M.I.T. ANNUAL CATALOGUES AND BULLETINS
1936/37

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MASSACHUSETTS INSTITUTE

of

TECHNOLOGY

CATALOGUE

for the Academic Year 1936-1937

VOLUME 71 NUMBER 4

A BULLETIN OF GENERAL INFORMATION ABOUT THE INSTITUTE, ITS GOVERNMENT, STAFF, REGULATIONS, REQUIREMENTS FOR ADMISSION, FACILITIES, AND COURSES OF INSTRUCTION, BOTH UNDERGRADUATE AND GRADUATE

PUBLISHED BY THE INSTITUTE · CAMBRIDGE

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CALENDAR

FOR ACADEMIC YEAR 1936–1937

1936

Entrance Examinations at Technology Begin		Sept. 16
Institute Year Begins		Sept. 28
Columbus Day (*Holiday*)		Oct. 12
Armistice Day (*Holiday*)		Nov. 11
Thanksgiving Day (*Holiday*)		Nov. 26
Christmas Vacation	Dec. 23 through	Jan. 3

1937

Last Exercises, First Term		Jan. 23
Examination Period	Jan. 25 through	Feb. 6
Second Term Begins		Feb. 8
Washington's Birthday (*Holiday*)		Feb. 22
Spring Recess	Apr. 17 through	Apr. 21
Last Exercises, Second Term		May 26
Second Term Examinations Begin		May 27
Memorial Day (*Exercises omitted Monday, May 31*)		May 30
Commencement Day		June 8
Summer Session 1937 Begins (*Except for a few subjects which begin on June 7*)		June 15

FOR ACADEMIC YEAR 1937–1938

1937

Extrance Examinations at Technology Begin		Sept. 15
Institute Year Begins		Sept. 27
Columbus Day (*Holiday*)		Oct. 12
Armistice Day (*Holiday*)		Nov. 11
Thanksgiving Day (*Holiday*)		Nov. 25
Christmas Vacation	Dec. 23 through	Jan. 2

1938

Last Exercises, First Term		Jan. 22
Examination Period	Jan. 24 through	Feb. 5
Second Term Begins		Feb. 7
Washington's Birthday (*Holiday*)		Feb. 22
Spring Recess	Apr. 16 through	Apr. 20
Last Exercises, Second Term		May 25
Second Term Examinations Begin		May 26
Memorial Day (*Holiday*)		May 30
Commencement Day		June 7
Summer Session 1938 Begins (*Except for a few subjects which begin on June 6*)		June 14

In the adjacent column italicized dates indicate holidays when the exercises of the Institute are suspended.

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TABLE OF CONTENTS

REF
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Calendar 2
Table of Contents 3
Objectives and Policies of the Institute 5
Members of Corporation 7
Officers of Administration 8
Officers of Instruction 10
Members of Institute Staff 11
General Information 23
Location 23
Government and Administration 23
Degrees Granted 24
Coöperative Arrangements with Liberal Arts Colleges 24
General Regulations 24
Fees, Deposits, Payments, Expenses 26
Loans, Scholarships, Fellowships, Prizes 27
Placement 27
Educational Buildings 27
Student Housing 30
Recreational Facilities 30
Undergraduate Activities 30

UNDERGRADUATE COURSES

Requirements for Admission
Subjects Required for Admission 32
Methods of Admission 32
Examinations 33
Other Information 34
Admission with Advanced Standing 34
Undergraduate Courses of Study 36
Professional Summer Schools 37
Reserve Officers' Training Corps 37
Requirements for the Bachelor's Degree 37
Subject Numbering System 38
Undergraduate Course Schedules
First Year 38
Civil Engineering (I) 39
Mechanical Engineering (II) 40
Mechanical Engineering, Coöperative (II-A) 41
Mining Engineering (III_1) 43
Petroleum Production (III_2) 44
Metallurgy (III_3) 44
Physical Metallurgy (III_4) 45
Architecture (IV) 46
Architectural Engineering (IV-A) 47
City Planning (IV-B) 48
Chemistry (V) 48
Electrical Engineering (VI) 49
Illuminating Engineering (VI-B) 50
Electrical Communications (VI-C) 52
Electrical Engineering, Coöperative (VI-A) 52
Biology and Public Health (VII_1) 57
Industrial Biology (VII_2) 58
Public Health Engineering (VII_3) 59
General Physics ($VIII_1$) 59
Applied Physics ($VIII_2$) 61
General Science (IX-A) 62
General Engineering (IX-B) 62
Chemical Engineering (X) 63
Chemical Engineering Practice (X-B) 63
Sanitary Engineering (XI) 64
Geology (XII) 65
Naval Architecture and Marine Engineering (XIII) 68
Marine Transportation (XIII-C) 69
Electrochemical Engineering (XIV) 70
Business and Engineering Administration (XV) 71

415982

Aeronautical Engineering (XVI) . . . 74
Building Engineering and Construction (XVII) . . . 75
Mathematics (XVIII) . . . 76
Course Schedules for Reserve Officers' Training Corps . . . 77
The Lowell Institute
Lowell Institute Lectures . . . 80
The Lowell Institute School . . . 80
Instructing Staff . . . 80

THE GRADUATE SCHOOL

Administration of the Graduate School . . . 82
Committee on the Graduate School . . . 82
Chairmen of Department and Course Committees . . . 82
History and Organization . . . 83
Requirements for Admission . . . 83
Coöperation with Harvard University . . . 84
The Master's Degree . . . 84
Requirements . . . 84
Prescribed Curricula . . . 86
Program of Studies for Teaching Fellows and Assistants . . . 86
Degrees of Doctor of Philosophy, of Science or of Public Health . . . 86
Requirements . . . 87
Graduate Programs Offered
Civil and Sanitary Engineering . . . 89
Mechanical Engineering . . . 91
Mining Engineering . . . 94
Petroleum Engineering . . . 94
Metallurgy . . . 95
Physical Metallurgy . . . 95
Electrochemical Engineering . . . 96
Ceramics . . . 96
Architecture . . . 96
City Planning . . . 97
Architectural Engineering . . . 98
Chemistry . . . 98
Electrical Engineering . . . 102
Biology and Public Health . . . 105
Physics . . . 108
Chemical Engineering . . . 110
Geology . . . 112
Naval Construction . . . 113
Business and Engineering Administration . . . 114
Aeronautical Engineering . . . 115
Meteorology . . . 115
Economics and Social Science . . . 116
Mathematics . . . 118
Descriptions of Subjects . . . 119
Tabulation of Subjects . . . 178

APPENDICES

Student Aid and Prizes
Technology Loan Fund . . . 205
Freshman Scholarships . . . 205
Undergraduate Scholarship Aid for Upper Classmen . . . 207
Graduate Fellowships and Scholarships . . . 209
Teaching Fellows and Assistants . . . 209
Traveling Fellowships . . . 209
Honorary Fellows . . . 210
Funds Applicable to Fellowships and Graduate Scholarships . . . 210
Special Fellowships and Graduate Scholarships . . . 210
Prizes . . . 211
Student Housing
The Graduate House . . . 212
The Undergraduate Houses . . . 212
Alphabetical List of Subjects of Instruction . . . 221
Index . . . 222

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 . . . 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 method 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 2600, including 500 graduate students, a staff of over 500, a plant and endowment representing an investment of nearly $50,000,000, and a living alumni body of 31,000 in 82 countries. 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

*At the present time all the states of the union as well as 37 foreign countries are represented in the student body.

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 — much more than in most schools of engineering. 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.

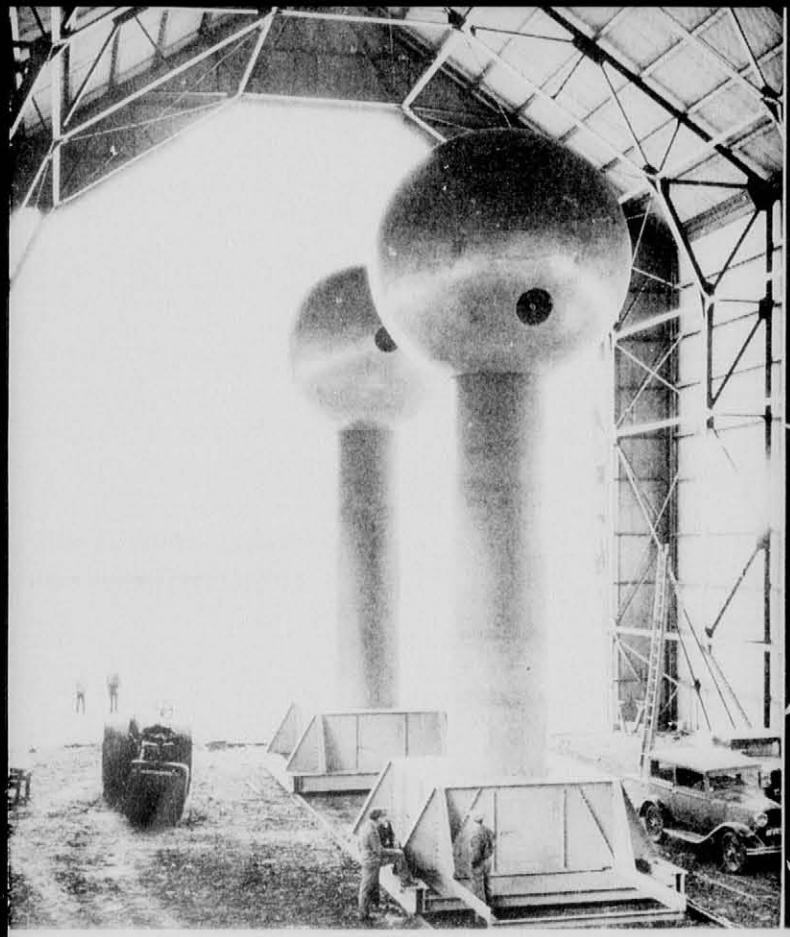
The number of Courses and options has been increased, until there are over forty regular Courses of Study, arranged to meet the needs of students of diverse interests. Moreover, the authority to make substitutions, which resides in the department heads and the petitions committee, renders it possible 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 at will for those who are pursuing unusual objectives.

Recently the Faculty adopted a report looking toward the reduction of the number of simultaneous subjects or branches of study, and a decrease in class hours in the upper years; and curricula are now being revised to meet the new requirements. The time thus freed for the students will make it possible for them to participate more extensively in various non-scheduled academic activities, to become better acquainted with the Institute's comprehensive research programs, and to take part in other affairs helpful in rendering them more broadly educated. There has been an increase in the use of honors groups, seminar methods of instruction, colloquia, and individual conferences.

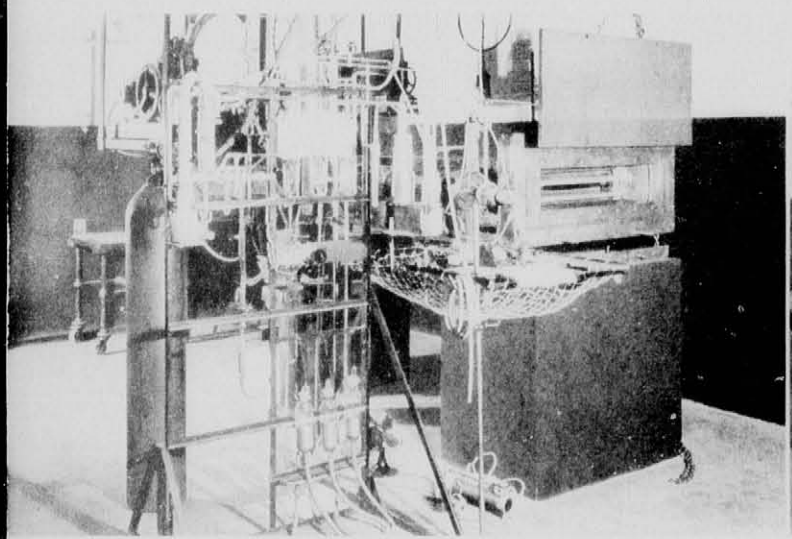
All this makes the Institute a place where a man may study, in the true atmosphere of a professional school, those aspects of science, architecture, or engineering which most appeal to him; with increased opportunity to map out his own path with the aid and counsel of the Staff.

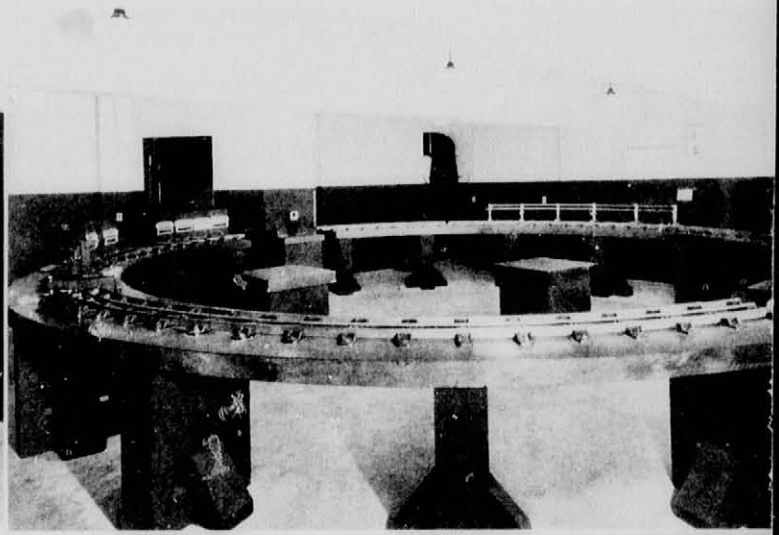
The Institute from the Boston side of the Charles River Basin. From left to right: *The main group of educational buildings; Walker Memorial and the Sailing Pavilion; the President's House, flanked by the Graduate House*

Main Hall of Walker Memorial (the student union). This great room serves not only as a dining hall, but as a place for student, staff, and alumni convocations, and for Technology social affairs. During a single academic year student gatherings totalling over 1,000 have used Walker Memorial



The Van de Graaff electrostatic generator, designed for atomic research, which generates the highest steady direct voltage ever produced by man





THE CORPORATION 1936–1937

President
KARL TAYLOR COMPTON

Vice-President
VANNEVAR BUSH

Secretary [1]
WALTER HUMPHREYS

Treasurer
HORACE SAYFORD FORD

Executive Committee (1935–1936)

PRESIDENT, TREASURER } EX OFFICIIS

GERARD SWOPE
FRANCIS RUSSELL HART
ELIHU THOMSON
REDFIELD PROCTOR
EDWIN SIBLEY WEBSTER

LIFE MEMBERS

ABBOTT LAWRENCE LOWELL
ELIHU THOMSON
CHARLES AUGUSTUS STONE
FRANCIS RUSSELL HART
WILLIAM CAMERON FORBES
EDWIN SIBLEY WEBSTER
PIERRE SAMUEL DUPONT
FRANK ARTHUR VANDERLIP
CHARLES HAYDEN
CHARLES THOMAS MAIN
HARRY JOHAN CARLSON
GERARD SWOPE
FRANKLIN WARREN HOBBS
WILLIAM HOWARD BOVEY
WILLIAM ROBERT KALES
JOSEPH WRIGHT POWELL
FRANCIS WRIGHT FABYAN
JOHN EDWARD ALDRED
FRANK WILLIAM LOVEJOY
WALTER HUMPHREYS
VICTOR MACOMBER CUTTER
ALBERT HENRY WIGGIN
JOHN RUSSELL MACOMBER
ALFRED LEE LOOMIS
JOHN JEREMIAH PELLEY
HARLOW SHAPLEY
ALFRED PRITCHARD SLOAN, JR.
CHARLES NEAVE
FRANKLIN ATWOOD PARK
LAMMOT DU PONT
FRANK BALDWIN JEWETT
REDFIELD PROCTOR
GODFREY LOWELL CABOT
WILLIAM CHAPMAN POTTER
PHILIP STOCKTON

TERM MEMBERS

Term expires June, 1937
BRADLEY DEWEY
MARTIN HERBERT EISENHART
DONALD GOODRICH ROBBINS

Term expires June, 1938
LOUIS SHATTUCK CATES
HOVEY THOMAS FREEMAN
HAROLD BOURS RICHMOND

Term expires June, 1939
JAMES MADISON BARKER
WILLIS FLEMING HARRINGTON
WILLIAM RUSSELL HEDGE

Term expires June, 1940
ARTHUR CALBRAITH DORRANCE
CHARLES EDWARD SMITH
RUFUS EICHER ZIMMERMAN

Term expires June, 1941
FREDERICK WILLIAM GARBER
BERNICE EDWIN HUTCHINSON
WILLIAM STARK NEWELL

REPRESENTATIVES OF THE COMMONWEALTH

HIS EXCELLENCY, JAMES MICHAEL CURLEY, *Governor*
HON. ARTHUR PRENTICE RUGG, *Chief Justice of the Supreme Court*
JAMES GERARD REARDON, *Commissioner of Education*

[1] Address correspondence to Massachusetts Institute of Technology.

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KARL TAYLOR COMPTON, D.Sc., D.ENG., PH.D., LL.D.

Vice-President
VANNEVAR BUSH, ENG.D., Sc.D.

Treasurer
HORACE SAYFORD FORD

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WILLIAM EMERSON, A.B.
Dean of Architecture

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Dean of Science

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

HAROLD EDWARD LOBDELL
Dean of Students

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Assistant Dean of Students

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Director, Division of Industrial Coöperation

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Placement Officer

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Librarian

BERTHA PRESTON TRULL, A.B.
Assistant Librarian

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Director of the Lowell Institute School

GEORGE W. MORSE, M.D., F.A.C.S.
Medical Director

LOUIS WARD CROKE, M.D.
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Honorary Lecturer on Vocational Education

JOHN JAMES ROWLANDS
Director of News Service

WALLACE MASON ROSS, B.S.
General Secretary, T. C. A.

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

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Bursar

WOLCOTT ANDERS HOKANSON
Assistant Bursar

ARTHUR CLARKE MELCHER, S.B.
Manager of Division of Laboratory Supplies

ALBERT VALENTINE SMITH
Superintendent of Buildings and Power

JAMES WILLIAM FRASER MACDONALD
Assistant Superintendent of Buildings and Power

LEICESTER FORSYTH HAMILTON, S.B.
Chairman of Dormitory Board

FREDERICK GILBERT HARTWELL
Manager of Dormitories and Walker Memorial

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

ALBERT WILLIAM BRIDGES
Manager of Dining Service

ADMINISTRATIVE COUNCIL

President
Vice-President
Treasurer
Dean of Engineering
Dean of Architecture
Dean of Science
Dean of the Graduate School
Dean of Students
Director of the Division of Industrial Coöperation
Chairman of Faculty
Bursar
President of the Alumni Association

† Address all correspondence regarding admission to either undergraduate or graduate study to Professor Thresher.

