)	224-A	180	
	570	(3)	224-B	145	
210-A	165		224-C	145	
210-B	165		225-A	165	
211	460	(2)	225-B	145	
	540	(3)	225-C	155	
212	460	(2)	226	500	(2)
	540	(3)		570	(3)
214	500	(2)			
	570	(3)			



301	$490 (2)	312	$470 (2)
	585 (3)		555 (3)
302	265	314	510 (2)
	355 (2)		585 (3)
303-A	215	315-A	200
	305 (2)	315-B	200
303-B	435 (2)	316	305
304-A	310		395 (2)
	400 (2)	317	305
304-B	220		395 (2)
304-C	230	318-A	215
305-A	310		305 (2)
	400 (2)	318-B	235
305-B	220		325 (2)
305-C	230	321-A	435 (2)
306-A	225	321-B	215
	315 (2)		305 (2)
306-B	215	322	305
	305 (2)		395 (2)
307-A	225	323	490 (2)
	315 (2)		585 (3)
307-B	200	324-A	185
307-C	195	324-B	150
308	510 (2)	324-C	150
	585 (3)	325-A	170
309	510 (2)	325-B	150
	585 (3)	325-C	160
310-A	170	326	510 (2)
310-B	170		585 (3)
311	470 (2)		
	555 (3)		

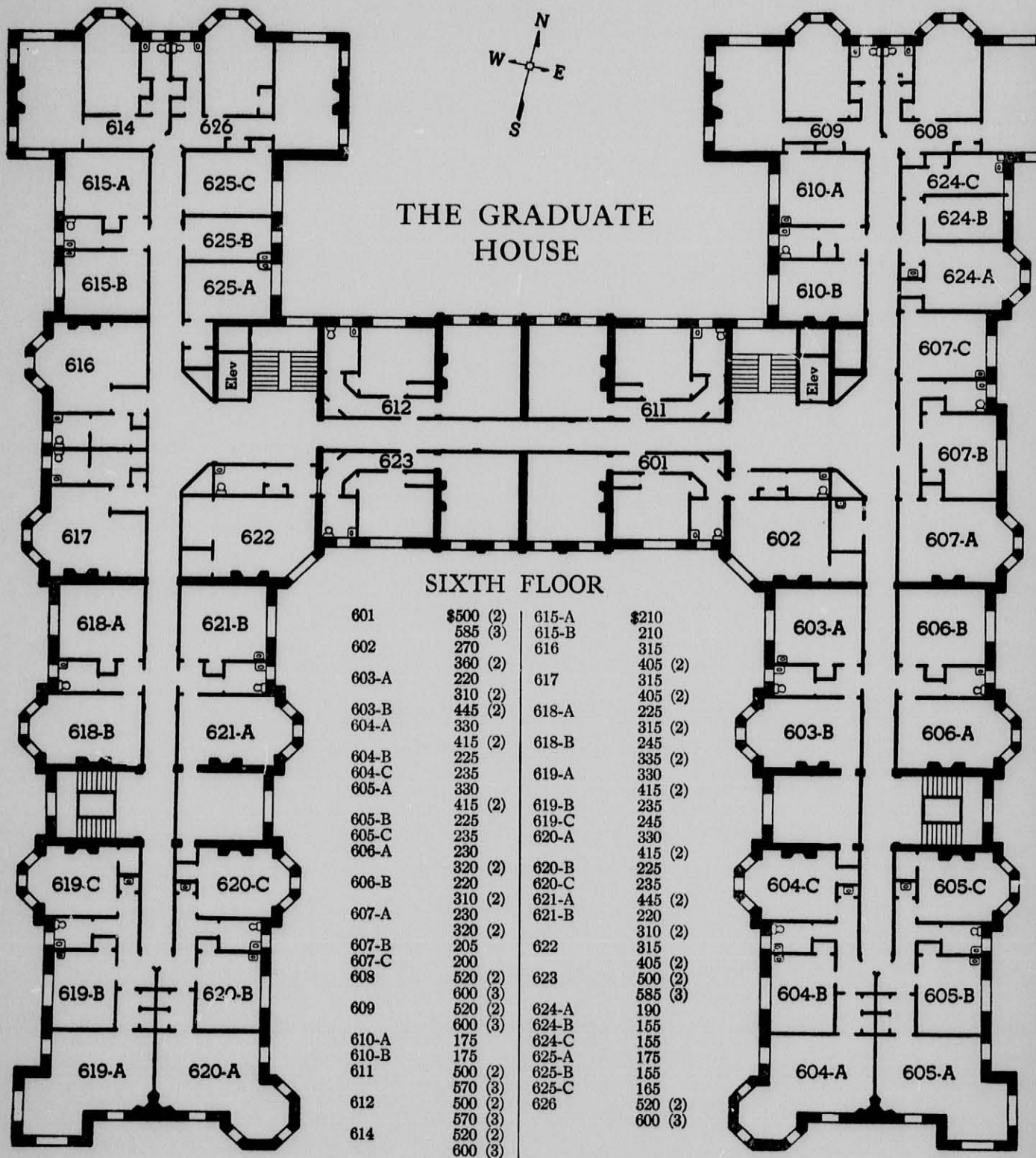


401	$490 (2)	415-A	$205
	585 (3)	415-B	205
402	265	416	310
	355 (2)		400 (2)
403-A	215	417	310
	305 (2)		400 (2)
403-B	435 (2)	418-A	220
404-A	320		310 (2)
	410 (2)	418-B	240
404-B	220		330 (2)
404-C	230	419-A	320
405-A	320		410 (2)
	410 (2)	419-B	230
405-B	220	419-C	240
405-C	230	420-A	320
406-A	225		410 (2)
	315 (2)	420-B	220
406-B	215	420-C	230
	305 (2)	421-A	435 (2)
407-A	225	421-B	215
	315 (2)		305 (2)
407-B	200	422	310
407-C	195		400 (2)
408	510 (2)	423	490 (2)
	585 (3)		585 (3)
409	510 (2)	424-A	185
	585 (3)	424-B	150
410-A	170	424-C	150
410-B	170	425-A	170
411	470 (2)	425-B	150
	555 (3)	425-C	160
412	470 (2)	426	510 (2)
	555 (3)		585 (3)
414	510 (2)		
	585 (3)		



FIFTH FLOOR

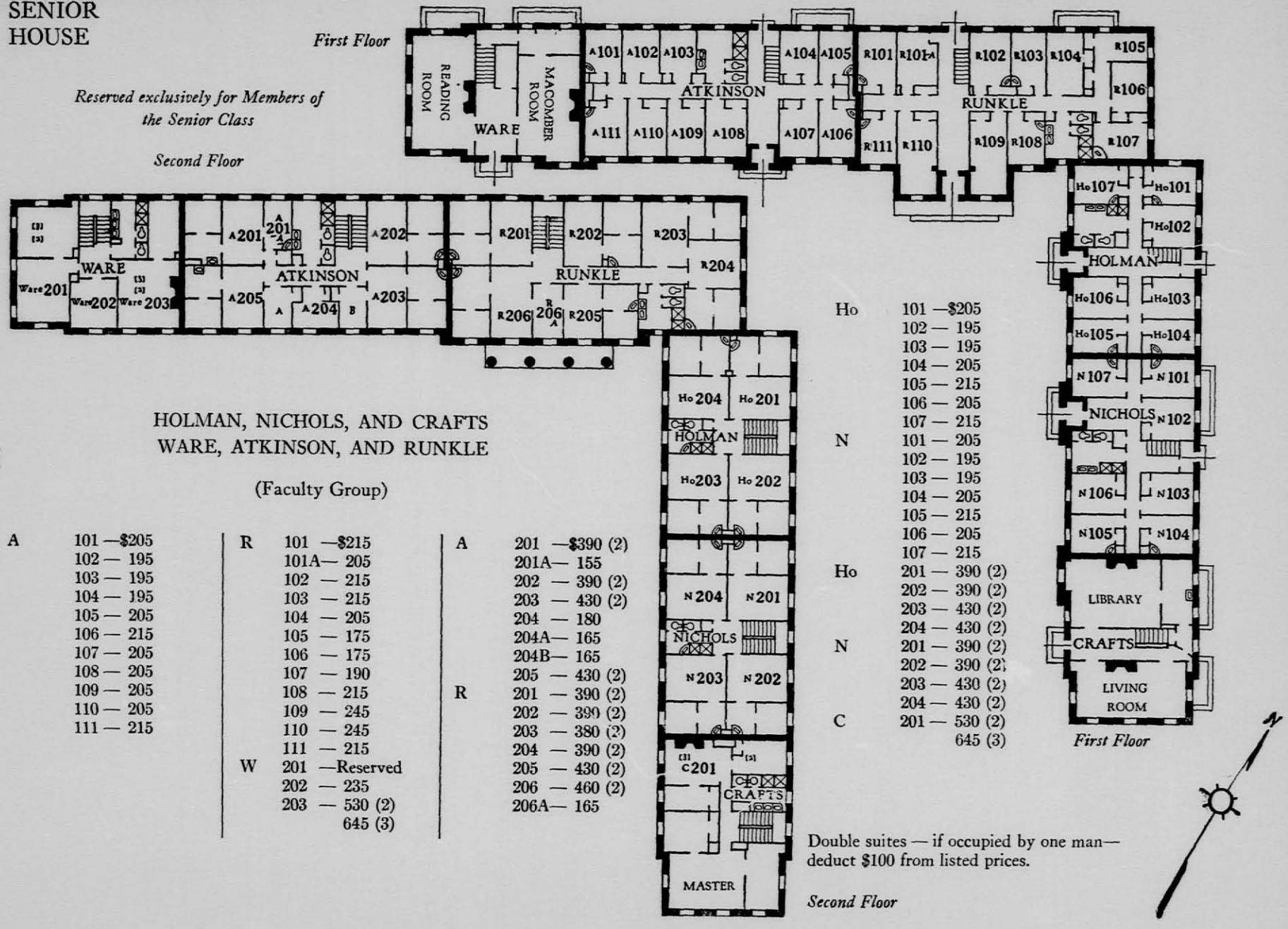
501	$500 (2)	515-A	$210
	585 (3)	515-B	210
502	270	516	315
	360 (2)		405 (2)
503-A	220	517	315
	310 (2)		405 (2)
503-B	445 (2)	518-A	225
504-A	330		315 (2)
	415 (2)	518-B	245
504-B	225		335 (2)
504-C	235	519-A	330
505-A	330		415 (2)
	415 (2)	519-B	235
505-B	225	519-C	245
505-C	235	520-A	330
506-A	230		415 (2)
	320 (2)	520-B	225
506-B	220	520-C	235
	310 (2)	521-A	445 (2)
507-A	230	521-B	220
	320 (2)		310 (2)
507-B	205	522	315
507-C	200		405 (2)
508	520 (2)	523	500 (2)
	600 (3)		585 (3)
509	520 (2)	524-A	190
	600 (3)	524-B	155
510-A	175	524-C	155
510-B	175	525-A	175
511	500 (2)	525-B	155
	570 (3)	525-C	165
512	500 (2)	526	520 (2)
	570 (3)		600 (3)
514	520 (2)		
	600 (3)		