HEADS OF DEPARTMENTS AND PROFESSIONAL COURSES

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JEROME CLARKE HUNSAKER, Sc.D.

Architectural Engineering
WILLIAM HENRY LAWRENCE, S.B.

Architecture
WILLIAM EMERSON, A.B.

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

Building Engineering and Construction
ROSS FRANCIS TUCKER, S.B.

Business and Engineering Administration
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Chemical Engineering
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Chemistry
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THEODORE SMITH, A.M.
Assistant Professor of English
ROBERT SMITH WOODBURY, S.B.
Assistant Professor of the History of Science

Instructors

PAUL CONANT EATON, S.B., A.M.
ARTHUR CHACE WATSON, A.B.
WALTER FRANCIS URBACH, A.M.

GEOLOGY

Professors

WARREN JUDSON MEAD, PH.D.
Professor of Geology; in charge of the Department
HERVEY WOODBURN SHIMER, PH.D., SC.D.
Professor of Paleontology
FREDERICK KUHNE MORRIS, B.S., M.A.
Professor of Geology
LOUIS BYRNE SLICHTER, PH.D.
Professor of Geophysics
WALTER HARRY NEWHOUSE, PH.D.
Associate Professor of Economic Geology
MARTIN JULIAN BUERGER, PH.D.
Associate Professor of Mineralogy and Petrography

Lecturer

WALTER LUCIUS WHITEHEAD, PH.D. *Coal and Petroleum*

Research Associates

MORTIMER CHARLES BLOOM, B.S.
CHAIM LEIB PEKERIS, SC.D.

Teaching Fellows

NEWTON WEBER BUERGER, S.M.
ELY MENCHER, B.S.
WILLIAM PARRISH, S.B.
OLAF NORBERG ROVE, M.S.

HYGIENE

GEORGE W. MORSE, M.D., F.A.C.S.
Professor; Medical Director; in charge of the Department
HAROLD EDWARD LOBDELL
Dean of Students
LOUIS WARD CROKE, M.D.
Assistant Medical Director
BENJAMIN ERNEST SIBLEY, M.D.
Assistant to Medical Director
HARLAND FRANCIS LANCASTER, M.D.
Assistant to Medical Director
ROGER THOMAS DOYLE, M.D.
Assistant to Medical Director
HENRY PATRICK MCCARTHY
Director of Physical Training
JOHN WEBSTER WILLIAMS, M.D. *Pathologist*
SANFRID KNUT JOHNSON *Trainer*
OSCAR FREDERICK HEDLUND *Track Coach*
WILLIAM B. HAINES *Crew Coach*
JOHN LIONEL SUMMERS *Squash Coach*
ROBERT BOWIE *Field Coach*

MATHEMATICS

Professors

HENRY BAYARD PHILLIPS, PH.D.
Professor of Mathematics; in charge of the Department
FRANK LAUREN HITCHCOCK, PH.D.
Professor of Mathematics
NORBERT WIENER, PH.D.
Professor of Mathematics
GEORGE RUTLEDGE, PH.D.
Professor of Mathematics
PHILIP FRANKLIN, PH.D.
Associate Professor of Mathematics
DIRK JAN STRUIK, PH.D.
Associate Professor of Mathematics
JESSE DOUGLAS, PH.D.
Associate Professor of Mathematics
RAYMOND DONALD DOUGLASS, PH.D.
Associate Professor of Mathematics
SAMUEL DEMITRY ZELDIN, PH.D.
Assistant Professor of Mathematics
EBERHARD HOPF, PH.D.
Assistant Professor of Mathematics
PRESCOTT DURAND CROUT, PH.D.
Assistant Professor of Mathematics

Instructors

GEORGE PROCTOR WADSWORTH, PH.D.
ROBERT HORTON CAMERON, PH.D.
WILLIAM CLARE TAYLOR, M.A.
WILLIAM TED MARTIN, PH.D.

MECHANICAL ENGINEERING

Professors

JEROME CLARKE HUNSAKER, SC.D.
Professor in charge of the Department; in charge of the Course in Aeronautical Engineering
CHARLES EDWARD FULLER, S.B.
Professor of Theoretical and Applied Mechanics; Dean of Army Students; Chairman of the Faculty
JOSEPH CAINS RILEY, S.B.
Professor of Heat Engineering
CHARLES WILLIAM BERRY, S.B.
Professor of Heat Engineering
GEORGE WRIGHT SWETT, S.B.
Professor of Machine Design; Secretary of the Faculty
CHARLES FAYETTE TAYLOR, PH.B., M.E.
Professor of Automotive Engineering
GORDON BALL WILKES, S.B.
Professor of Heat Engineering
EARLE BUCKINGHAM
Professor of Mechanical Engineering
THEODORE HOWARD TAFT, S.B.
Associate Professor of Heat Engineering
LAWRENCE SOUTHWICK SMITH, S.B.
Associate Professor of Applied Mechanics
WALTER HERMAN JAMES, S.B.
Associate Professor of Mechanical Engineering
ADDISON FRANCIS HOLMES, S.B.
Associate Professor of Applied Mechanics
JESSE JENNINGS EAMES, S.B.
Associate Professor of Mechanical Engineering
DEAN ABNER FALES, S.B.
Associate Professor of Automotive Engineering
IRVING HENRY COWDREY, S.B.
Associate Professor of Testing Materials
WILLIAM HENRY JONES, S.B.
Associate Professor of Heat Engineering
ALFRED VICTOR DE FOREST, S.B.
Associate Professor of Mechanical Engineering
JOSEPH HENRY KEENAN, S.B.
Associate Professor of Mechanical Engineering
EDWARD ROBINSON SCHWARZ, S.B.
Associate Professor of Textile Engineering
JAMES HOLT, S.B.
Associate Professor of Mechanical Engineering
JOHN MOYES LESSELLS, B.SC.
Associate Professor of Mechanical Engineering
ARTHUR LAWRENCE TOWNSEND, S.B.
Assistant Professor of Mechanical Engineering
CARL LOUIS SVENSON, S.M.
Assistant Professor of Mechanical Engineering
ALVIN SLOANE, B.S.
Assistant Professor of Mechanical Engineering

Instructors

Jeremiah Francis O'Neill (*Absent*)
Arthur Brown English
Robert Butterfield Cheney
Birthram Sheppard
Herbert Carlton Moore, S.M.
Andrew Wyles Lawson
Charles Arthur Bulfinch
Carl Magnus Frithiof Peterson, S.M.
Walter Walery Soroka, S.M.
Horace Elmer Hall, S.M.
Henry Francis King, Sc.D.
Charles Winters MacGregor, Ph.D.
Robert Weston Vose, S.M.
Herman Gustav Protze, Jr., S.M.
William MacGregor Murray, S.M.
Peter Edward Kyle, M.E.
Hemenway Regnold Bullock
John Anthony Hrones, S.B.

Research Assistants

Harold Bellinson, S.B.
Robert Hector Boden, S.M.
David Alfred Mooney, S.B.
Mitchell Andrew Sieminski

Assistants

John Goffe Benson, S.B.
Ralph John Bowley
Clarence William Christiansen
Henry Edward Kiley, S.B.
Leo Judson Kramer, S.B.
Leopold Robert Michel, M.E., M.S.
Blake Mills, S.M.
George Parmakian, S.B.
Roger Larry Putney, S.B.
Brandon Garner Rightmire, B.M.E., M.A.
Joseph Rodney Stoddard, S.B.
Kenneth Warren Swain, S.B.
Robert Downs Williams, A.B.

MILITARY SCIENCE AND TACTICS

Professors

Samuel Curtis Vestal, Grad. U.S.N.A. Colonel, Coast Artillery Corps
Professor of Military Science and Tactics; in charge of the Department

James Cornelius Ruddell, Grad. U.S.M.A., S.M., Major, Coast Artillery Corps
Associate Professor of Military Science and Tactics; in charge of Coast Artillery unit; Executive Officer

Harold A. Nisley, Grad. U.S.M.A., M.S., Major Ordnance Department
Associate Professor of Military Science and Tactics; in charge of Ordnance Unit

Thomas Joseph Johnston, Major, Chemical Warfare Service
Associate Professor of Military Science and Tactics; in charge of Chemical Warfare Unit

Archibald Donald Fisken, A.B. Major, Coast Artillery Corps
Associate Professor of Military Science and Tactics; with Coast Artillery Unit

James Francis Clark Hyde, B.S., Major, Corps of Engineers
Associate Professor of Military Science and Tactics; in charge of Engineer Unit

Kirke Brooks Lawton, B.S., Major, Signal Corps
Associate Professor of Military Science and Tactics; in charge of Signal Corps Unit

William Crawford Denniston Bridges, B.S., 1st Lieutenant, Corps of Engineers
Assistant Professor of Military Science and Tactics; with Engineer Unit

Instructors

Alfred Floyd Truax, Technical Sergeant, D.E.M.L., Signal Corps

Mark Braden Ashley, Staff Sergeant, D.E.M.L., Coast Artillery Corps

Harold Francis McDonnell, LL.B. Staff Sergeant, D.E.M.L., Corps of Engineers

Alexander Holmes, Staff Sergeant, D.E.M.L., Coast Artillery Corps
Armorer

John Burke Fitzgerald, Staff Sergeant, D.E.M.L., Coast Artillery Corps
Armorer

Samuel Leroy Frey, Sergeant, D.E.M.L., Chemical Warfare Service

Eric Hilmer Frithiof Svensson, Warrant Officer, U.S.A., Ret.
In charge of Band

MINING AND METALLURGY

(Including Electrochemical Engineering and Ceramics)

Professors

William Spencer Hutchinson, S.B.
Professor of Mining; in charge of the Department

George Booker Waterhouse, Ph.D.
Professor of Metallurgy

Robert Seaton Williams, Ph.D.
Professor of Physical Metallurgy

Charles E. Locke, S.B.
Professor of Mining Engineering and Ore Dressing

MAURICE DEKAY THOMPSON, PH.D.
Professor of Electrochemistry

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

EDWARD EVERETT BUGBEE, S.B.
Associate Professor of Mining Engineering and Metallurgy

HORACE THARP MANN, SC.D.
Associate Professor of Petroleum Engineering

VICTOR OLIVER HOMERBERG, SC.D.
Associate Professor of Physical Metallurgy

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

FRANCIS BITTER, PH.D.
Associate Professor of the Physics of Metals

FREDERICK HARWOOD NORTON, S.B.
Associate Professor of Ceramics

IGOR NICHOLAS ZAVARINE, SC.D.
Assistant Professor of Physical Metallurgy

FRANKLIN LEROY FOSTER, S.M.
Assistant Professor of Mining

John Wulff

Lecturer

JAMES BIRKETT WATERFIELD, B.S.

Instructors

RUFUS COOK REED, S.M.
MORRIS COHEN, SC.D.

Teaching Fellows

GURDON MONTAGUE BUTLER, M.S.
REINHARDT SCHUHMAN, JR., S.B.
HARRY WHITTAKER, B.S.

Assistants

ARDREY MIDDLETON BOUNDS, M.S.
JAMES MERRITT CAYFORD, M.S.
ELDON NORTH DUNLAP, S.M.
JOHN LAWRENCE GOHEEN, JR., S.B.
ROBERT BRUCE GORDON, B.S.
ALBERT RUDOLPH KAUFMAN, B.S.

MODERN LANGUAGES

Professors

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

HERMAN RUDOLPH KURRELMEYER, PH.D.
Professor of German

Instructors

FRANCIS MORTON CURRIER, A.M.

RICHARD FELIX KOCH, A.M.

NAVAL ARCHITECTURE AND MARINE ENGINEERING

Professors

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

GEORGE OWEN, S.B.
Professor of Naval Architecture

LAWRENCE BOYLSTON CHAPMAN, S.B.
Professor of Marine Transportation and Marine Engineering

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

FRANK MEMBELL LEWIS
Professor of Marine Engineering

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

Lecturer

GEORGE CHARLES MANNING, GRAD. U.S.N.A., S.M.
Lieutenant Commander (C.C.) U.S.N. *Naval Architecture*

Honorary Curator of the Nautical Museum

JAMES ROBERTSON JACK

PHYSICS

Professors

JOHN CLARKE SLATER, PH.D.
Professor of Physics; in charge of the Department (Absent 2d Term)

HARRY MANLEY GOODWIN, PH.D.
Professor of Physics and Electrochemistry; Dean of the Graduate School

CHARLES LADD NORTON, S.B.
Professor of Industrial Physics; Director of Division of Industrial Coöperation

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, M.A.
Professor of Optics and Photography

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

ROBERT JEMISON VAN DE GRAAFF, PH.D.
Associate Professor of Physics

PHILIP MCCORD MORSE, PH.D.
Associate Professor of Physics

BERTRAM EUGENE WARREN, SC.D.
Associate Professor of Physics

DONALD CHARLES STOCKBARGER, SC.D.
Associate Professor of Physics

HANS MUELLER, D.SC.
Associate Professor of Physics

JULIUS ADAMS STRATTON, D.SC.
Associate Professor of Physics

FRANCIS WESTON SEARS, S.M.
Assistant Professor of Physics

NATHANIEL HERMAN FRANK, SC.D.
Assistant Professor of Physics (Absent 1st Term)

WAYNE BUCKLES NOTTINGHAM, PH.D.
Assistant Professor of Physics

~~ERIK GUSTAF RUDBERG, PH.D.~~
Assistant Professor of Physics

WILLIAM PHELPS ALLIS, SC.D.
Assistant Professor of Physics

JOSEPH CANON BOYCE, PH.D.
Assistant Professor of Physics

ROBLEY DUNGLISON EVANS, PH.D.
Assistant Professor of Physics

JOHN CARL GAUDE WULFF, D.SC.
Assistant Professor of Physics

EDWARD STONESTREET LAMAR, PH.D.
Assistant Professor of Physics

Instructors

GEORGE GRAHAM HARVEY, PH.D.
ROBERT BURNETT KING, PH.D.
WILLIAM CRONK ELMORE, PH.D.
PHILIP THUMAN SMITH, PH.D.
ARTHUR FRANCIS TURNER, PH.D.

Research Associates

LESTER CLARE VAN ATTA, PH.D.
CHESTER MURRAY VAN ATTA, PH.D.
WALTER EDWARD ALBERTSON, PH.D.

Research Assistants

PAUL FRANKLIN BARTUNEK, PH.D.
DOYLE LANGDON NORTHRUP, S.M.

Teaching Fellows

NORMAN FRANKLIN BARNES, A.B.
WILLIAM WALKER BARTLETT, S.M.
MAURICE EVAN BELL, SC.B.
WILLIAM WEBER BUECHNER, S.B.
ROBERT MEDILL ELLIOTT, S.B.
JOHN EDWIN FREEHAFER, M.S.
ALEXANDER SUSS LANGSDORF, A.B.
JOSEPH MORGAN, M.A.
OTTO MORNINGSTAR, B.S.
RICHARD BURTON NELSON, B.S.
MYRON HIRAM NICHOLS, A.B.
FREDERICK WILLIAM PAUL, B.A., M.S.
LEONARD ISAAC SCHIFF, B.E.
EDWARD JAY SCHREMP, S.B.
LEO PETER TARASOV, B.S.
ARTHUR JAMES COCHRANE WILSON, B.S.

Assistants

PETER ALDRICH COLE, A.B.
RICHARD EDGAR EVANS, PH.D.
JAMES WOODRUFF FARMER, B.E.E.
EDMUND TEOFIL PIOTROWSKI
ALLYN BRAYMAN WHITE, A.B.

DIVISION OF GENERAL STUDIES

(In charge of Faculty Committee on General Studies)

WILLIAM EMERSON, A.B.
Dean of Architecture, Chairman

F. ALEXANDER MAGOUN, S.M.
Associate Professor of Humanics

Lecturers

SAMUEL CHAMBERLAIN
Expressions of Graphic Art

THEODOR CARL MÜLLER
Design in Manufactured Products

DIVISION OF INDUSTRIAL COÖPERATION

CHARLES LADD NORTON, S.B.
Professor of Industrial Physics; Director

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

JOHN MAJOR NALLE, S.M.
Placement Officer

Industrial Research Fellow

JOHN ALBERT FELLOWS, B.A., S.M.

Research Associates

Frederick Samuel Dellenbaugh, Ph.D.
Albert Louis Kaye, Sc.D.
Howard Agnew Smith, Ph.D.
William Ellwood Yelland, Ph.D.

STAFF OF THE INSTITUTE LIBRARY

William N. Seaver, A.B.
Bertha P. Trull, A.B.
Ruth McGlashan Lane, A.B., B.S.
Mirian S. Smith, B.S.
Marguerite Chamberlain, A.B., B.S.

RESEARCH FELLOWS

BIOLOGY AND PUBLIC HEALTH

Bryce Prindle, Ph.D.

METEOROLOGY

George Grimminger, A.B.
James William W. Osmun, B.S.
Albert Kenneth Showalter, A.B.

PHYSICS

David Richardson, Ch.E.

FACULTY COMMITTEES

1936–1937

GRADUATE SCHOOL

Dean of the Graduate School (*Chairman*)*
Director of Admissions (*Secretary*)*
J. W. M. Bunker
L. B. Chapman
O. G. C. Dahl
W. M. Fife
W. P. Fiske
R. E. Freeman
C. E. Fuller
W. S. Hutchinson
W. H. Lawrence
J. F. Norris
H. B. Phillips
K. T. Sherwood
H. W. Shimer
J. C. Slater
R. H. Smith

UNDERGRADUATE COURSES

	(*Term Expires*)
E. B. Millard (*Chairman*)	1938
R. F. Elder	1937
E. F. Langley	1937
H. L. Hazen	1938
W. H. Lawrence	1939
J. H. Keenan	1939
J. B. Babcock	1940
A. L. Townsend	1940

COURSE IX

R. G. Hudson (*Chairman*)*	
E. R. Schwarz	1937
F. W. Sears	1938
C. H. Porter	1939
C. S. Robinson	1940

* Ex officio.

GENERAL STUDIES

	(*Term Expires*)
Dean of Architecture (*Chairman*)*	
W. H. Timbie	1937
F. K. Morris	1938
G. R. Harrison	1939
E. S. Burdell	1940
H. R. Bartlett	1941

PROVISIONAL STUDENTS AND DISCIPLINE

Dean of Students (*Chairman*)*	
Registrar*	
H. B. Phillips	1937
J. D. Mitsch	1938
D. A. Fales	1939

The Committees on First Year Instruction, Second, Third, and Fourth Year Students are determined according to rule.