601	$500 (2)	615-A	$210
	585 (3)	615-B	210
602	270	616	315
	360 (2)		405 (2)
603-A	220	617	315
	310 (2)		405 (2)
603-B	445 (2)	618-A	225
604-A	330		315 (2)
	415 (2)	618-B	245
604-B	225		335 (2)
604-C	235	619-A	330
605-A	330		415 (2)
	415 (2)	619-B	235
605-B	225	619-C	245
605-C	235	620-A	330
606-A	230		415 (2)
	320 (2)	620-B	225
606-B	220	620-C	235
	310 (2)	621-A	445 (2)
607-A	230	621-B	220
	320 (2)		310 (2)
607-B	205	622	315
607-C	200		405 (2)
608	520 (2)	623	500 (2)
	600 (3)		585 (3)
609	520 (2)	624-A	190
	600 (3)	624-B	155
610-A	175	624-C	155
610-B	175	625-A	175
611	500 (2)	625-B	155
	570 (3)	625-C	165
612	500 (2)	626	520 (2)
	570 (3)		600 (3)
614	520 (2)		
	600 (3)		

SENIOR HOUSE

Reserved exclusively for Members of the Senior Class



HOLMAN, NICHOLS, AND CRAFTS
WARE, ATKINSON, AND RUNKLE

(Faculty Group)

A	101 —$205	
	102 — 195	
	103 — 195	
	104 — 195	
	105 — 205	
	106 — 215	
	107 — 205	
	108 — 205	
	109 — 205	
	110 — 205	
	111 — 215	

R	101 —$215	
	101A— 205	
	102 — 215	
	103 — 215	
	104 — 205	
	105 — 175	
	106 — 175	
	107 — 190	
	108 — 215	
	109 — 245	
	110 — 245	
	111 — 215	
W	201 —Reserved	
	202 — 235	
	203 — 530 (2)	
	645 (3)	

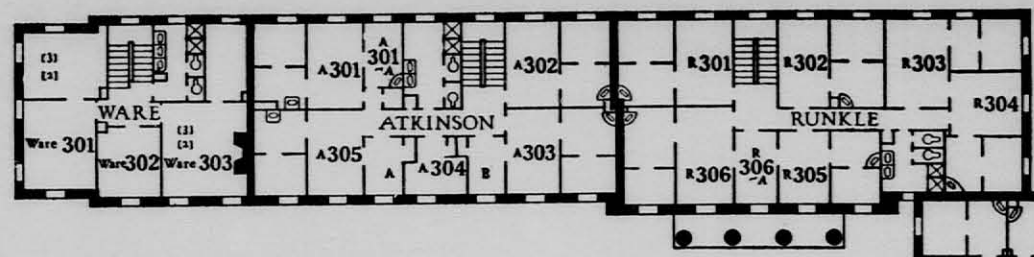
A	201 —$390 (2)	
	201A— 155	
	202 — 390 (2)	
	203 — 430 (2)	
	204 — 180	
	204A— 165	
	204B— 165	
	205 — 430 (2)	
R	201 — 390 (2)	
	202 — 390 (2)	
	203 — 380 (2)	
	204 — 390 (2)	
	205 — 430 (2)	
	206 — 460 (2)	
	206A— 165	

Ho	101 —$205	
	102 — 195	
	103 — 195	
	104 — 205	
	105 — 215	
	106 — 205	
	107 — 215	
N	101 — 205	
	102 — 195	
	103 — 195	
	104 — 205	
	105 — 215	
	106 — 205	
	107 — 215	
Ho	201 — 390 (2)	
	202 — 390 (2)	
	203 — 430 (2)	
	204 — 430 (2)	
N	201 — 390 (2)	
	202 — 390 (2)	
	203 — 430 (2)	
	204 — 430 (2)	
C	201 — 530 (2)	
	645 (3)	

Double suites — if occupied by one man— deduct $100 from listed prices.

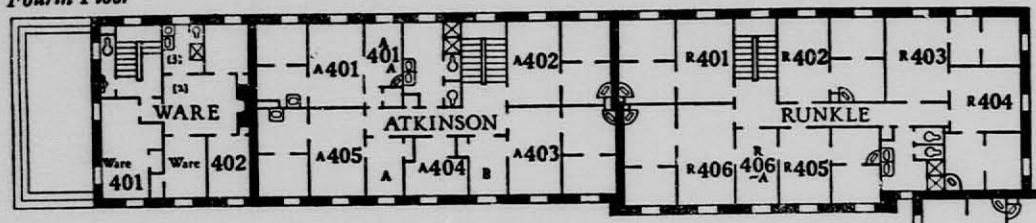
Third Floor

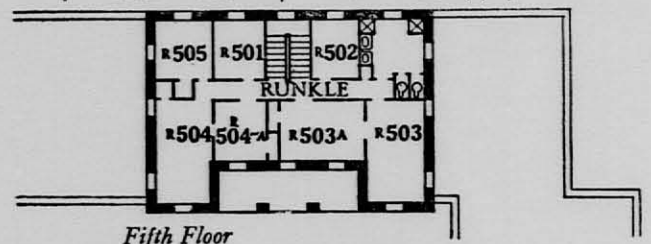
W 301 —$530 (2)	A301 —$390 (2)	R301 —$390 (2)
645 (3)	301A— 155	302 — 390 (2)
W 302 — 235	302 — 390 (2)	303 — 380 (2)
W 303 — 530 (2)	303 — 430 (2)	304 — 390 (2)
645 (3)	304 — 180	305 — 430 (2)
	304A— 165	306 — 460 (2)
	304B— 165	306A— 165
	305 — 430 (2)	



Fourth Floor

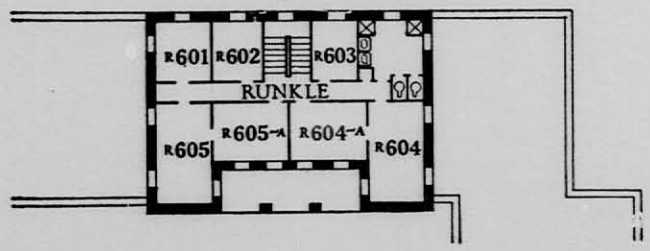
W 401 —$265	A 401A—$155	A 404B—$165	R 404 —$390 (2)
402 — 630 (2)	402 — 390 (2)	405 — 430 (2)	405 — 430 (2)
735 (3)	403 — 430 (2)	R 401 — 390 (2)	406 — 460 (2)
A 401 — 390 (2)	404 — 180	402 — 390 (2)	406A— 165
	404A— 165	403 — 380 (2)	





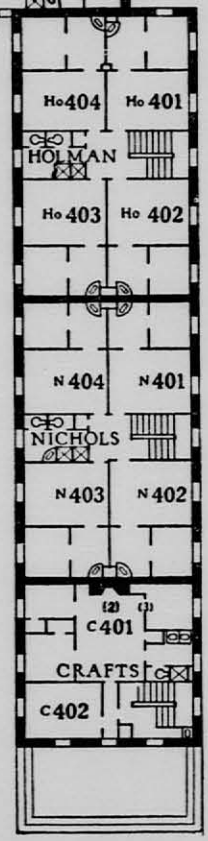
Fifth Floor

R	501 — $155	R	503A — $230
	502 — 150		504 — 235
	503 — 230		504A — 200
			505 — 165



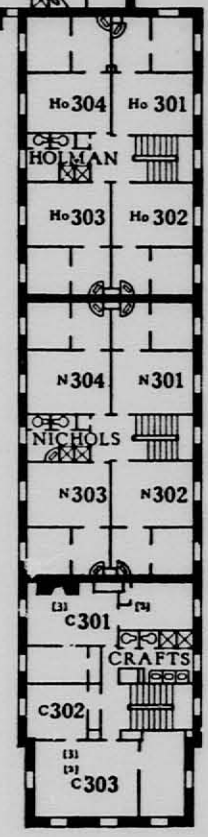
Sixth Floor

R	601 — $155	R	604 — $200
	602 — 150		604A — 200
	603 — 145		605 — 200



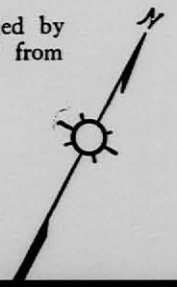
Fourth Floor

Ho	301 —$390 (2)	
	302 — 390 (2)	
	303 — 430 (2)	
	304 — 430 (2)	
N	301 — 390 (2)	
	302 — 390 (2)	
	303 — 430 (2)	
	304 — 430 (2)	
C	301 — 530 (2)	
	645 (3)	
	302 — 245	
	303 — 530 (2)	
	645 (3)	
Ho	401 — 390 (2)	
	402 — 390 (2)	
	403 — 430 (2)	
	404 — 430 (2)	
N	401 — 390 (2)	
	402 — 390 (2)	
	403 — 430 (2)	
	404 — 430 (2)	
C	401 — 630 (2)	
	735 (3)	
	402 — 255	



Third Floor

Double suites — if occupied by one man — deduct $100 from listed prices.