UNDERGRADUATE SCHOLARSHIPS

Dean of Students (*Chairman*)*	
K. D. Fernstrom	1937
H. C. Weber	1937
J. R. Markham	1938
B. A. Thresher	1938
R. D. Douglass	1939
K. C. Reynolds	1939
C. H. Blake	1940
J. C. Boyce	1940
T. S. Gray	1941
W. C. Voss	1941

PETITIONS

	(*Term Expires*)
Assistant Secretary (*Chairman*) *	
Secretary*	
Dean of Students*	
J. W. Howard	1937
K. C. Reynolds	1938
L. B. Slichter	1939
E. E. Bugbee	1940

ADMISSIONS

Director of Admissions (*Chairman*)*	
Dean of Students*	
Registrar*	
F. G. Fassett, Jr.	1937
D. S. Tucker	1937
R. D. Douglass	1938
W. T. Hall	1938
H. E. Edgerton	1939
W. J. Mead	1939

COMMITTEE ON THE LIBRARY

R. R. Lawrence (*Chairman*)	1937
Librarian (*Secretary*)*	
O. Ingraham	1937
E. Mirabelli	1938
R. S. Williams	1938
W. P. Allis	1939
P. Roberts	1939

NOMINATING COMMITTEE

1936–1937

G. R. Harrison (*Chairman*)
J. C. Hunsaker
W. H. McAdams
W. H. Lawrence
M. P. Horwood

COMMITTEES ON JOINT PROJECTS

CORROSION

W. K. Lewis (*Chairman*)
R. S. Williams
M. deK. Thompson

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

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*)
C. W. Berry
H. C. Hottel
J. H. Keenan
C. F. Taylor
G. B. Wilkes
O. G. C. Dahl

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

AIR CONDITIONING

J. H. Keenan (*Chairman*)
J. W. M. Bunker
J. Holt
H. C. Hottel

C. S. Draper
M. P. Horwood
W. H. Jones
H. Peters
C. G. A. Rossby
E. R. Schwarz
T. K. Sherwood
M. W. Jennison

OTHER COMMITTEES AND BOARDS

COMMITTEE ON CONDUCT OF EXAMINATIONS

L. F. Hamilton (*Chairman*)
A. L. Townsend
J. D. Mitsch
C. H. R. Mabie
S. G. Simpson
L. M. Dawes

COMMITTEE ON STABILIZATION OF ENROLLMENT

H. E. Lobdell (*Chairman*)
N. H. Frank
B. A. Thresher
W. H. McAdams
C. E. Tucker
J. M. Nalle

INSTRUCTION OF SUPERIOR STUDENTS

C. E. Fuller (*Chairman*)
H. H. W. Keith
E. B. Millard
R. E. Freeman
R. H. Frazier

GRADUATION EXERCISES

R. G. Hudson (*Chairman*)
H. M. Goodwin
R. S. Williams
J. W. M. Bunker
R. C. Eddy
J. C. MacKinnon
H. S. Ford

STUDENT-FACULTY

S. C. Prescott (*Chairman*)
C. E. Fuller
W. M. Fife
K. D. Fernstrom
J. A. Stratton
R. D. Douglass

SUMMER SESSION

E. S. Burdell (*Chairman*)
G. R. Harrison
A. F. Holmes
J. C. MacKinnon
J. C. Balsbaugh

DIVISION OF HUMANITIES

E. S. Burdell (*Chairman*)
T. L. Davis
W. H. Timbie

PATENT POLICY

V. Bush (*Chairman*)
J. W. M. Bunker
C. L. Norton
F. G. Keyes
E. L. Bowles

DORMITORY BOARD

L. F. Hamilton (*Chairman*)
H. E. Lobdell
H. S. Ford
A. A. Ashdown

LOAN BOARD

H. E. Lobdell (*Chairman*)
K. T. Compton
B. A. Thresher
H. S. Ford
D. L. Rhind (*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 seventeen educational buildings and laboratories, infirmary, Walker Memorial (the student union), student houses, and athletic plant, including gymnasia, playing fields, field house, sailing pavilion, and boat house.

All of the departments of instruction are located in Cambridge except the School of Architecture which occupies the Rogers Building (491 Boylston Street) on the site in Boston granted by the Commonwealth in 1861.

To supplement its educational facilities in Cambridge and in Boston, the Institute maintains well equipped summer engineering camps, one in Maine, the other in New Jersey; practice schools and training outposts in large industrial plants in several eastern cities; and a large research station at South Dartmouth, Mass.

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 Nominating, 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 is 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, Vice-President, and Treasurer there are other duly appointed officers of administration and instruction. Chief among the former are the Deans of Engineering, Architecture, Science, the Graduate School, and Students; 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, comprise the Administrative Council.

The Faculty consists of all Professors, Associate Professors, and Assistant Professors, certain designated Instructors, and the following administrative officers *ex officiis:* the President and Vice-President, the Deans, Registrar, Librarian, and the Assistant Dean of Students. For its government the Faculty has adopted a set of "Rules" 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" 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 divides, as inferred 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 which are provided in order that students may supplement the cultural values inherent in their scientific and engineering studies 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 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 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 in its special research laboratories.

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.* Especially if the student then continues with post-graduate work, as more and more of the best students are finding it advisable to do, the total time and expense of this entire educational program may constitute serious obstacles.

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 degrees from both institutions. 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 with the dean or registrar of the college of his selection in regard to his most advantageous schedule of studies.

The following colleges are joining with the Institute in this program, and several others have the plan under advisement: Miami University, Middlebury College, Ohio Wesleyan University, Reed College, Ripon College, St. Lawrence University, 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 Massachusetts legal holidays, which are January 1, February 22, April 19, May 30, July 4, Labor Day, October 12, November 11, Thanksgiving Day and December 25.

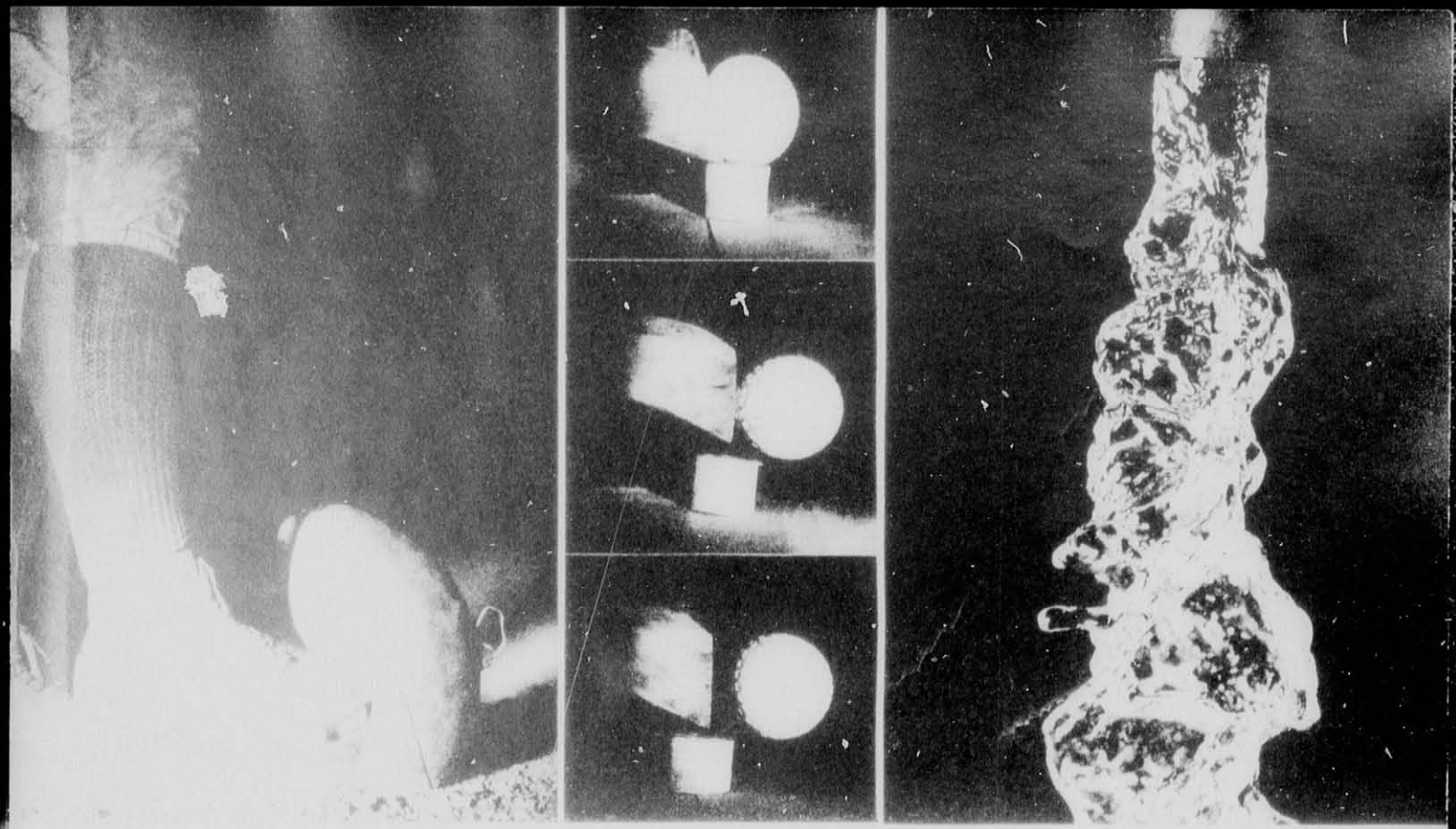
Registration. At a date specified in the registration instructions, before the opening of each term, the student is required to fill out and present registration forms to the Registrar.

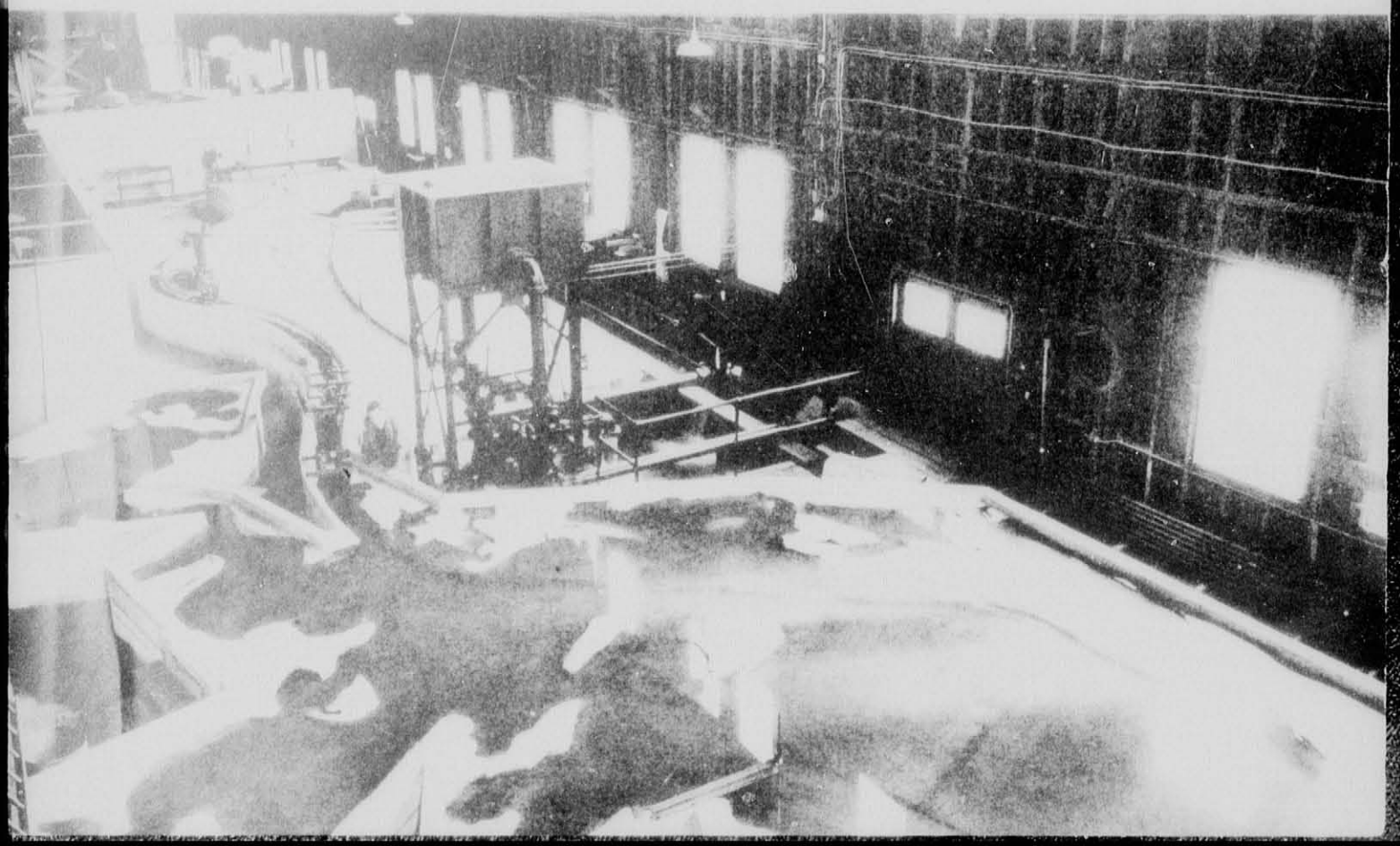
Provisional Admission. All students admitted to subjects without having fulfilled the usual preparation requirements are considered as provisional students in such subjects. Students whose work is generally low, and students readmitted to the Institute after dismissal, or after withdrawal incident to 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.

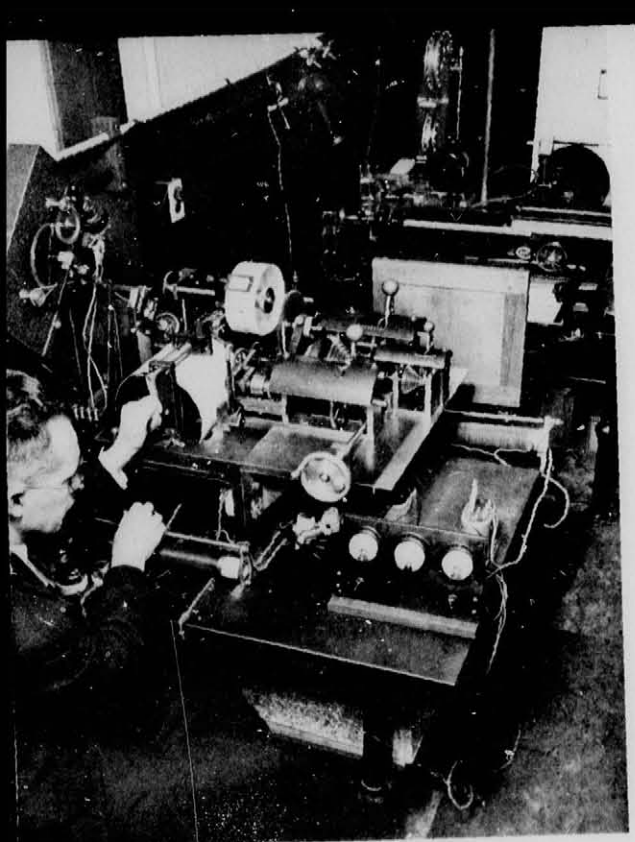
A student taking a dependent subject without a clear record in each required preparatory subject may be required to drop that subject at any time if his work is unsatisfactory.

Entrance conditions must be made up before the beginning of the second year, except as extension of

*One year with summer work may be sufficient in chemical engineering in favorable cases.



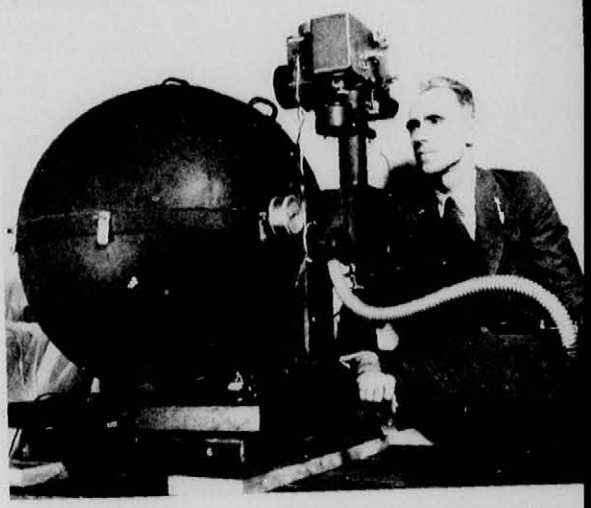




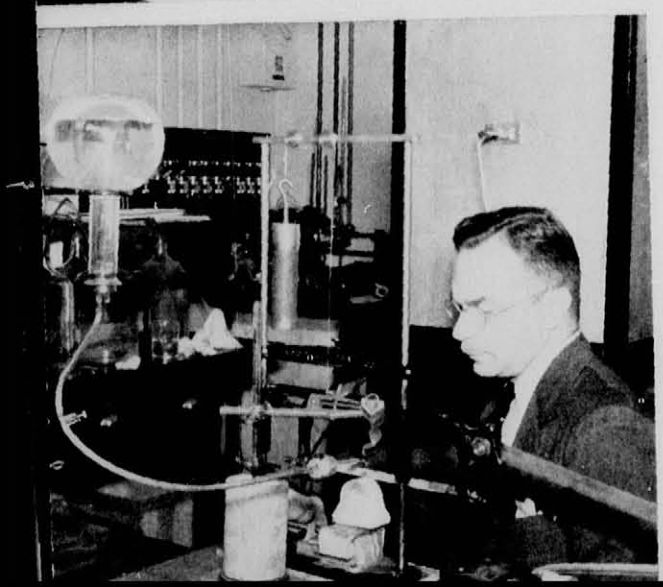
Left. *In the Department of Physics nearly threescore workers, aided by extraordinary analyzing machine, developed at the Institute, are engaged in a gigantic redetermination of the wavelengths ("the fingerprints") of the elements*

Right. *In the Department of Civil Engineering engineers are finding out how to design structures to resist earthquakes. In the picture the white shadowgraph (or optical cam) was made from the record of 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*

Right. *In the Department of Electrical Engineering is this Jumbo of cosmic-ray intensity meters*



Left. *In the Department of Geology geophysicists designed and built this new and highly sensitive seismograph. It reports earth displacements of less than a millionth of an inch, earth tiltings as slight as one millionth of a degree*



Right. *Algebra in terms of metal. A new machine for solving multiple simultaneous equations — another of several great machines developed at the Institute for aiding scientists and engineers in solving laborious mathematical problems*

Left. *The artificial growth of large and optically perfect lithium fluoride crystals which transmit further into the ultraviolet region of the light spectrum than any other known optical material is a recent achievement in the Department of Physics*

time or other alternative may for special reasons be allowed by the Faculty.

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 to the Dean of Students, he may permit a student whose term work has been satisfactory to take the next 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 4.00 and above, may take examinations for advanced standing, in subjects for which they have never been registered, during the condition examination periods in September and March. Notice of intention must be filed with the Registrar on the usual petition blanks, and must be submitted at least two weeks before the scheduled examination period.

The privilege of an examination in a subject which involves laboratory instruction, or drawing, must be approved by the Faculty member in charge of the subject.

REQUIREMENTS FOR THE BACHELOR'S DEGREES. 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.), a 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 and have presented a satisfactory thesis on some subject included in his course of study.

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 monies due the Institute are paid.

Requirements for advanced degrees may be found in the Graduate School section of this Catalogue.

HEALTH OF STUDENTS. The Department of Hygiene is organized to protect and improve the health of students. A clinic is held by a doctor every morning 8:30–9:30 and 10–12, and every afternoon 1–3 and 4–5, for the care of the sick. Students in the first year are required to take physical exercise, and have the option of taking routine gymnastic work in the gymnasium or substituting one of the competitive sports. Gymnastic facilities are available for all students.

The Homberg Memorial Infirmary cares for seventeen ward and private room patients and is fully equipped. A moderate charge *per diem* is made to students who use a bed in the wards with an increased fee for use of a private room. Extra charges are made only for special medical or surgical services, or for special nursing, medicines or supplies.

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 at the Institute.

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 the same 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 so to administer the discipline of the school 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 10–100.

Advisers. The Dean of Students is the general consulting officer for all students, and coöperates with the President in matters touching 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 Assistant Dean of Students serves as Registration Officer for all first-year students, except those in the Course in Architecture.

FEES, DEPOSITS, PAYMENTS, EXPENSES

Tuition Fees. For all students pursuing regular courses, undergraduate or graduate, the tuition fee of $500 per year must be paid *in advance* as follows: $250 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.

For convenience, the tuition fees for students taking coöperative work in II-A or VI-A after the second year is $166 for the summer term and $167 for the two regular academic terms. If not registered or attending in the summer term, the regular tuition fee of $250 per academic term is required.

Sons of regular Army, Navy and Marine Corps Officers who are admitted to the Institute as undergraduate students 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 awards, if recommended by the Committee, may continue at the half tuition rate during their second and succeeding undergraduate years.

The tuition for members of the teaching staff working for the Master's degree is at the special rate of $4.75 per "unit" for all subjects, including research or thesis, for which they are registered. A "unit" signifies 15 hours work, and applies to both exercise and preparation. Thus for a subject listed as 2–4 units, the fee would be $6\times\$4.75=\$28.50$.

For fees and deposits required for the professional summer schools see page 37.

Members of the teaching staff on full-time appointment, pursuing programs leading to the Doctor's degree, and taking more than one subject or engaged on research or thesis, pay $85 for each term for which they are registered as proceeding toward the degree. If taking but a single subject, the fee shall be at the staff rate of $4.75 per "unit." Those on half-time appointment pay $125 for each term for which they are registered as proceeding toward the degree. The above fees admit members of the Staff working for the Doctor's degree to all subjects, both undergraduate and graduate, which are approved by their respective Departmental Committees, and to thesis work.

The only fee charged for carrying on research or thesis during the Summer Session is a registration fee of $5.

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.

Entrance Examination Fee. The charge for entrance examinations is $10, except that when a candidate takes only one examination the fee is $5. A candidate will be required to pay the fee for each period in which he takes examinations. Fees should be paid in advance of the first examination.

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 in the case of 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 entertainment 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 an Advisory Committee appointed by the Corporation.

Subject to modification, dues will be apportioned as follows:

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

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 1936–1937, 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	$500
Board	300
Room	205
Books and materials	70
	$1,075

To assist students to secure employment, either during the school year or the summer, an Undergraduate Employment Office is maintained by the Technology Christian Association. Application may be made at this office by students desiring to help themselves in meeting their expenses. Prospective students should, however, realize that the demands of the Institute curriculum are such as to make it impracticable to devote a large amount of time to outside employment during the school year. 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 language and business customs of a strange country.

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 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 1,500 men have borrowed more than $900,000 from the Technology Loan Fund; that, during 1936–1937, $85,000 and $91,000 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

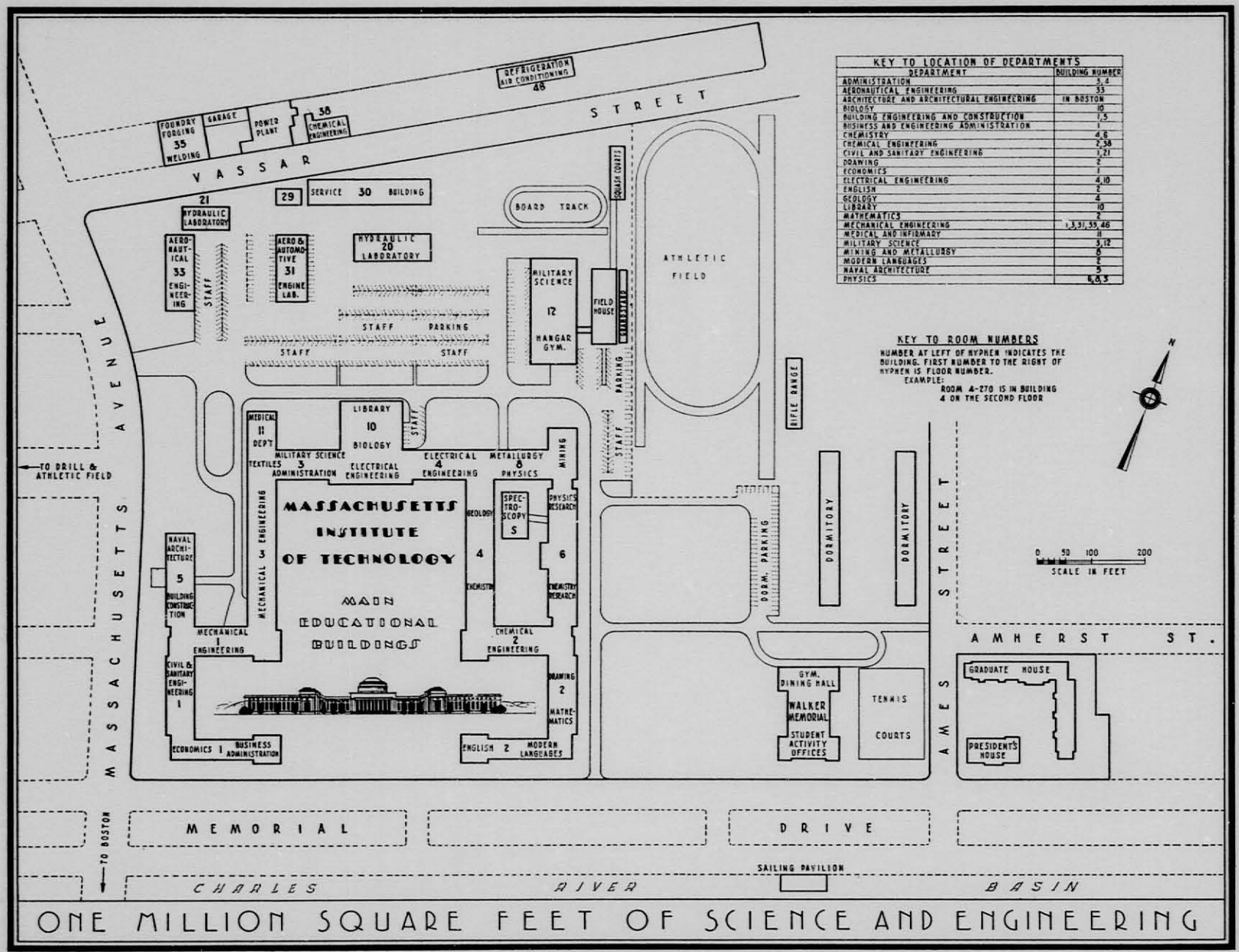
Without assuming responsibility of finding employment for graduates, the Institute assists them in their placement problems. Senior and graduate students are offered a program of placement training planned to acquaint them with industrial opportunities and to outline the principles to be observed in 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 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, except the School of Architecture, are brought together in a group of conjoined buildings containing approximately one million square feet of floor space (see next page).

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 hous-


KEY TO LOCATION OF DEPARTMENTS
DEPARTMENT | BUILDING NUMBER
ADMINISTRATION | 3, 4
AERONAUTICAL ENGINEERING | 33
ARCHITECTURE AND ARCHITECTURAL ENGINEERING | IN BOSTON
BIOLOGY | 10
BUILDING ENGINEERING AND CONSTRUCTION | 1, 5
BUSINESS AND ENGINEERING ADMINISTRATION | 1
CHEMISTRY | 4, 6
CHEMICAL ENGINEERING | 2, 38
CIVIL AND SANITARY ENGINEERING | 1, 21
DRAWING | 2
ECONOMICS | 1
ELECTRICAL ENGINEERING | 4, 10
ENGLISH | 2
GEOLOGY | 4
LIBRARY | 10
MATHEMATICS | 2
MECHANICAL ENGINEERING | 1, 3, 31, 35, 46
MEDICAL AND INFIRMARY | 11
MILITARY SCIENCE | 3, 12
MINING AND METALLURGY | 8
MODERN LANGUAGES | 2
NAVAL ARCHITECTURE | 5
PHYSICS | 6, 8, 5
KEY TO ROOM NUMBERS
NUMBER AT LEFT OF HYPHEN INDICATES THE BUILDING. FIRST NUMBER TO THE RIGHT OF HYPHEN IS FLOOR NUMBER.
EXAMPLE:
ROOM 4-270 IS IN BUILDING 4 ON THE SECOND FLOOR
N
0 50 100 200
SCALE IN FEET
REFRIGERATION AIR CONDITIONING 48
FOUNDRY FORGING 35 WELDING
GARAGE
POWER PLANT
38 CHEMICAL ENGINEERING
VASSAR STREET
29
SERVICE 30 BUILDING
21 HYDRAULIC LABORATORY
AERONAUTICAL 33 ENGINEERING
AERO & AUTOMOTIVE 31 ENGINE LAB.
HYDRAULIC 20 LABORATORY
STAFF
STAFF PARKING
BOARD TRACK
SQUASH COURTS
ATHLETIC FIELD
MILITARY SCIENCE 12 HANGAR GYM.
FIELD HOUSE
PARKING
RIFLE RANGE
MASSACHUSETTS AVENUE
TO DRILL & ATHLETIC FIELD
MEDICAL 11 DEPT
LIBRARY 10 BIOLOGY
TEXTILES
MILITARY SCIENCE 3 ADMINISTRATION
ELECTRICAL ENGINEERING
ELECTRICAL 4 ENGINEERING
METALLURGY 8 PHYSICS
MINING
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
MAIN EDUCATIONAL BUILDINGS
SPECTROSCOPY 5
PHYSICS RESEARCH
GEOLOGY
4
6
CHEMISTRY
CHEMISTRY RESEARCH
NAVAL ARCHITECTURE 5
BUILDING CONSTRUCTION
MECHANICAL & ENGINEERING
MECHANICAL 1 ENGINEERING
CHEMICAL 2 ENGINEERING
CIVIL & SANITARY ENGINEERING 1
DRAWING 2
MATHEMATICS
ECONOMICS 1 BUSINESS ADMINISTRATION
ENGLISH 2 MODERN LANGUAGES
DORM. PARKING
DORMITORY
DORMITORY
MASS. STREET
AMHERST ST.
GYM. DINING HALL
WALKER MEMORIAL
STUDENT ACTIVITY OFFICES
TENNIS COURTS
AMES
GRADUATE HOUSE
PRESIDENT'S HOUSE
MEMORIAL DRIVE
TO BOSTON
SAILING PAVILION
CHARLES RIVER BASIN
ONE MILLION SQUARE FEET OF SCIENCE AND ENGINEERING

ing, 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, and the Laboratories of Steam and Compressed Air, Refrigeration, Testing Materials, Hydraulics, Gas Engines, Mining, Metallurgy, Chemical Engineering, Physical Chemistry, Applied Physics, Electrical Engineering, Biology, Geology, and Mineralogy.

At Round Hill, the estate of the late Colonel E. H. R. Green at South Dartmouth, Mass., is located the M. I. T. Experimental Station. Its facilities comprise the great Van de Graaff 10,000,000-volt electrostatic generator for nuclear research as well as laboratories for research in the propagation of radio signals and for meteorological research, including fundamental studies of fog.

THE LIBRARY. The Institute Library, one of the leading collections on science and engineering in the United States, includes the Central Library and a number of well-organized branches, containing all together approximately 300,000 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 1,300 periodicals, not counting transactions and other annuals.

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 the principal collections in physics, chemistry, chemical engineering, biology, public health, and mechanical and electrical engineering. Especially notable is the Vail Collection (about 35,000 volumes) in electrical engineering. Cultural subjects, such as history, biography, travel, literature, are 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 closes at four o'clock daily except Saturdays when it closes at noon. 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 stacks.

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 film reproductions. A certificate, obtainable at the 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, Architecture, Civil Engineering and Economics (including Business and Engineering Administration), Eastman (for graduate students and others doing advanced work in physics, mathematics and chemistry), Lindgren (geology, mining, metallurgy and ceramics), Naval Architecture, 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.

SUMMER CAMPS. Two admirably located and amply equipped engineering camps are maintained, one by the Department of Mining and Metallurgy, the other by the Department of Civil and Sanitary Engineering. During the summer sessions at these camps, students get field practice under competent instructors and, incidentally, obtain the healthful experience of approximately two months of outdoor life.

The former is in the magnetic iron ore field near Dover, N. J., about an hour's distance from New York City on the Delaware, Lackawanna and Western Railroad; the latter on the shore of Gardner's Lake about eight miles from East Machias, Me.

Camp Technology, the summer school of Civil Engineering comprises about 850 acres of rolling terrain, some of which is wooded, in a region well adapted for carrying out exercises 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's Lake, and, in a direct line, is less than three miles from tidewater. 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; and for the Staff in a clubhouse known as Eaton Hall. Other structures include a geodetic observatory, a seismograph house, a limnological laboratory, extra space for drafting or classroom usage, and an infirmary which serves as an emergency hospital. A physician is in constant attendance throughout the period of instruction.

The Camp is equipped with excellent sanitary facilities, electric light, a wholesome water supply from driven wells.

STUDENT HOUSING

Complete information on the Student Houses, both Graduate and Undergraduate, including floor plans and rentals, is presented in Appendix B of this Catalogue.

The Institute Houses, accommodating a total of 625 men, consist of twelve halls: six named for former members of the Faculty, Ware, Atkinson, Runkle, Holman, Nichols and Crafts, and six for Alumni of the Institute, Walcott, Bemis, Goodale, Munroe, Hayden and Wood. These halls are on the Institute campus adjacent to Walker Memorial, which contains the dining service and is the headquarters of student activities.

GRADUATE HOUSE. The six halls of the Faculty Group are reserved exclusively for graduate students. A younger member of the Faculty who is familiar with the aims and problems of graduate students is resident house master, and he, with the assistance of a house committee, has supervision of the halls. The rooms are generally double suites, consisting of bedroom, dressing room with lavatory and large study. There are a limited number of single rooms. All rooms in these halls have been newly furnished and equipped. Applications for rooms should be addressed to Professor A. A. Ashdown, House Master.

UNDERGRADUATE HOUSES. The six halls of the Alumni Group are reserved exclusively for undergraduate students. Most rooms are for single occupancy, some interconnecting, with a limited number of double and triple suites. They are fully equipped for immediate occupancy. The government of the undergraduate houses is administered as a part of the general plan of student self-government at the Institute with the coöperation of the Dormitory Board appointed by the President and acting in an advisory capacity.

Reprints of Appendix B ("Student Housing") of this catalogue giving details in regard to applications for and allotment of rooms, equipment, rentals, payments, occupancy, government and other information may be had on application to D. L. Rhind, Bursar.

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 is 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 a *table d'hôte* lunch is served 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, a football field, a quarter-mile cinder track with a 220-yard straightaway, and accommodations for the field events. To care for the needs of the track men during the winter an outdoor board track is provided.