UNDERGRADUATE HOUSES

MUNROE, HAYDEN AND WOOD HALLS (Alumni Group)

Reserved for Undergraduates

MUNROE

201 — $220
202 — 220
203 — 220
204 — 230
205 — 220
206 — 540 (2), 705 (3)
207 — 230
208 — 225
209 — 225
210 — 225
211 — $225
212 — 225
213 — 225

5 0 5 10 15 20 25 30 40 50
Scale of feet

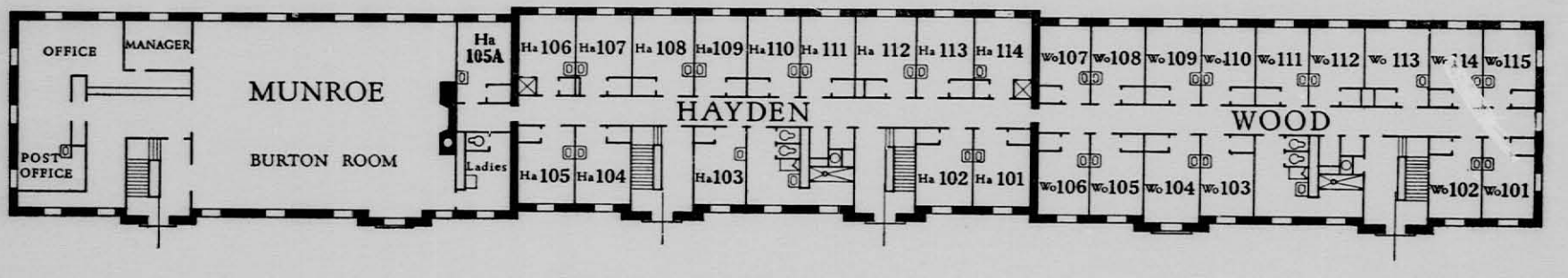
HAYDEN

101 — $210
102 — 210
103 — 210
104 — 210
105 — 210
105A — 220
106 — 220
107 — 220
108 — 220
109 — 215
110 — 215
111 — 215
112 — 220
113 — 220
114 — 220
201 — $220
202 — 220
203 — 220
204 — 220
205 — 220
206 — 230
207 — 230
208 — 230
209 — 225
210 — 225
211 — 225
212 — 230
213 — 230
214 — 230

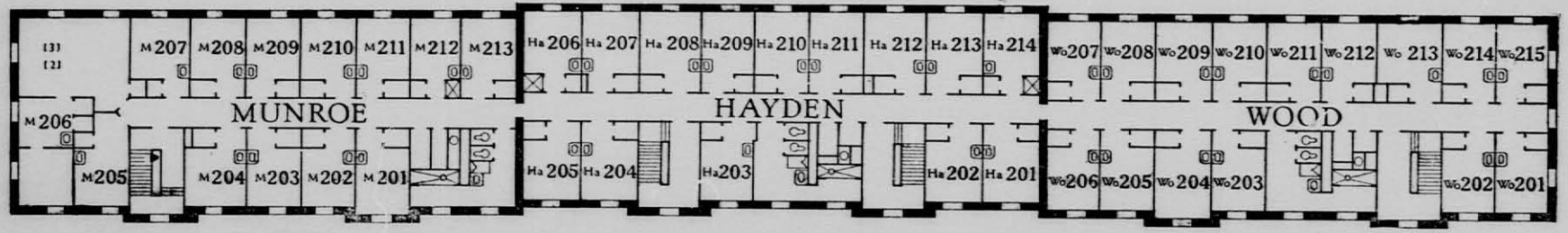
WOOD

101 — $220
102 — 205
103 — 205
104 — 210
105 — 205
106 — 205
107 — 215
108 — 215
109 — 215
110 — 215
111 — 215
112 — 215
113 — 220
114 — 215
115 — 230
201 — $230
202 — 215
203 — 215
204 — 215
205 — 215
206 — 215
207 — 225
208 — 225
209 — 225
210 — 225
211 — 225
212 — 225
213 — 230
214 — 225
215 — 240