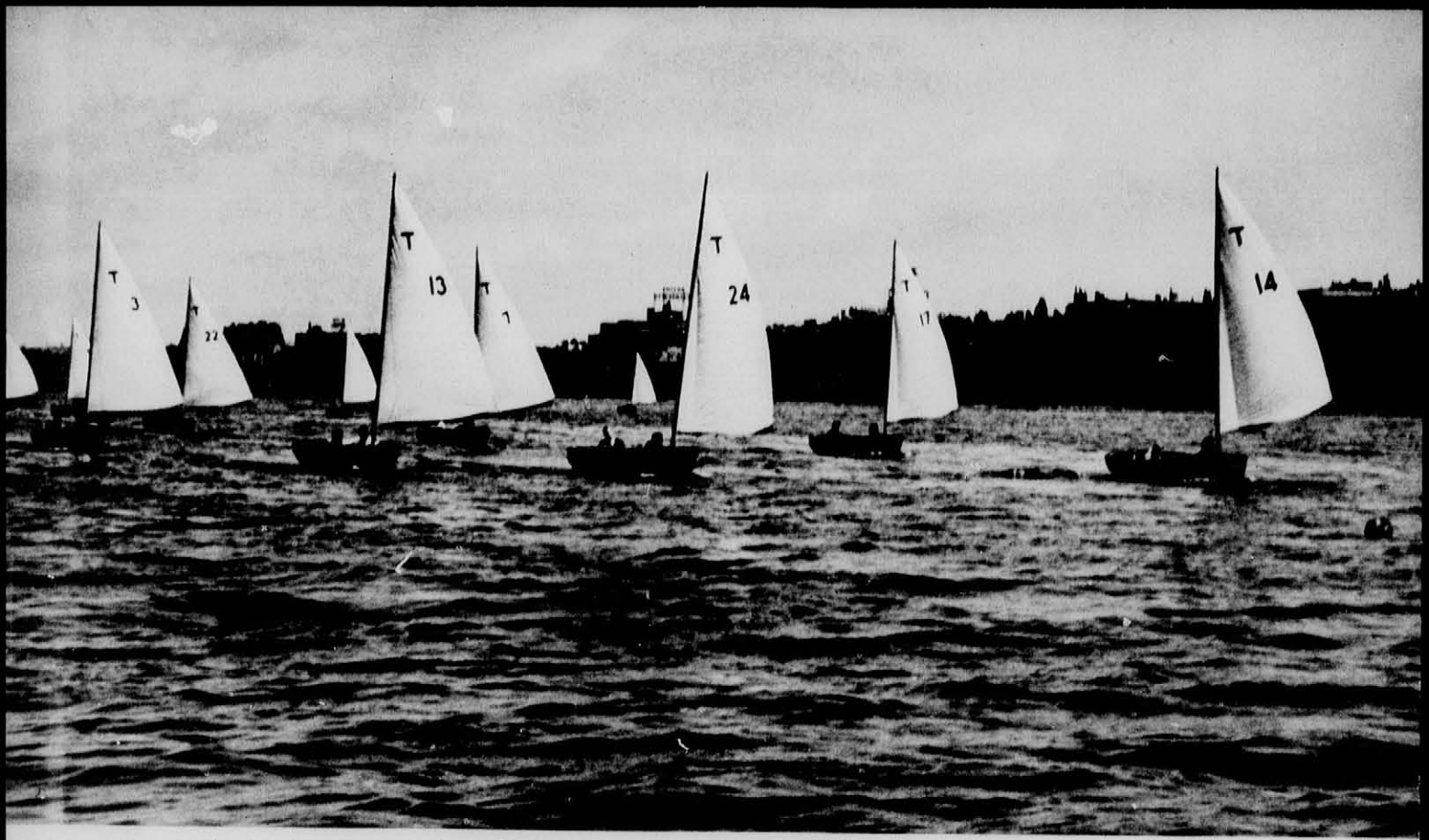
The new Barbour Field House, opened in September, 1934, has, in addition to modern shower and locker facilities, special rooms for visiting teams. Connected with the Field House there is another gymnasium with a regulation basketball court, a movable boxing ring, wrestling mats and indoor jumping pits, and a Squash Building with eight courts. On the land west of Massachusetts Avenue are fields for soccer, lacrosse and baseball, as well as additional tennis courts.

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 thirty-six dinghies (see page 31).

UNDERGRADUATE ACTIVITIES

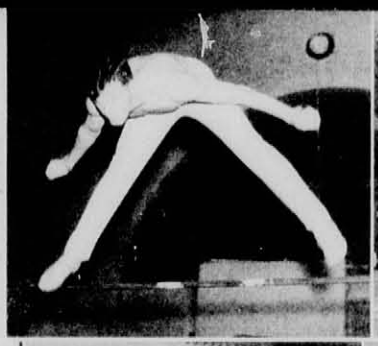
To complement and aid its educational work and to enrich its community life, Technology provides extensive opportunities for students to participate in those extra-curricular pursuits—athletic, literary, dramatic, and social—which further the development of character and personality and yield health, 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.

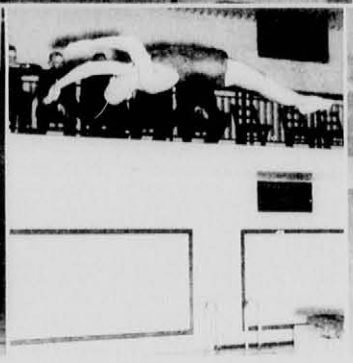
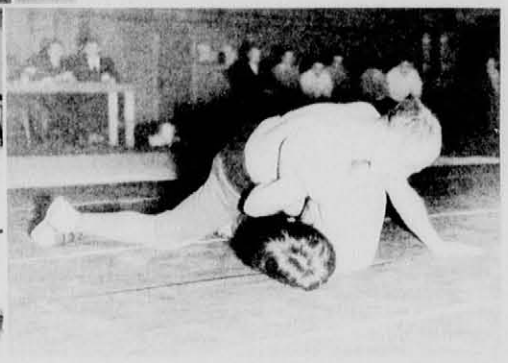
ATHLETICS. The purpose of athletics at the Institute is not to develop highly-trained athletes, but rather to encourage all students to participate in some form of physical recreation. Control is vested in the M. I. T. Athletic Association, an undergraduate organization composed of all captains and managers 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



Every student has the opportunity to learn sailing and seamanship under the guidance of the M.I.T. Nautical Association, one of the most popular undergraduate activities. Here are 11 of Technology's fleet of 36 dinghies running before the wind for a close finish in a race on the Charles River Basin

Headquarters of the Commodore and the Sailing Master in the Sailing Pavilion, the center of Technology's undergraduate nautical activity. The binnacle, an inlaid compass on the floor, and numerous pictures of yachts and ships give atmosphere to this room from which all races are controlled by automatic signals



The conduct of athletics at Technology is governed by two principles: (1) to provide exercise and healthful recreation through sports for all students, and (2) to encourage the development of initiative and judgment among undergraduates through student management of athletics. Toward this end the Athletic Association conducts varsity and freshman intercollegiate athletic schedules in 16 sports and promotes an extensive intramural athletic program. Students at Technology have ample time and opportunity to play, and a fine tradition of clean sportsmanship prevails

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 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 thirty-six dinghies, constituting a special Technology class designed by Technology men, is 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, sponsored by the Department of English and History, produces plays. Members of the Debating Society participate in intercollegiate 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. The Combined Professional Societies also manage Open House, which brings more than 20,000 visitors to the Institute.

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.

REQUIREMENTS FOR ADMISSION

UNDER the plan for stabilization of the Institute enrollment the size of the First Year classes admitted in 1936 and in 1937 may not exceed six hundred. Since it is expected that the number of applicants in each year will be more than six hundred, the power to select those to be admitted will be vested in the Faculty Committee on Admissions.

Preference will be accorded applicants whose evidence of adequate academic fitness and of professional promise suggests 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.

The candidate is requested to indicate his choice of 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.

SUBJECTS REQUIRED FOR ADMISSION

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.

Since most of the work in the first year is based upon Mathematics and Physics, the following five subjects are specifically required of each applicant (the figure in parentheses after each subject indicates the usual unit rating):

ALGEBRA (2)	SOLID GEOMETRY (½)
PLANE GEOMETRY (1)	TRIGONOMETRY (½)
PHYSICS (1)	

Further evidence of adequate preparation, amounting to ten units of elective subjects (or seven if three units of English are offered) is required and may be chosen from the following groups:

FOREIGN LANGUAGE	MATHEMATICS
SOCIAL SCIENCE (History, Civics, etc.)	MECHANIC ARTS
	MECHANICAL DRAWING
BIOLOGICAL SCIENCE (Biology, Zoölogy, etc.)	COMMERCIAL STUDIES
	FINE ARTS, DRAMA, AND MUSIC
PHYSICAL SCIENCE (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 are recommended:

Chemistry (1). Chemistry is a required subject in the first year for students in all Courses except Architecture.

History (1). The study of history is advisable in order that a student may have a better understanding of contemporary civilization.

French (3) or *German* (3). 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 being eligible for the Bachelor's degree. A student who intends to pursue graduate work should consider when planning his entrance program that one (or sometimes both) of these languages will be required for advanced study. Information about the language requirements in particular Courses may be obtained by writing to the Director of Admissions.

The Scholastic Aptitude Test is not required.

METHODS OF ADMISSION

For each applicant, regardless of the method by which he seeks admission, it is expected that the following will be submitted by April 15 of the year in which he plans to enter:

1. A statement of recommendation obtained by the Institute directly from his principal or headmaster.
2. Endorsements on forms provided by the Director of Admissions from two persons (not relatives) of recognized standing in their community.
3. An autobiographical essay of about 250 words.

I. ADMISSION WITHOUT EXAMINATIONS

1. The applicant must have been graduated from a secondary school accredited by the Institute and have ranked in the highest fifth of his class for the two years immediately preceding his graduation. This plan of admission will not apply unless the graduating class has a minimum of ten students. The method of accrediting schools is based upon the success of their graduates at Technology. An applicant ineligible

for consideration under this plan will be so notified at the time of filing his preliminary application.

2. The applicant must have completed preparation in the subjects specifically required for admission and in ten units of electives (or seven if three units of English are offered). (See "Subjects Required for Admission above.")

3. The evidence of preparation, as specified in the two foregoing paragraphs, should be submitted before April 15 of the year of anticipated admission.

II. Admission by Examinations

Plan A

1. An applicant must pass examinations in Algebra, Plane Geometry, Solid Geometry, and Trigonometry.

2. He must present school records, or pass examinations, in Physics and ten units of electives (or seven if three units of English are offered) chosen from the list under "Subjects Required for Admission." Preference will be given to applicants who present school records of certificate grade in these subjects.

Examinations may be extended over a period of not more than three years and may be taken under any one (or a combination) of the following:

(*a*) By College Entrance Examination Board examinations, which are offered in various educational centers in June.

Records of 60 per cent, or above, will be accepted, except that if the combined examination Mathematics CD, Plane and Solid Geometry, is taken, a record of at least 70 per cent is required.

Records in Mathematics Alpha and Mathematics Beta will *not* be accepted under any plan of admission. Records in Mathematics Gamma will be accepted in place of examinations in the single mathematical subjects (Algebra, Plane Geometry, Solid Geometry, and Trigonometry) if the candidate is applying from a school which prepares for the Gamma examination.

(*b*) By New York State Regents examinations.

Only grades of 80 per cent, or better, will be accepted in the specifically required examination subjects. The official report of these examinations will be secured by the Institute from the State Board of Regents at Albany.

If an applicant takes the College Board examinations in the same year and fails them, the Regents results will not be accepted in the particular subjects failed. A final candidate should repeat the examinations failed by taking them during the September examination period at the Institute, unless he prefers to take the subjects at the Institute Summer Session.

(*c*) By Institute entrance examinations, given at the Institute in September.

Plan B

At the request of a principal or head master, the Director of Admissions may permit an applicant to seek admission under "Plan B" of the College Entrance Examination Board.

EXAMINATIONS

Time and Place of Entrance Examinations. June examinations for admission to the first year class are held under the direction of the College Entrance Examination Board in all the principal cities of the United States, in Canada, London, Paris, Geneva and other foreign centers. Information in regard to these examinations may be obtained from the Secretary, 431 West 117th Street, New York.

In September the Institute conducts its own examinations which are held in Cambridge only. However, candidates are advised to attend the June examinations. Correspondence in regard to the September examinations and questions relating to admissions or courses of study should be addressed to the Director of Admissions.

C. E. E. B. Examinations, June 19–26, 1937. The application for examination must be addressed to the College Entrance Examination Board, 431 West 117th Street, New York City. It must be made on a form to be obtained from the Secretary of the Board. If the application is received sufficiently early, the examination fee will be $10 whether the candidate is examined in the United States, Canada or elsewhere. A list of the places at which these examinations are to be held in June, 1937 is published by the Board about March 1.

Table of Equivalents:

M. I. T. Subjects	*C. E. E. B. Subjects*
Algebra	Mathematics A, or A1 and A2
Geometry, Plane	Mathematics C
Geometry, Solid	Mathematics D
Plane Trigonometry	Mathematics E
Physics	Physics
English	English
Chemistry	Chemistry
History	History A, B, C, or D
French (Elementary)	French 2
French (Intermediate)	French 3
German (Elementary)	German 2
German (Intermediate)	German 3

Division of Entrance Examinations. Plan A candidates may distribute their entrance examinations over three consecutive years, and may take examinations either in June or September.

A preliminary candidate is one who is taking examinations a year or more in advance of his anticipated admission.

SCHEDULE OF EXAMINATIONS AT INSTITUTE IN SEPTEMBER 1937. (Application in advance for admission to the examinations is not necessary. Candidates will register during the examination period.)

Wednesday, September 15

Algebra	9.00 A.M. to 12.00 M.
*French (Elementary)	2.00 P.M. to 5.00 P.M.

Thursday, September 16

English	9.00 A.M. to 12.00 M.
*German (Elementary)	2.00 P.M. to 5.00 P.M.

Friday, September 17

Trigonometry	9.00 A.M. to 10.45 A.M.
Physics	11.00 A.M. to 1.00 P.M.
*French (Intermediate)	2.00 P.M. to 5.00 P.M.
*German (Intermediate)	2.00 P.M. to 5.00 P.M.

Saturday, September 18

Plane Geometry	9.00 A.M. to 10.45 A.M.
Solid Geometry	11.00 A.M. to 1.00 P.M.

Monday, September 20

Chemistry	9.00 A.M. to 11.00 A.M.
History, United States or Ancient	1.30 P.M. to 4.30 P.M.

INSTITUTE ENTRANCE EXAMINATION FEE. The charge for entrance examinations held at the Institute is $10, except that when a candidate takes only one examination the fee is $5. A candidate will be required to pay the fee for each period in which he takes examinations. Fees should be paid in the examination room in advance of the first examination.

OTHER INFORMATION

APPLICATION FOR ADMISSION. Candidates should write to the Director of Admissions for forms on which to make application.

SUMMER COURSES IN ENTRANCE SUBJECTS. The Institute offers summer courses corresponding to entrance requirements in Algebra, Solid Geometry, Trigonometry, Physics, Chemistry, English, French and German. A satisfactory record in any of these subjects will be accepted as completing the corresponding entrance requirement.

GENERAL PREPARATION. The applicant intending to enter the Institute should bear in mind that the broader his intellectual training and the more extensive his general acquirements, the greater will be the advantages he may expect to gain. Thorough preparation in the subjects set for examinations is important; the training given in the better high and preparatory schools will, in general, afford suitable preparation.

The attention of teachers and applicants is particularly called 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 object of the elective requirements is to secure and to recognize greater breadth of preparatory training. The time allotment for each unit of elective should be equivalent to four or five periods per week for a school year of approximately forty weeks.

ADMISSION WITH ADVANCED STANDING

The Institute offers to both graduates and undergraduates of other colleges opportunities for transfer on as favorable a basis as is compatible with the requirements of its professional courses and standards. As most of these requirements are, however, prescribed, it is important that the applicant's previous work should have been planned with due reference to them.

In general, an applicant from another college who has attended one full year or more, obtained satisfactory grades (the lowest passing grade is not a satisfactory grade on which to base credit) and received honorable dismissal, may expect provisional credit for entrance and undergraduate subjects in so far as he has covered those subjects. Mathematics beyond that required for entrance is essential as a basis for transfer. In case a student is lacking some of the required entrance subjects he will, unless especially excused, be expected to clear his entrance deficiencies by taking entrance examinations.

A candidate for admission with advanced standing should send early in June, and in any case not later than July 15, his application blank indicating his choice of course, accompanied by an official record from the college or university which he has attended, showing the subjects credited at entrance and those which he has taken in college, with his grades; also a statement of honorable dismissal (or its equivalent) or a certificate of graduation. He should send sheets detached from his college catalogue describing the subjects which he has pursued. On these sheets he should write his name and (in the margin) check the subjects that he has taken. By preparing a tabulation of his subjects and credits on the application form for admission with advanced standing and underlining the Course Schedule to show the subjects in which he expects to receive credit, he may be able to estimate the terms of his admission and his probable deficiencies. This tabulation will also be helpful to the Committee on Admissions in determining his rating. As soon as his rating is determined, a report will be sent him in the form of a certified Course Schedule which will show with what Institute subjects he is credited.

A student who plans to enter the third or fourth year at the Institute should, if possible, send his credentials not later than May 15, including a certificate of the subjects completed together with a state-

* Separate examinations must be taken in elementary and intermediate language.

ment of those which he expects to complete before entrance. Students desiring credit in Electrical Engineering Laboratory should present their reports as well as their college records in that subject. The candidate should forward in June a record of the additional subjects completed at that time. Candidates having deficiencies are advised to make them up by attending the Summer Session at the Institute.

Questions about credits in professional subjects given in the *third* or *fourth* year will, in general, await adjustment in personal interview. In such cases the student is expected to consult the department concerned before the opening of the term so that he may complete his registration in season. Representatives of the departments will be on duty during the week preceding the opening of the school for consultation.

Students applying for admission with advanced standing to Architecture, Course IV, will be graded in design in accordance with their performance in their first problem.

Admission of Special Students. An applicant considerably above the usual age, pursuing special work, may be classed as a special student. He should present a plan for study approved by the Department with which his work will be taken. He may be excused from the usual entrance examinations in case he has presented to the Department evidence of such professional or other experience as will justify the expectation that he can profitably undertake the work desired. In all other cases, special students will be expected to take those examinations on which the work they desire depends, or to present college records in corresponding subjects.

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.

School of Architecture

ARCHITECTURE, Course IV.

ARCHITECTURAL ENGINEERING, Course IV-A.

CITY PLANNING, Course IV-B.

School of Engineering

AERONAUTICAL ENGINEERING, Course XVI.

BUILDING ENGINEERING AND CONSTRUCTION, Course XVII.

BUSINESS AND ENGINEERING ADMINISTRATION, Course XV, with options in Engineering and Chemistry.

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

CIVIL ENGINEERING, Course I, with options. General (1), Transportation Engineering (2), and Hydroelectric Engineering (3).

ELECTRICAL ENGINEERING, Course VI. Also options in Illuminating Engineering, VI-B, and in Communications Engineering, VI-C, and Coöperative Course in Electrical Engineering, VI-A.

ELECTROCHEMICAL ENGINEERING, Course XIV.

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), Production (4), Textile (5). Also Coöperative Course in Mechanical Engineering, II-A.

MINING ENGINEERING AND METALLURGY, Course III, with options. Mining Engineering (1), Petroleum Production (2), Metallurgy (3), Physical Metallurgy (4).

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), Industrial Biology (2), Public Health Engineering (3).

CHEMISTRY, Course V.

GENERAL SCIENCE, Course IX-A.

GEOLOGY, Course XII, with options. General Geology and Stratigraphy (1), Physical and Economic Geology (2), Mineralogy (3), Geophysics (4).

MATHEMATICS, Course XVIII.

PHYSICS, Course VIII, with options. General Physics (1), and Applied Physics (2).

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 Catalogue.*

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.

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, 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 roughly into two groups, Engineering and Chemistry. In each group certain basic subjects are common to all Courses. In individual Courses the remaining units are 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, and VI-A, which are coöperative Courses requiring outside work in industry, are of five years duration, and lead to the degrees of Bachelor of Science and Master of Science.

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 Mining and Metallurgy. The students, accompanied by instructors, give their time to fieldwork, or visit and report on mines or 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's Lake near the town of East Machias, Maine.

The subjects given at the camp are required for students of Courses I, VII Option 3, XI, XV Option 1a, and XVII, but students from other Courses will be admitted. The session is for seven weeks.