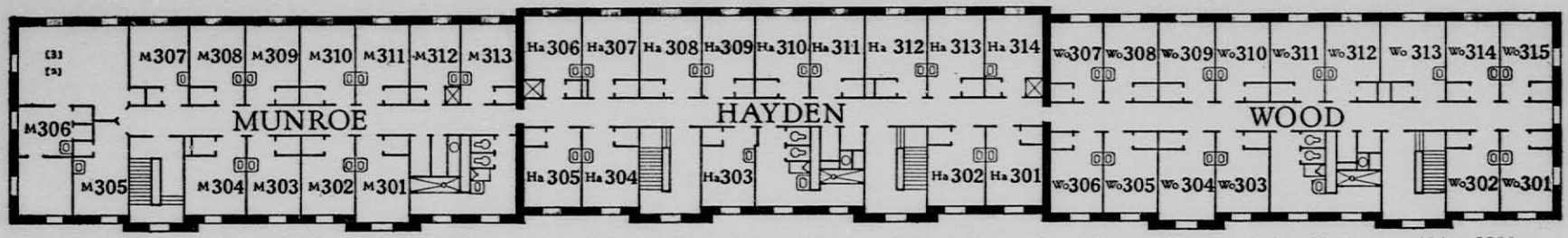
First Floor



Second Floor



Third Floor

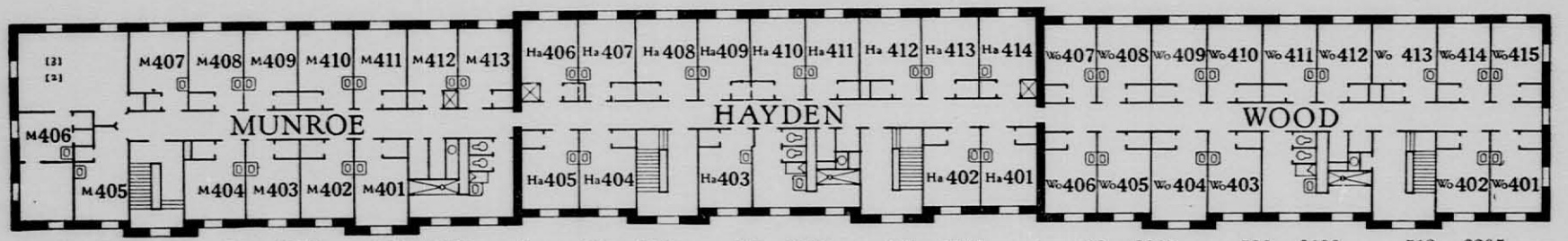


301 —$215	308 —$215	402 —$205
302 — 210	309 — 215	403 — 205
303 — 210	310 — 215	404 — 215
304 — 220	311 — 215	405 — 205
305 — 210	312 — 215	406 — 500 (2)
		660 (3)
306 — 520 (2)	313 — 215	407 — 215
690 (3)		
307 — 220	401 — 205	408 — 210

301 —$210	309 —$215	403 —$205
302 — 210	310 — 215	404 — 205
303 — 210	311 — 215	405 — 205
304 — 210	312 — 220	406 — 215
305 — 210	313 — 220	407 — 215
306 — 220	314 — 220	408 — 215
307 — 220	401 — 205	409 — 210
308 — 220	402 — 205	410 — 210

301 —$220	310 —$215	404 —$200
302 — 205	311 — 215	405 — 200
303 — 205	312 — 215	406 — 200
304 — 210	313 — 220	407 — 210
305 — 205	314 — 215	408 — 210
306 — 205	315 — 230	409 — 210
307 — 215	401 — 215	410 — 210
308 — 215	402 — 200	411 — 210
309 — 215	403 — 200	412 — 210

Fourth Floor

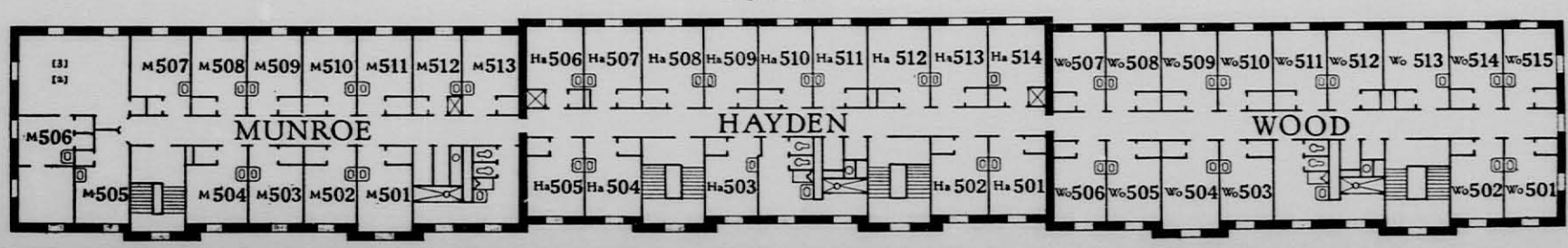


409 —$210	504 —$205	509 —$200
410 — 210	505 — 195	510 — 200
411 — 210	506 — 480 (2)	511 — 200
412 — 210	630 (3)	512 — 200
413 — 210	507 — 205	513 — 200
501 — 195	508 — 200	
502 — 195		
503 — 195		