The tuition fee is $100. The cost of operating the camp during the session is shared equally by those in attendance. Deposit for board and incidental expenses is $80.

Summer School of Surveying for Mining Engineers. Surveying, 1.10, which is given at the Summer Mining Camp at the Scrub Oak Mine near Dover, N. J., includes topographic surveying, leveling and mine surveying. It is required for students in Course III, Options 1 and 2, between their second and third year; and it is open to students in other departments desiring to elect it after their second year. The camp is about one hour's distance from New York City, on the Lackawanna Line. The fee is $100. Deposit for board and incidental expenses is $80. The session is for seven weeks.

Summer School in Mining Practice. Mining Practice, 3.08, required of all students in Course III, Options 1 and 2, between their second and third year, is given at the Summer Mining Camp. The fee is $15; deposit for board and incidental expenses, $20.

Summer School in Petroleum Production. Oil Field Visits 3.89, required of all students in Course III Option 2, either between the second and third or between the third and fourth years, is given in the oil fields of western Pennsylvania. The fee is $15 and each student will pay his own expenses estimated at $30.

Summer School of Metallurgy. Plant Visits 3.60, required of all students in Course III, Options 3 and 4, and any others planning to register for Metallurgy 3.41, 3.411, 3.43 or 3.431. 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.

Summer School of Surveying. Students in Courses III, Option 3, and VI are required to take Surveying, 1.02, in the early part of the summer following their second year; students in VI-A, following their first year. Given in Cambridge and vicinity. The fee is $20.

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; or 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 119–177.

Department	Subject Numbers
Civil and Sanitary Engineering	1.00 to 1.99
Mechanical Engineering	2.00 to 2.99
Mining and 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
Drawing	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 36 all of the Courses of Study, the schedules of which are given for all but the first year on the following pages, are identical in the first year with the exceptions of Architecture (IV) and City Planning (IV-B). Below are the first year schedules for these two groups.

FIRST YEAR

ALL COURSES (Except IV and IV-B)

First Term	5·01	Chemistry, General	7–4
	8·01	Physics	6–5
	D11	Engineering Drawing	6–0
	E11	English Composition	3–5
	M11	Calculus	3–6
	MS11	Military Science	3–0
	PT1	Physical Training	1–0
			29–20
Second Term	5·02	Chemistry, General	7–4
	8·02	Physics	6–5
	D12	Descriptive Geometry	6–0
	E12	English Composition	3–5
	M12	Calculus	3–6
	MS12	Military Science	3–0
	PT2	Physical Training	1–0
			29–20

COURSES IV and IV-B

First Term	4·06	Graphics	6–0
	4·11	Shades and Shadows	2–0
	4·12	Perspective	2–0
	4·711	Architectural Design I	10–1
	E11	English Composition	3–5
	L63	French	3–5
	M111	Calculus	3–6
	MS11	Military Science	3–0
	PT1	Physical Training	1–0
			33–17
Second Term	2·031T	Structural Mechanics, Elem.	3–6
	4·312T	Abstract Design	5–4
	4·712	Architectural Design I	12–0
	E12	English Composition	3–5
	L64	French	3–5
	MS12	Military Science	3–0
	PT2	Physical Training	1–0
			30–20

UNDERGRADUATE COURSE SCHEDULES FOR 1936–1937

I. CIVIL ENGINEERING

CIVIL engineering is the broadest in scope of the engineering professions, being the parent stem from which have diverged most of the other branches of engineering. It covers surveying, methods and practice, including topographic, geodetic and hydrographic surveying, and surveys for engineering construction; transportation engineering, consisting of the building and operation of railroads, highways, canals, docks, harbors, airports, and other similar works; municipal engineering, including the construction of sewers, waterworks, roads, and streets; structural engineering, including the design and construction of bridges, buildings, retaining walls, foundations and all fixed structures; hydraulic engineering, including the development of water power and public water supplies, the improvement of rivers and the reclamation of land by irrigation. All of these branches of engineering rest upon a relatively compact body of principles.

In the comparatively advanced work of the upper years the student is offered a choice of three options or groups of study, namely: a general option in civil engineering, including the study of hydraulic and sanitary engineering in considerable detail, an option in transportation engineering dealing principally with railway and highway transportation and to some extent with air and water transportation and an option in hydroelectric engineering in which special consideration is given to the subject of water power development. The work in all the options is the same for the first three years.

All options of the Course lead to the degree of Bachelor of Science in Civil Engineering.

FIRST YEAR. See page 38.

SECOND YEAR. ALL OPTIONS

First	1·00	Surveying	2–2
Term	1·39	Graphic Statics	3–1
	2·00T	Applied Mechanics	3–5
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		General Study	2–2
			24–26
Second	1·01	Surveying and Top. Draw.	4–0
Term	1·12	Astronomy and Spher. Trig.	3–4
	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
			25–24

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. ALL OPTIONS

First	1·13	Geodesy	2–2
Term	1·21	Rail. and High. Curves	2–2
	1·35	Roads and Pavements	2–1
	2·04	Applied Mechanics	3–5
	6·40	Electrical Eng., Elem.	4–6
	6·89	Electrical Eng. Lab.	2–2
	Ec11	Political Economy	3–3
		General Study	3–3
			21–24
Second	1·22	Quantity Surveying	2–2
Term	1·40T	Structures	7–4
	1·62	Hydraulics	4–6
	2·371T	Testing Materials Lab.	2–1
	12·32	Geology	6–4
	15·52	Accounting	4–2
	Ec12	Political Economy	3–3
			28–22

FOURTH YEAR. OPTION 1. GENERAL

First	1·35	Roads and Pavements*	2–1
Term	1·41	Structures	3–6
	1·48	Foundations	3–4
	1·501	Bridge Design	8–0
	1·75	Hydraulic & San. Eng.	4–6
	1·801	Hydraulic & San. Des.	3–0
	2·411	Heat Engineering	2–4
		Thesis	2
			48
Second	1·42	Structures	2–4
Term	1·502	Structural Design	6–0
	1·58	Des. Reinf. Concrete Structures	6–0
	1·76	Sanitary Engineering	2–3
	1·79	Sanitary Design	2–0
	2·421	Heat Engineering	2–4
	2·687T	Hydraulic Laboratory	2–2
		Thesis	7
		General Study	3–3
			48

FOURTH YEAR. OPTION 2. TRANSPORTATION ENGINEERING

First	1·271	Transportation Eng.	6–5
Term	1·35	Roads and Pavements*	2–1
	1·41	Structures	3–6
	1·48	Foundations	3–4
	1·501	Bridge Design	8–0
	2·411	Heat Engineering	2–4
		Thesis	2
			46
Second	1·272	Transportation Eng.	5–4
Term	1·42	Structures	2–4
	1·502	Structural Design	6–0
	1·58	Des. Reinf. Concrete Structures	6–0
	2·421	Heat Engineering	2–4
	2·687T	Hydraulic Laboratory	2–2
		Thesis	7
		General Study	3–3
			50

* For 1936–37 only. The permanent schedule for the fourth year includes 1·25T Engineering Construction.

I. Civil Engineering Continued

FOURTH YEAR. OPTION 3. HYDROELECTRIC ENGINEERING

First	1·35	Roads and Pavements*	2–1
Term	1·41	Structures	3–6
	1·48	Foundations	3–4
	1·501	Bridge Design	8–0
	1·70	Water Power Engineering	7–4
	2·411	Heat Engineering	2–4
		Thesis	2
			46
Second	1·42	Structures	2–4
Term	1·502	Structural Design	6–0
	1·58	Des. Reinf. Concrete Structures	6–0
	1·71	Water Power Eng.	6–3
	2·421	Heat Engineering	2–4
	2·687T	Hydraulic Laboratory	2–2
		Thesis	7
		General Study	3–3
			50

*For 1936–37 only. The permanent schedule for the fourth year includes 1·25T Engineering Construction.

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 covered, 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.

The Department will not recommend a student for the degree unless he has acquired a reading knowledge of either French or German. This requirement may be fulfilled by (1) three years of secondary school language (French or German or both) with certificate grade, or (2) two years of French or two years of German, with certificate grade, and a cumulative rating at the Institute of not less than 3.50 at the end of the second year. Until this requirement is met, registration as a senior student in the Mechanical Engineering Course will not be permitted.

FIRST YEAR. See page 38

SECOND YEAR

First	2·00T	Applied Mechanics	3–5
Term	2·31	Foundry Practice	3–1
	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
			26–24
Second	2·01	Applied Mechanics	3–5
Term	2·70	Machine Drawing	4–0
	2·852	Machine Tool Practice	4–0
	8·04	Physics	6–4
	10·16	Applied Chemistry	2–2
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			28–22

REQUIRED DURING SUMMER

	2·02T	Applied Mechanics	8–0

THIRD YEAR

First	2·04	Applied Mechanics	3–5
Term	2·251T	Fluid Mechanics	5–3
	2·32T	Mechanical Processes	5–1
	2·35T	Materials of Engineering	3–3
	2·40	Heat Engineering	4–5
	Ec11	Political Economy	3–3
		General Study	3–3
			26–23
Second	2·06T	Applied Mechanics	3–5
Term	2·252	Fluid Mechanics	5–3
	2·42	Heat Engineering	4–5
	2·731	Machine Design	4–1
	6·40	Electrical Eng., Elem.	4–6
	Ec12	Political Economy	3–3
			23–23

II. Mechanical Engineering Continued

FOURTH YEAR. OPTION 1. GENERAL

First Term	2·081	Applied Mechanics	3–5
	2·37	Testing Materials Lab.	4–2
	2·43	Heat Engineering	3–5
	2·55T	Power Plant Eng.	3–3
	2·681	Engineering Laboratory	3–3
	2·732	Machine Design	4–2
	6·47	App. of Elec. in Industry	4–4
			24–24
Second Term	2·082	Applied Mechanics	3–5
	2·56T	Power Plant Eng.	3–3
	2·682	Engineering Laboratory	3–3
		General Study	3–3
		Elective and Thesis*	22
			48

ELECTIVES

2·11	Industrial Plant Eng.	3–3
2·82	Diesel Engine Design	6–0
2·83T	Steam Turbine Eng.	4–2

FOURTH YEAR. OPTION 2. AUTOMOTIVE

First Term	2·081	Applied Mechanics	3–5
	2·37	Testing Materials Lab.	4–2
	2·791	Automotive Engines	4–4
	2·793	Automotive Engine Des.	6–0
	2·795	Automotive Vehicles	3–3
	2·797	Automotive Vehicle Des.	6–0
	6·47	App. of Elec. in Industry	4–4
			30–18
Second Term	2·082	Applied Mechanics	3–5
	2·681	Engineering Laboratory	3–3
	2·792	Automotive Engines	4–4
	2·794	Automotive Engine Des.	3–0
	2·796	Automotive Vehicles	3–3
	2·798	Automotive Vehicle Des.	3–0
		General Study	3–3
		Thesis	10
			50

FOURTH YEAR. OPTION 3. REFRIGERATION AND AIR CONDITIONING

First Term	2·43	Heat Engineering	3–5
	2·51T	Heat Measurements	3–3
	2·55T	Power Plant Eng.	3–3
	2·621	Refrigeration Eng.	3–3
	2·66	Heat, Vent. & Air Cond.	3–5
	2·681	Engineering Laboratory	3–3
	6·47	App. of Elec. in Industry	4–4
			22–26
Second Term	2·56T	Power Plant Eng.	3–3
	2·622T	Refrigeration Eng.	3–5
	2·69	Refrig. & Air Cond. Lab.	6–6
		General Study	3–3
		Elective and Thesis*	16
			48

*Thesis not less than 10 units.

FOURTH YEAR. OPTION 4. PRODUCTION

First Term	2·081	Applied Mechanics	3–5
	2·37	Testing Materials Lab.	4–2
	2·55T	Power Plant Eng.	3–3
	2·681	Engineering Laboratory	3–3
	2·732	Machine Design	4–2
	2·871T	Manufacturing Eng.	3–6
	6·47	App. of Elec. in Industry	4–4
			24–25
Second Term	2·082	Applied Mechanics	3–5
	2·56T	Power Plant Eng.	3–3
	2·77	Design of Prod. Mach.	4–2
	2·872T	Prep. for Manufacturing	3–3
	3·71	Heat Treatment	4–2
		General Study	3–3
		Thesis	10
			48

FOURTH YEAR. OPTION 5. TEXTILE

First Term	2·081	Applied Mechanics	3–5
	2·37	Testing Materials Lab.	4–2
	2·66	Heat, Vent. & Air Cond.	3–5
	2·681	Engineering Laboratory	3–3
	2·732	Machine Design	4–2
	2·901T	Prin. Fabric Structure	3–5
	2·903	Elem. Textile Manuf.	3–5
			23–27
Second Term	2·082	Applied Mechanics	3–5
	2·902	Prin. Fabric Structure	3–5
	2·904	Prin. Textile Manuf.	3–6
	8·173	Color Measurements	3–2
		General Study	3–3
		Thesis	10
			47

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 either at the Institute or 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

II-A. Mechanical Engineering Continued

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 Co-operative Course is restricted to students of marked aptitude who have clear records in the first two years of Course II. 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, but the Department will not recommend a student for the degrees unless he has acquired a reading knowledge of either French or German.

II-A. Mechanical Engineering

FIRST YEAR. See page 38

SECOND YEAR. SAME AS COURSE II

THIRD YEAR

AT WORKS

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

AT M. I. T.

First	2·06T	Applied Mechanics	3–5
Term	2·253	Fluid Mechanics	7–5
	2·35T	Materials of Eng.	3–3
	2·40	Heat Engineering	4–5
	2·731	Machine Design	4–1
	Ec11	Political Economy	3–3
		General Study	2–2
			26–24

AT WORKS

Second	2·42	Heat Engineering	4–5
Term	2·952T	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	Political Economy	3–3
			16–18

AT WORKS

First	2·081	Applied Mechanics	3–5
Term	2·953	Manufacturing Practice (General Electric Co.)	40 h.p.w.

AT M. I. T.

Second	2·082	Applied Mechanics	3–5
Term	2·51T	Heat Measurements	3–3
	2·551	Power Plant Eng.	3–5
	2·681	Engineering Laboratory	3–3
	2·733	Machine Design	4–2
	2·82	(a) Diesel Eng. Des.	6–0
	2·83T	(b) Steam Turbine Eng.	4–2
		General Study	3–3
		(a)	25–21
		(b)	23–23

GRADUATE YEAR (In effect 1937–38)

AT WORKS

Summer		Graduate Study & Research	12
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. MINING AND METALLURGY

INCLUDING CERAMICS

THE demands made upon engineers in mining engineering, metallurgy and petroleum engineering call for training in a variety of lines. The Courses are designed to give the student sound training in the sciences, upon which professional practice is based. The application of these sciences is enforced through instruction in mining engineering, metallurgy and petroleum engineering, as well as in related branches of mechanical, civil and electrical engineering. Thus equipped, the student can take up specialized work after graduation with the expectation of carrying it on successfully, while the broad foundation laid in scientific and engineering subjects affords the general training needed in case he desires to engage in technical enterprises other than mining, metallurgy or petroleum engineering.

III. Mining and Metallurgy Continued

Valuable opportunities are offered for observation and field work in the laboratories of the Institute, in the Summer Mining Camp at Dover, N. J., and the summer visits to oil fields and metallurgical plants. Four optional courses are open to students in mining engineering and metallurgy.

OPTION 1. MINING ENGINEERING. The field of mining engineering includes study in geology, mining methods and economics and principles of mining, together with instruction in metallurgical subjects adequate to equip the graduate to engage in the practice of the branches of metallurgy which so often make an important part of mining operations.

OPTION 2. PETROLEUM PRODUCTION. Emphasizes prospecting, development, production, transportation and storage of petroleum. Prominence is given to methods of finding and developing petroleum resources; to methods of drilling wells and extracting oil and gas from natural reservoirs; to the maintenance of oil and gas wells and fields; to methods of transportation of crude oil and gas and the storage of oil. Stress is placed on statistics of importance in the study of petroleum economics from a world viewpoint.

OPTION 3. METALLURGY. Prominence is given to the metallurgical processes; the production, properties and treatment of metals and alloys; and to metallography. Opportunity is given to specialize in iron and steel, copper and non-ferrous metallurgy, in gold and silver or in metallography. Trips are made to mills, foundries and shops in the vicinity, and are followed by conferences and reports.

OPTION 4. PHYSICAL METALLURGY. Designed to give special training in the structures, properties, uses and methods of testing of the ferrous and non-ferrous metals and alloys. Metallography, mechanical treatment and testing, heat treatment, x-ray examination of metals and allied subjects are included. Training in production metallurgy is also given.

CERAMICS. The instruction and research in Ceramics is mainly intended for graduate work leading to a Master's or Doctor's degree. However, it is possible 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 the testing of raw materials and finished ware.

Option 1 and Option 2 lead to the degree of Bachelor of Science in Mining Engineering; Option 3 and Option 4 lead to the degree of Bachelor of Science in Metallurgy.