411 —$210	505 —$195	512 —$205
412 — 215	506 — 205	513 — 205
413 — 215	507 — 205	514 — 205
414 — 215	508 — 205	
501 — 195	509 — 200	
502 — 195	510 — 200	
503 — 195	511 — 200	
504 — 195		

413 —$215	506 —$190	513 —$205
414 — 210	507 — 200	514 — 200
415 — 225	508 — 200	515 — 215
501 — 205	509 — 200	
502 — 190	510 — 200	
503 — 190	511 — 200	
504 — 190	512 — 200	
505 — 190		

Fifth Floor



UNDERGRADUATE HOUSES

GOODALE, BEMIS AND WALCOTT HALLS (Alumni Group)

Reserved for Undergraduates

GOODALE

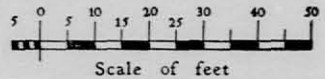
101 —$215	201 —$225
102 — 205	202 — 215
103 — 205	203 — 215
104 — 215	204 — 225
105 — 205	205 — 215
106 — 205	206 — 215
107 — 215	207 — 225
108 — 225	208 — 235
109 — 215	209 — 225
110 — 215	210 — 225
111 — 225	211 — 235
112 — 215	212 — 225
113 — 215	213 — 225
114 — 225	214 — 235

BEMIS

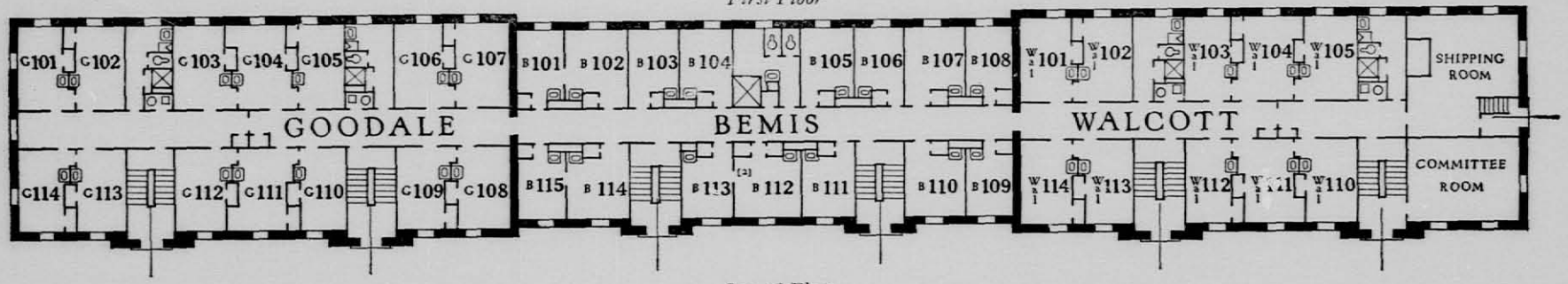
101 —$175	201 —$185
102 — 200	202 — 215
103 — 175	203 — 185
104 — 175	204 — 185
105 — 175	205 — 185
106 — 175	206 — 185
107 — 200	207 — 215
108 — 175	208 — 185
109 — 185	209 — 195
110 — 210	210 — 225
111 — 185	211 — 195
112 — 270 (2)	212 — 280 (2)
113 — 185	213 — 195
114 — 219	214 — 225
115 — 185	215 — 195

WALCOTT

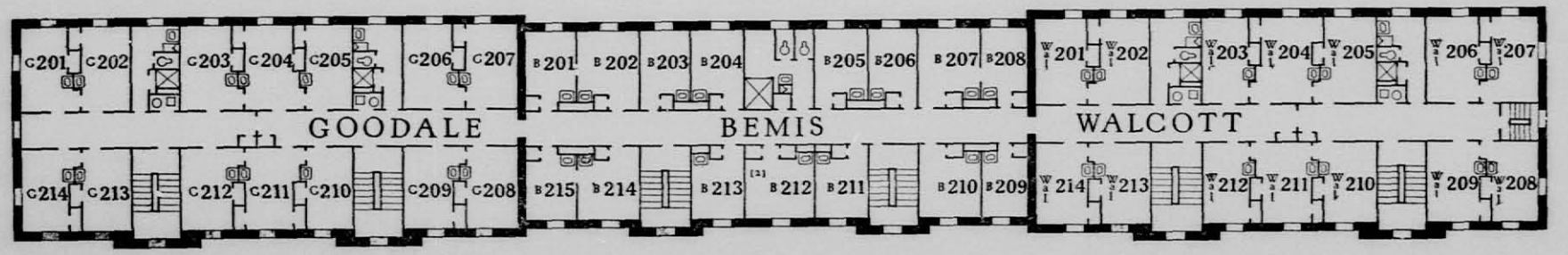
101 —$215	201 —$225
102 — 205	202 — 215
103 — 205	203 — 215
104 — 215	204 — 225
105 — 205	205 — 215
110 — 215	206 — 215
111 — 225	207 — 235
112 — 215	208 — 235
113 — 215	209 — 225
114 — 225	210 — 225
	211 — 235
	212 — 225
	213 — 225
	214 — 235