OPTION 1. MINING ENGINEERING

FIRST YEAR. See page 38

SECOND YEAR

First	3·00	Int. to Mining & Metal	1–0
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
			30–20
Second	2·00T	Applied Mechanics	3–5
Term	5·12	Quantitative Analysis	7–2
	8·04	Physics	6–4
	12·30	Geology	4–1
	E22	Literature and History	3–5
	MS22	Military Science	3–0
		General Study	2–2
			28–19

REQUIRED DURING SUMMER. AT SUMMER MINING CAMP

1·10	Surveying	23–1
3·08	Mining Practice	3–0

THIRD YEAR

First	2·01	Applied Mechanics	3–5
Term	3·01	Mining Methods	7–7
	3·31	Fire Assaying	6–2
	12·31	Geology	5–3
	Ec11	Political Economy	3–3
		General Study	2–2
			26–22
Second	2·04	Applied Mechanics	3–5
Term	3·02	Mining Methods	7–7
	3·21	Ore Dressing	3–2
	3·22	Ore Dressing Lab.	7–2
	12·40	Economic Geology	3–5
	Ec12	Political Economy	3–3
			26–24

FOURTH YEAR

First	3·03	Economics of Mining	2–4
Term	3·13	Appl. of Science to Prosp.	4–2
	3·412	Metallurgy	3–3
	3·415	Metal. & Electroch. Lab.	4–0
	3·432	Metal. Iron & Steel	2–1
	6·40	Electrical Eng. Elem.	4–6
	6·85	Electrical Eng. Lab.	2–3
	12·33	Field Geology	3–2
		General Study	2–2
			26–23
Second	1·44	Stationary Structures	2–2
Term	3·04	Principles of Mining	2–4
	3·42	Metallurgy	5–2
	17·46	Building Construction	3–3
		Thesis	13
		General Study	2–2
		Elective	8
			48

III. Mining and Metallurgy Continued

Option 2. Petroleum Production

FIRST YEAR. See page 38

SECOND YEAR

First	3·00	Int. to Mining & Metal	1–0
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
			30–20
Second	2·00T	Applied Mechanics	3–5
Term	5·12	Quantitative Analysis	7–2
	8·04	Physics	6–4
	12·30	Geology	4–1
	E22	Literature and History	3–5
	MS22	Military Science	3–0
		General Study	2–2
			28–19

Required during Summer. At Summer Mining Camp

1·10	Surveying	23–1
3·08	Mining Practice	3–0
3·89	Oil Field Visits	3–0

THIRD YEAR

First	2·01	Applied Mechanics	3–5
Term	3·81	Petroleum Eng., Elem.	6–6
	12·31	Geology	5–3
	Ec11	Political Economy	3–3
		General Study	2–2
		Elective	8
			46
Second	2·04	Applied Mechanics	3–5
Term	3·23	Ore Dressing	3–2
	3·82	Petroleum Eng., Elem.	5–4
	12·40	Economic Geology	3–5
	12·80	Geology of Coal & Petrol.	4–3
	Ec12	Political Economy	3–3
		General Study	2–2
			23–24

FOURTH YEAR

First	3·03	Economics of Mining	2–4
Term	3·13	Appl. of Science to Prosp.	4–2
	3·432	Metal. of Iron & Steel	2–1
	3·691	Metallog. & Corrosion	5–1
	3·85	Petroleum Production	4–4
	6·40	Electrical Eng., Elem.	4–6
	6·85	Electrical Eng. Lab.	2–3
	12·33	Field Geology	3–2
			26–23
Second	1·44	Stationary Structures	2–2
Term	3·04	Principles of Mining	2–4
	3·86	Petroleum Production	3–4
	17·46	Building Construction	3–3
		Thesis	14
		General Study	2–2
		Elective	7
			48

Option 3. Metallurgy

FIRST YEAR. See page 38

SECOND YEAR

First	3·00	Int. to Mining & Metal	1–0
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
			30–20
Second	2·00T	Applied Mechanics	3–5
Term	2·311	Foundry Practice	3–0
	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
			28–22

Required during Summer

1·02	Surveying	3–1
2·701T	Machine Drawing	6–0

THIRD YEAR

First	2·01	Applied Mechanics	3–5
Term	2·40	Heat Engineering	4–5
	2·50	Heat Measurements	3–1
	3·05	Mining, Elements of	2–2
	3·31	Fire Assaying	6–2
	5·13	Quantitative Analysis	7–2
	Ec11	Political Economy	3–3
			28–20
Second	2·04	Applied Mechanics	3–5
Term	3·21	Ore Dressing	3–2
	3·22	Ore Dressing Lab.	7–2
	3·61	Metallography	4–1
	Ec12	Political Economy	3–3
		General Study	3–3
		Elective	8
			47

Required during Summer

3·60	Metallurgical Plant Visits	3–1

FOURTH YEAR

First	2·371T	Testing Materials Lab.	2–1
Term	3·41	(b) Metallurgy	8–3
	3·411	(a) Metallurgy	4–3
	3·415	Metal. & Electroch. Lab.	4–0
	3·43	(a) Metallurgy	7–3
	3·431	(b) Metallurgy	3–3
	3·75	Electrochemistry, Elem.	2–2
	5·61	Physical Chemistry I	4–4
	6·40	Electrical Eng., Elem.	4–6
		General Study	2–2
			29–21
Second	1·63	Hydraulics	2–3
Term	3·42	Metallurgy	5–2
	3·44	Metallurgy	4–3
	3·45	Met. & Heat Treat. of Steel	2–1
	6·85	Electrical Eng. Lab.	2–3
		Thesis	15
		General Study	3–3
			48

III. Mining and Metallurgy Continued

Option 4. Physical Metallurgy

FIRST YEAR. See page 38

SECOND YEAR

First	2·311	Foundry Practice	3–0
Term	2·321	Forging	2–0
	3·00	Int. to Mining & Metal	1–0
	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
			27–18
Second	2·011	Applied Mechanics	3–5
Term	2·854	Machine Tool Laboratory	3–0
	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
			28–22

THIRD YEAR

First	2·04	Applied Mechanics	3–5
Term	3·621	Metallography	9–3
	5·13	Quantitative Analysis	7–2
	5·61	Physical Chemistry I	4–4
	12·25	Crystallography	3–2
	Ec11	Political Economy	3–3
			29–19
Second	2·371T	Testing Materials Lab.	2–1
Term	2·701T	Machine Drawing	6–0
	3·622	Metallography	9–3
	3·656	X-Ray Metallography	3–3
	3·71	Heat Treatment	4–2
	Ec12	Political Economy	3–3
		General Study	2–2
		General Study	2–2
			31–16

Required during Summer

	3·60	Metallurgical Plant Visits	3–1

FOURTH YEAR

First	2·371T	Testing Materials Lab.	2–1
Term	2·50	Heat Measurements	3–1
	3·41	(b) Metallurgy	8–3
	3·411	(a) Metallurgy	4–3
	3·415	Metal. & Electroch. Lab.	4–0
	3·43	(a) Metallurgy	7–3
	3·431	(b) Metallurgy	3–3
	3·67	Physics of Metals	2–4
	6·40	Electrical Eng., Elem.	4–6
		Elective	5
			49
Second	3·422	Metallurgy	2–2
Term	3·44	Metallurgy	4–3
	3·66	Applications of Metallography	6–2
	3·71	Heat Treatment	4–2
	6·75	Electrical Eng. Lab.	2–2
		Thesis	13
		Elective	6
			48

IV. ARCHITECTURE

THE School of Architecture comprises Course IV, Architecture; Course IV-A, Architectural Engineering (see page 47); Course IV-B, City Planning (see page 48) and the Division of Drawing.

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 forgo 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.

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.

FIRST YEAR

First	4·06	Graphics	6–0
Term	4·11	Shades and Shadows	2–0
	4·12	Perspective	2–0
	4·711	Architectural Design I	10–1
	E11	English Composition	3–5
	L63	French	3–5
	M111	Calculus	3–6
	MS11	Military Science	3–0
	PT1	Physical Training	1–0
			33–17
Second	2·031T	Structural Mechanics El.	3–6
Term	4·312	Abstract Design	5–4
	4·712	Architectural Design I	12–0
	E12	English Composition	3–5
	L64	French	3–5
	MS12	Military Science	3–0
	PT2	Physical Training	1–0
			30–20

SECOND YEAR

First	2·032	Structural Mechanics	2–4
Term	4·021	Freehand Drawing	4–0
	4·321	Theory of Architecture	1–1
	4·421	Architectural History	4–5
	4·721	Architectural Design II	13–0
	E21	Literature and History	3–5
	L65	French	2–3
	MS21	Military Science	3–0
			32–18
Second	2·033	Structural Mechanics	2–4
Term	4·022	Freehand Drawing	4–0
	4·322	Theory of Architecture	1–1
	4·422	Architectural History	4–5
	4·722	Architectural Design II	13–0
	E22	Literature and History	3–5
	L66	French	2–3
	MS22	Military Science	3–0
			32–18

THIRD YEAR

First	4·031	Freehand Drawing	4–0
Term	4·071	Modeling	3–0
	4·331	Theory of Architecture	2–0
	4·461	Europ. Civilization & Art	3–4
	4·641	Hist. & Prin. City Planning	3–1
	4·731	Architectural Design III	12–0
	4·811	Construction	7–0
	E41	Problem Analysis	2–2
	Ec11	Political Economy	3–3
			39–10
Second	4·032	Freehand Drawing	4–0
Term	4·072	Modeling	3–0
	4·332	Theory of Architecture	2–0
	4·462	Europ. Civilization & Art	3–4
	4·732	Architectural Design III	17–0
	4·812	Construction	7–0
	E42	Problem Analysis	2–2
	Ec12	Political Economy	3–3
			41–9

FOURTH YEAR

First	2·651	Mech. Equip. of Bldgs.	2–2
Term	4·041	Freehand Drawing	4–0
	4·081	Color, Comp., Th. & App.	1–3
	4·341	Theory of Architecture	1–1
	4·471	Europ. Civilization & Art	2–3
	4·741	Architectural Design IV	21–0
	G651	General Science	2–2
		General Study	2–2
			35–13
Second	4·042	Freehand Drawing	4–0
Term	4·082	Color, Comp., Th. & App.	1–3
	4·342	Theory of Architecture	1–1
	4·472	Europ. Civilization & Art	2–3
	4·742	Architectural Design IV	29–0
	G652	General Science	2–2
			39–9

IV. Architecture Continued

FIFTH YEAR

First	4·051	Freehand Drawing	6–0
Term	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	30–0
			40–9
Second	4·052	Freehand Drawing	6–0
Term	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-A. ARCHITECTURAL ENGINEERING

THE Institute was among the earliest of the technical schools to recognize the growing demand for men with a thorough, fundamental training in engineering who should at the same time have acquired a sufficient acquaintance with the aims and ideals of the architect to be able to work in sympathy with him.

The introduction of new building materials, steel about 1885 and reinforced concrete somewhat later, opened hitherto undreamed of possibilities in the structural problems and added greatly to their complexity. This laid the way for specialization in the architectural profession and gave birth to a new profession, architectural engineering.

Every important architectural structure today is the result of three elements working in close association with one another; first the designing element which is the real creative element, second the engineering element which controls the design of the structure, and lastly the administrative element. Every architectural firm must comprise the creative and the administrative element, in the smaller offices sometimes combined in a single person. The engineering element on the other hand may or may not be directly a part of the office equipment. It is always desirably so, but it may be sought outside the office in one of the structural firms specializing in architectural construction, or it may be sought in the services of a consulting architectural engineer called to work in association with the architect. In addition to these three there must also be the construction element represented by the contractor.

The Course in Architectural Engineering is essentially an engineering course, giving fundamental and comprehensive training in engineering and including sufficient preparation in Architecture to put the student in sympathy with the ideals of the architect.

The student who elects IV-A should be interested in mathematics and its many applications and at the same time his tastes should be of sufficient breadth to have some inclination toward the so-called fine arts. The latter is essential if he is to be a success as an engineer practicing in Architecture.

The Course is four years in length and leads to the degree of Bachelor of Science in Architectural Engineering.

FIRST YEAR. See page 38

SECOND YEAR

First	2·00T	Applied Mechanics	3–5
Term	4·13	Perspective	2–2
	4·423	Architectural History	4–4
	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	4·424	Architectural History	4–4
	8·04	Physics	6–4
	12·49	Geology of Materials	2–2
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			24–26

REQUIRED DURING SUMMER

2·04	Applied Mechanics	3–5
4·22	Architectural Practice	6–0

THIRD YEAR

First	1·02	Surveying	3–1
Term	2·06T	Applied Mechanics	3–5
	2·351	Materials of Eng.	2–2
	4·911	Structural Analysis	17–2
	8·06	Acoustics, Ill. & Color	1–2
	E35	Reports	2–4
	Ec11	Political Economy	3–3
			31–19
Second	1·401	Structures	3–5
Term	1·63	Hydraulics	2–3
	4·78	Planning Principles	4–8
	4·912	Structural Design	11–0
	12·49	Geology of Materials	2–2
	Ec12	Political Economy	3–3
	G50	Fine Arts	2–2
			27–23

FOURTH YEAR

First	1·41	Structures	3–6
Term	1·48	Foundations	3–4
	1·531	Reinf. Concrete Design	10–0
	2·371T	Testing Materials Lab.	2–1
	2·38T	Test. Mat. Lab. (Concrete)	3–2
	4·921	Structural Design	10–0
		General Study	2–2
			33–15
Second	1·42	Structures	2–4
Term	1·532	Reinf. Concrete Design	8–0
	2·65	Mech. Equip. Bldgs. H. & V.	4–3
	4·25	Est. & Man. Const. Oper.	1–3
	4·922	Structural Design	6–0
	17·50	Job Management	2–0
		Thesis	11
		General Study	2–2
			48

IV-B. CITY PLANNING

A COURSE in City Planning is now available to students enrolling in the School of Architecture. The object of the course is to encourage in the student a breadth of outlook which will enable him to see city planning problems in a broad perspective, and to provide him with the technical equipment necessary for the proper working out of practical solutions.

Problems dealt with in the advanced work in design include the preparation of preliminary surveys, the layout of street and park systems, zoning, traffic and transportation problems, and the design of housing groups for urban and suburban areas. So equipped, the graduate is qualified to coöperate intelligently with engineers, landscape architects, lawyers, economists and sociologists in the planning or replanning of towns, cities and regions.

The value of an architectural training as a basis for a study of city planning lies in the methods of attacking problems of planning acquired by the architect during his work in design, in which he is taught to think along both aesthetic and practical lines and to keep these two phases in their correct relationship. Moreover, he becomes accustomed to representing his ideas in graphic form—both in the initial stages of studying the problem and in the final presentation. The Course follows the architectural curriculum for three years.

The instruction given in the fourth and fifth years is divided into two major divisions. The first 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 relate them to the drafting room work in design. Subjects covering engineering problems in their relation to City Planning Design are given in Surveying, Landscape Construction, Municipal Engineering, and Principles of Sanitary Science and Public Health.

The second 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 the solutions.

The Course in City Planning covers a period of five years and leads to the degree of Bachelor of Architecture in City Planning.

SAME AS COURSE IV, ARCHITECTURE, THROUGH THE THIRD YEAR. (See page 46)

FOURTH YEAR

First	1·02	Surveying	3–1
Term	4·041	Freehand Drawing	4–0
	4·081	Color, Comp., Th. & App.	1–3
	4·341	Theory of Arch.	1–1
	4·471	Europ. Civilization & Art.	2–3
	4·741	Architectural Design IV	21–0
		General Study	4–4
			36–12
Second	4·082	Color, Comp., Th. & App.	1–3
Term	4·472	Europ. Civilization & Art.	2–3
	4·62	Site Plan. and Const. Details	6–0
	4·642	Th. & Prac. City Planning	3–3
	4·672	City Planning Design	18–0
	Ec86	Meth. Social Investigation	2–3
	G74	San. Sci. & P. H. Prin.	2–2
			34–14

FIFTH YEAR

First	1·34	Municipal Engineering	3–4
Term	4·481	Europ Civilization & Art.	2–3
	4·651	Th. & Prac. City Planning	3–3
	4·681	City Planning Design	25–0
	Ec83	Social & Econ. Factors. C. P.	2–3
			35–13
Second	4·482	Europ. Civilization & Art.	2–3
Term	4·652	Th. & Prac. City Planning	3–3
	4·682	City Planning Design	12–0
	Ec84	Social & Econ. Factors. C. P.	2–3
		Thesis	18–0
			37–9

V. CHEMISTRY

THE curriculum in Chemistry includes a number of individual subjects in Chemistry, all of which are general and fundamental in character. The aim of the Course is to give the student thorough instruction by means of lectures, recitations and laboratory practice, in the principles of inorganic, analytical, organic, physical and industrial chemistry. Instruction in mathematics, physics, English, German, French, and chemical literature is included in the Course.

A second aim is to stimulate and develop the research attitude in the student. In any scientific career, whether in the field of applied or pure science, the highest satisfaction and material success is attained by those who possess the ability to surmount difficulties as they appear, solve untried problems systematically and use acquired knowledge to extend old boundaries. The "Thesis" coming in the fourth year is calculated to test the student's aptitude for creative effort and the time allotment is sufficient for the solution of a substantial problem. Each student is assigned, after individual discussion, a thesis problem suited to his tastes and abilities. It is expected

V. Chemistry Continued

that he will plan and execute the problem with reasonable aid from his instructors. After it is completed a concise but complete report is presented as part of the requirement for graduation. The facilities for research work in all branches of chemistry are exceptional.

An important feature of the Course is the system of electives in the third and fourth years whereby students may extend their knowledge of subjects of special interest to them. Students intending to enter the graduate school may elect a series of subjects tending to enhance their ability to utilize the opportunities available for advanced study. Students intending to enter particular lines of industrial activity may take courses giving them a command of the fundamental aspects of their special field of interest in science or engineering, or they may devote this elective time to cultural subjects. In practice the plan is applied by continuous observation of the student's aptitudes and development combined with consultations with the Department's registration officers, who may suggest several series of electives from other Departments from which the student may derive the maximum benefit. Thus each student has the benefit of counsel by experienced instructors who can assist him in acquiring the education and training indispensable to well balanced and intelligent living. Elective series are available in inorganic, organic and physical chemistry, ceramics, textiles, economics, metallography, mineralogy and geology, biochemistry, industrial chemistry, food and water chemistry, mining and metallurgy.

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

V. Chemistry

FIRST YEAR. See page 38

REQUIRED DURING SUMMER

	5·10	Qualitative Analysis	14–4

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	5·13	Quantitative Analysis	7–2
	5·142	Analytical Chemistry	2–1
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
			27–23

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 as an elective in the third year particularly if they expect to be candidates for an advanced degree.

THIRD YEAR

First Term	5·141	Analytical Chemistry	3–1
	5·41	Organic Chemistry I	4–3
	5·414	Organic Chemistry Lab.	9–0
	5·61	Physical Chemistry I	4–4
	5·611	Physical Chem. Lab. I	4–0
	5·81	Chemical Literature I	2–3
	Ec11	Political Economy	3–3
		Elective	6
			49
Second Term	5·42	Organic Chemistry I	4–2
	5·424	Organic Chemistry Lab.	9–0
	5·62	Physical Chemistry II	4–4
	5·621	Physical Chem. Lab. II	4–0
	5·82	Chemical Literature II	1–1
	10·203	Industrial Chemistry	3–4
	Ec12	Political Economy	3–3
		Elective	7
			49

FOURTH YEAR

First Term	5·061	Inorganic Chemistry	2–3
	5·417	Quant. Organic Anal.	4–0
	5·63T	Int. to Thermodynamics	3–5
	10·21	Industrial Chemistry	2–2
		General Study	2–2
		Thesis	16
		Elective	8
			49
Second Term	5·062	Inorganic Chemistry	2–3
	5·64T	Int. to Radiation Chem.	2–3
	5·66	Surface & Colloid Chem.	2–3
	5·83	History of Chemistry	2–2
		General Study	2–2
		Thesis	16
		Elective	10
			49

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 power engineering, hydraulic power engineering, and political economy. 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 to the various problems in railroad work, power-station design, electric machine design, industrial applications of electric power, illumination, communications, etc.