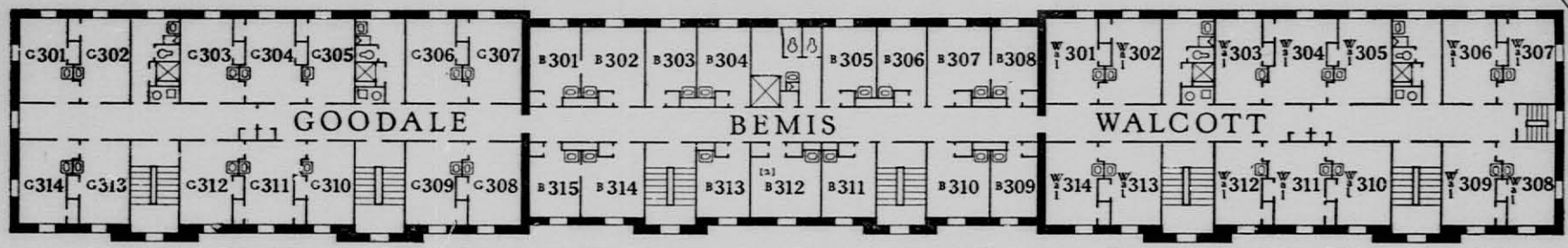
First Floor



Second Floor



Third Floor

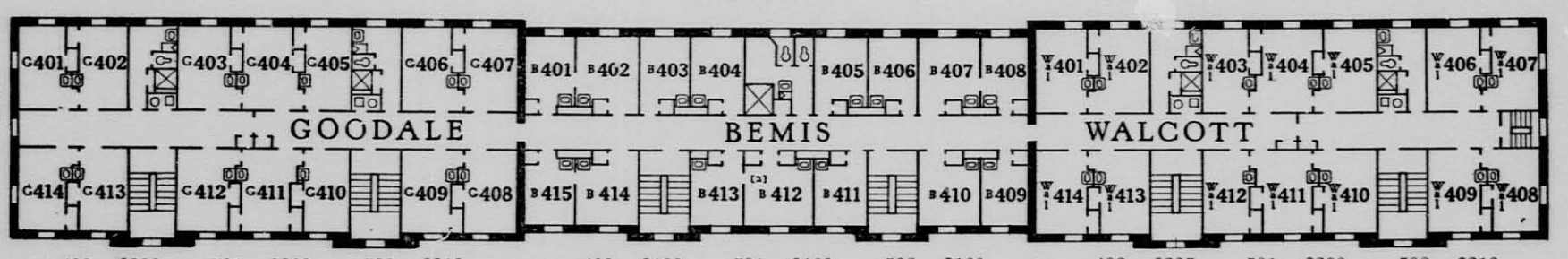


GOODALE		
301 —$215	308 —$225	401 —$210
302 — 205	309 — 215	402 — 200
303 — 205	310 — 215	403 — 200
304 — 215	311 — 225	404 — 210
305 — 205	312 — 215	405 — 200
306 — 205	313 — 215	406 — 200
307 — 215	314 — 225	407 — 210

BEMIS		
301 —$175	309 —$185	401 —$170
302 — 200	310 — 210	402 — 195
303 — 175	311 — 185	403 — 170
304 — 175	312 — 270 (2)	404 — 170
305 — 175	313 — 185	405 — 170
306 — 175	314 — 210	406 — 170
307 — 200	315 — 185	407 — 195
308 — 175		408 — 170

WALCOTT		
301 —$215	308 —$230	401 —$210
302 — 205	309 — 215	402 — 200
303 — 205	310 — 215	403 — 200
304 — 215	311 — 225	404 — 210
305 — 205	312 — 215	405 — 200
306 — 205	313 — 215	406 — 200
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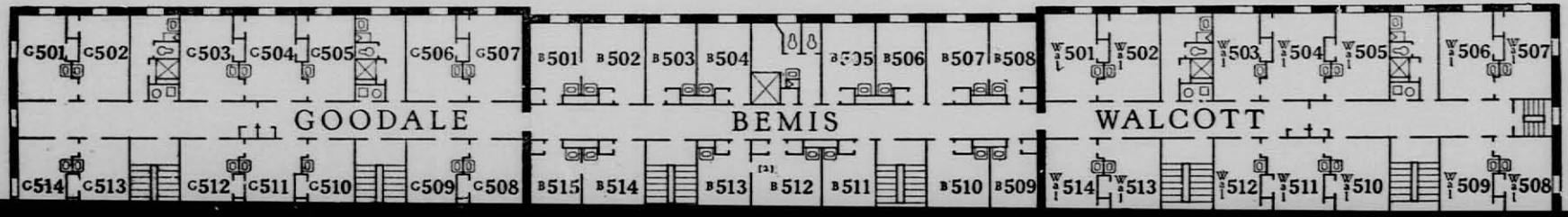


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