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

VI. Electrical Engineering Continued

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

On account of the great importance of new technical material appearing in German and French publications, and also recognizing the cultural value of foreign languages, the Department will not recommend a student for a degree unless he has acquired a reading knowledge of either German or French.

This requirement may be fulfilled by (1) three years of secondary school language (German or French or both) with certificate grade, or (2) two years of German or two years of French, taken at the Institute. Until this requirement is met, registration as a senior student in the Electrical Engineering Course will not be permitted. One year of language, if taken at the Institute, may be used as the general study requirement of the third year.

VI. Electrical Engineering

FIRST YEAR. See page 38

SECOND YEAR

First Term	2·00T	Applied Mechanics	3–5
	2·853	Machine Tool Laboratory	4–0
	8·03	Physics	5–5
	E21	Literature and History	3–5
	Ec11	Political Economy	3–3
	M21	Calculus	3–6
	MS21	Military Science	3–0
			24–24
Second Term	2·01	Applied Mechanics	3–5
	6·00	Electrical Eng. Prin.	4–4
	6·75	Electrical Eng. Lab.	2–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			24–26

REQUIRED DURING SUMMER

1·02	Surveying	3–1

THIRD YEAR

First Term	2·04	Applied Mechanics	3–5
	2·40	Heat Engineering	4–5
	6·01T	Electrical Eng., Prin.	5–7
	6·76T	Electrical Eng. Lab.	4–4
	M31	Differential Equations	2–4
		General Study	3–3
			21–28
Second Term	2·07	Applied Mechanics	3–5
	2·42	Heat Engineering	4–5
	6·02T	Electrical Eng., Prin.	5–6
	6·77T	Electrical Eng. Lab.	6–6
	Ec12	Political Economy	3–3
		General Study	2–2
			23–27

FOURTH YEAR

First Term	1·64	Hydraulics	3–6
	2·686T	Engineering Laboratory	3–3
	6·03T	Electrical Eng., Prin.	6–8
	6·78T	Electrical Eng. Lab.	4–5
		Thesis	2
		Professional Elective	3–6
			49
Second Term	6·04T	Electrical Eng., Prin.	6–9
	6·79	Electrical Eng. Lab.	3–4
	G51	Biography in Science	3–3
		Thesis	11
		Professional Elective	3–6
			48

ELECTIVES

First Term	6·211	App. of Elec. in Industry	3–6
	6·221	Central Stations	3–6
	6·241	Electric Railways	3–6
	6·251	Electric Machine Des.	3–6
	6·26	Elec. Insul. & its Behavior	5–4
	6·281	Prin. Wire Com.	3–6
	6·29	Storage Batteries	1–1
	6·80	Electrical Eng. Lab.	Time arr.
	M77	Vector Analysis	3–6

ELECTIVES

Second Term	6·20	Power Trans. Equipment	3–6
	6·212	App. of Elec. in Industry	3–6
	6·222	Central Stations	3–6
	6·242	Electric Railways	3–6
	6·252	Electric Machine Des.	3–6
	6·27	Illuminating Eng., Prin.	5–4
	6·282	Prin. Radio Com.	3–6
	6·48	Electric 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 gaseous-conduction lamps for highways and for interiors, the use of built-in architectural lighting, and the growing consciousness of the necessity of careful planning of lighting to insure good vision and prevent impairment of eye-

sight—make the field of illuminating engineering increasingly attractive and important.

Illuminating engineering is fundamentally different from all other branches of engineering because the psychophysiological aspects of vision must always be considered and because esthetics are also of importance. Course VI-B is especially designed to meet these requirements. The fundamental subjects, physics, mathematics, and principles of electrical engineering, are essentially as in Course VI, but considerable time is also devoted to a study of optics, vision, color, architecture, the calculation of illumination, and the design of lighting systems of all kinds. 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 50.

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

Option VI-B. Illuminating Engineering

FIRST YEAR. See page 38

SECOND YEAR

First	2·00T	Applied Mechanics	3–5
Term	4·021	Freehand Drawing	4–0
	4·031	Color, Comp. Th. & App.	1–3
	4·13	Perspective	2–2
	8·03	Physics	5–5
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
			24–26
Second	4·022	Freehand Drawing	4–0
Term	4·082	Color, Comp. Th. & App.	1–3
	6·00	Electrical Eng. Prin.	4–4
	6·75	Electrical Eng. Lab.	2–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			26–24

THIRD YEAR

First	4·421	Architectural History	4–5
Term	6·01T	Electrical Eng. Prin.	5–7
	6·76T	Electrical Eng. Lab.	4–4
	8·161	Optics	3–6
	Ec11	Political Economy	3–3
		General Study	3–3
			22–28
Second	4·422	Architectural History	4–5
Term	6·02T	Electrical Eng. Prin.	5–6
	6·27	Illuminating Eng. Prin.	5–4
	6·771	Electrical Eng. Lab.	5–6
	Ec12	Political Economy	3–3
		General Study	2–2
			24–26

FOURTH YEAR

First	2·01	Applied Mechanics	3–5
Term	6·03T	Electrical Eng. Prin.	6–8
	6·271	Illuminating Eng. Prin.	5–4
	8·50	Heat & Thermodynamics	3–4
		Thesis* and Elective	10
			48
Second	2·04	Applied Mechanics	3–5
Term	4·78	Planning Principles	4–8
	6·272	Illuminating Eng., Prin.	5–4
	G51	Biography in Science	3–3
		Thesis* and Elective	13
			48

Electives

First	8·162	Optical Measurements	3–2
Term	8·171	Advanced Optics	2–3
	8·461	Int. Theoret. Physics	4–8

Electives

Second	6·48	Electric Equip. Bldgs.	1–2
Term	8·15	Photography	2–1
	8·311	Atomic Structure	3–5
	8·312	Atomic Structure Lab.	3–2
	8·462	Int. Theoret. Physics	4–8

* Thesis not less than 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 50.

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

Option VI-C. Electrical Communications

Same as regular Course VI to the beginning of third year

THIRD YEAR

First	2·04	Applied Mechanics	3–5
Term	6·01T	Electrical Eng., Prin.	5–7
	6·76T	Electrical Eng. Lab.	4–4
	8·50	Heat & Thermodynamics	3–4
	M31	Differential Equations	2–4
		General Study	3–3
			20–27
Second	6·02T	Electrical Eng., Prin.	5–6
Term	6·30	Electrical Com., Prin.	3–6
	6·77T	Electrical Eng. Lab.	6–6
	8·201	Electronics	3–5
	Ec12	Political Economy	3–3
		General Study	2–2
			22–28

FOURTH YEAR

First	6·03T	Electrical Eng., Prin.	6–8
Term	6·31	Electrical Com., Prin.	3–3
	6·331	Electrical Com. Lab.	4–4
	8·05	Vibrations and Sound	3–6
		Thesis	2
		Elective	3–6
			50
Second	6·32	Electrical Com., Prin.	3–5
Term	6·332	Electrical Com. Lab.	4–6
	6·781T	Electrical Eng. Lab.	2–3
	G51	Biography in Science	3–3
		Thesis	11
		Elective	3–6
			49

Electives

First	6·211	Appl. of Elec. in Indust.	3–6
Term	6·221	Central Stations	3–6
	6·241	Electric Railways	3–6
	6·251	Electric Machine Des.	3–6
	6·26	Elec. Insul. & its Behavior	5–4
	6·281	Prin. Wire Com.	3–6
	6·29	Storage Batteries	1–1
	6·80	Electrical Eng. Lab.	Time arr.
	M77	Vector Analysis	3–6

Electives

Second	6·20	Power Trans. Equipment	3–6
Term	6·212	Appl. of Elec. in Indust.	3–6
	6·222	Central Stations	3–6
	6·242	Electrical Railways	3–6
	6·252	Electric Machine Des.	3–6
	6·27	Illuminating Eng., Prin.	5–4
	6·282	Prin. Radio Com.	3–6
	6·48	Electric Equip. Bldgs.	1–2
	6·80	Electrical Eng. Lab.	Time arr.
	8·54	Electromagnetic Theory	3–6

VI-A. ELECTRICAL ENGINEERING

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

Option 2—Public Utilities.

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

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

Option 3—Communications. In coöperation with the Bell Telephone System in New York City.

The Institute offers three distinct coöperative Courses in Electrical Engineering. Option 1 affords training for the technical and executive responsibilities of electrical manufacturing industries. The manufacturing practice is taken at the plants of the General Electric Company in Lynn, Schenectady, Pittsfield and Erie. Options 2 and 3 offer a training of like nature for the technical and executive responsibilities in the operation of public utilities and communications systems. For those who wish to go into the distribution of light and power, practical experience may be obtained with the Edison Electric Illuminating Company of Boston. For those desiring to go into electric railway work, experience with the Boston Elevated Railway is available. For communications work, the coöperation is with the shops of the Western Electric Company, Inc., the plants of the New York Telephone Company and the laboratories of the Bell Telephone Laboratories, Inc., coördinated through the American Telephone and Telegraph Company.

Each Course covers a period of five years, the first two being identical with Course VI, and the last three being equally divided between instruction at the Institute and practical training in the shops of the General Electric Company, or in the plants of the

VI-A. Electrical Engineering Continued

Boston Edison Company, the Boston Elevated Railway, or the Bell Telephone System.

The instruction of the first four years is similar in method and content to Course VI with minor omissions. The work of the final or fifth year is definitely of a graduate nature. For Option 1 the emphasis during this year is on problems of manufacturing enterprises, the design and development of engineering projects and creative research. For Option 2 the emphasis during the fifth year is on problems of public utilities together with research on technical, scientific and administrative matters incident to the conduct of affairs of such enterprises. In Option 3 the emphasis during the fifth year is on corresponding problems of electrical communications.

The training at the plants is laid out and conducted with a view to educational value and is intimately correlated with the professional instruction at the Institute. In the final year considerable latitude may be exercised in the assignment of men to posts in the engineering and research bureaus of the respective companies in order to utilize and develop individual aptitudes.

The number of men who may be admitted to the coöperative training each year is at present limited to forty-six. Candidates for admission are subject to the approval of both the Institute and the coöperating companies. 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. Well qualified students who have completed at other institutions the substantial equivalent of the work of the first two years of Course VI may be admitted to advanced standing at the beginning of the coöperative training. Students in training at the plants are subject to the usual regulations of the company. They receive regular compensation for their work, the total of which approximates the tuition charges for the three years of coöperation. The work in the shops, testing departments and engineering divisions is supplemented by conferences with department heads in which technical and administrative problems arising in the work are discussed. While at the shops, students also devote a maximum of five hours a week to classroom work in electrical engineering or other professional studies, for which ten hours of preparation a week is expected. At the conclusion of the Course, graduates are free to accept employment wherever offered without further obligation to the coöperating company.

Under present regulations no students will be admitted to Course VI-A in the second year with incomplete records in any entrance subject or an incomplete record in any first-year subject. On account of the number of applications it is probable that no admissions to the third year will be made without clear records in both first and second-year subjects and entrance requirements.

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

During the depression, it has not always been practicable to arrange for industrial practice of the proper kind and in sufficiently long periods to justify placing coöperative students at the works. The coöperating companies are making their selections, as usual, from the students of the second-year class and from students who transfer from other institutions, and who have completed the equivalent of the first two years. These selections are made with the understanding that assignments to the works will be made if and when the practice becomes available. The level of industrial activity has now risen sufficiently to permit many practice assignments of appropriate character. Extra classroom and laboratory work is substituted for the industrial practice when it is not available. A reading knowledge of German or French is required for a degree, as stated in detail on page 50.

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

VI-A. Electrical Engineering

FIRST YEAR. See page 38

REQUIRED DURING SUMMER

	1·02	Surveying	3–1

SECOND YEAR. SAME AS COURSE VI

GROUP A—OPTION 1. MANUFACTURING

THIRD YEAR

AT M. I. T.

Summer	2·04	Applied Mechanics	3–5
Term	2·371T	Testing Materials Lab.	2–1
	6·01T	Electrical Eng., Prin.	5–7
	6·76T	Electrical Eng. Lab.	4–4
			14–17

AT WORKS

First	6·02T	Electrical Eng., Prin.	5–6
Term	6·901	Manufacturing Practice (General Electric Co.)	40 h.p.w.

AT M. I. T.

Second	2·07	Applied Mechanics	3–5
Term	6·03T	Electrical Eng., Prin.	6–8
	6·77T	Electrical Eng. Lab.	6–6
	G51	Biography in Science	3–3
	M31	Differential Equations	2–4
			20–26

VI-A. Electrical Engineering, Group A—Option 1, Continued

FOURTH YEAR

AT WORKS

Summer	2·40	Heat Engineering	4–5
Term	6·902	Manufacturing Practice (General Electric Co.)	40 h.p.w.

AT M. I. T.

First	2·42	Heat Engineering	4–5
Term	6·04T	Electrical Eng., Prin.	6–9
	6·78T	Electrical Eng. Lab.	4–5
	Ec12	Political Economy	3–3
		General Study	3–3
			20–25

AT WORKS

Second	1·64	Hydraulics	3–6
Term	6·903	Manufacturing Practice (General Electric Co.)	40 h.p.w.
		Grad. Study & Research	8

GRADUATE YEAR

AT M. I. T.

Summer	6·501	Seminar	2–10
Term		Grad. Study & Thesis	22
			34

AT WORKS

First	6·904	Manufacturing Practice (General Electric Co.)	40 h.p.w.
Term		Thesis	14

AT M. I. T.

Second	6·502	Seminar	2–2
Term	15·63	Business Law & Org.	3–5
		General Study	3–3
		Grad. Study & Thesis	30
			48

GROUP A—OPTION 2. PUBLIC UTILITIES

THIRD YEAR

AT M. I. T.

Summer	2·04	Applied Mechanics	3–5
Term	2·371T	Testing Materials Lab.	2–1
	6·01T	Electrical Eng., Prin.	5–7
	6·76T	Electrical Eng. Lab.	4–4
			14–17

AT WORKS

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

AT M. I. T.

Second	2·07	Applied Mechanics	3–5
Term	6·03T	Electrical Eng., Prin.	6–8
	6·77T	Electrical Eng. Lab.	6–6
	G51	Biography in Science	3–3
	M31	Differential Equations	2–4
			20–26

FOURTH YEAR

AT WORKS

Summer	2·40	Heat Engineering	4–5
Term	6·912	Public Utility Practice (Edison Electric Ill. Co.)	40 h.p.w.
	6·922	Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.

AT M. I. T.

First	2·42	Heat Engineering	4–5
Term	6·04T	Electrical Eng., Prin.	6–9
	6·78T	Electrical Eng. Lab.	4–5
	Ec12	Political Economy	3–3
		General Study	3–3
			20–25

AT WORKS

Second	1·64	Hydraulics	3–6
Term	6·913	Public Utility Practice (Edison Electric Ill. Co.)	40 h.p.w.
	6·923	Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.
		Grad. Study & Research	8

GRADUATE YEAR

AT M. I. T.

Summer	6·501	Seminar	2–10
Term		Grad. Study & Thesis	22
			34

AT WORKS

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

AT M. I. T.

Second	6·502	Seminar	2–2
Term	15·63	Business Law & Org.	3–5
		General Study	3–3
		Grad. Study & Thesis	30
			48

GROUP A—OPTION 3. COMMUNICATIONS

THIRD YEAR

AT M. I. T.

Summer	2·04	Applied Mechanics	3–5
Term	2·371T	Testing Materials Lab.	2–1
	6·01T	Electrical Eng., Prin.	5–7
	6·76T	Electrical Eng. Lab.	4–4
			14–17

AT WORKS

First	6·02T	Electrical Eng., Prin.	5–6
Term	6·941	Communications Practice (Western Electric Co.)	40 h.p.w.

AT M. I. T.

Second	6·03T	Electrical Eng., Prin.	6–8
Term	6·77T	Electrical Eng. Lab.	6–6
	8·201	Electronics	3–5
	G51	Biography in Science	3–3
	M31	Differential Equations	2–4
			20–26

VI-A. Electrical Engineering, Group A—Option 3, Continued

FOURTH YEAR

At Works

Summer	6·31	Electrical Com. Prin.	3–5
Term	6·942	Communications Practice (N. Y. Telephone Co.)	40 h.p.w.

At M. I. T.

First	6·330T	Electrical Com. Lab.	6–8
Term	6·781T	Electrical Eng. Lab.	2–3
	8·50	Heat & Thermodynamics	3–4
	8·05	Vibrations and Sound	3–6
	Ec12	Political Economy	3–3
		General Study	3–3
			20–27

At Works

Second	6·32	Electrical Com., Prin.	3–5
Term	6·943	Communications Practice (Bell Telephone Lab.)	40 h.p.w.
		Grad. Study & Research	8

GRADUATE YEAR

At M. I. T.

Summer	6·501	Seminar	2–10
Term		Graduate Study & Thesis	22
			34

At Works

First	6·944	Communications Practice (Bell Telephone System)	40 h.p.w.
Term		Thesis	14

At M. I. T.

Second	6·502	Seminar	2–2
Term	15·63	Business Law & Org.	3–5
		General Study	3–3
		Grad. Study & Thesis	30
			48

Group B—Option 1. Manufacturing

THIRD YEAR

At Works

Summer	6·01T	Electrical Eng., Prin.	5–7
Term	6·901	Manufacturing Practice (General Electric Co.)	40 h.p.w.

At M. I. T.

First	2·04	Applied Mechanics	3–5
Term	6·02T	Electrical Eng., Prin.	5–6
	6·761	Electrical Eng. Lab.	2–3
	6·77T	Electrical Eng. Lab.	6–6
	Ec12	Political Economy	3–3
	M31	Differential Equations	2–4
			21–27

At Works

Second	6·03T	Electrical Eng., Prin.	6–8
Term	6·902	Manufacturing Practice (General Electric Co.)	40 h.p.w.

FOURTH YEAR

At M. I. T.

Summer	2·07	Applied Mechanics	3–5
Term	6·04T	Electrical Eng., Prin.	6–9
	6·78T	Electrical Eng. Lab.	4–5
			13–19

At Works

First	2·40	Heat Engineering	4–5
Term	6·903	Manufacturing Practice (General Electric Co.)	40 h.p.w.
		Graduate Study	4

At M. I. T.

Second	1·64	Hydraulics	3–6
Term	2·371T	Testing Materials Lab.	2–1
	2·42	Heat Engineering	4–5
	15·63	Business Law & Org.	3–5
	G51	Biography in Science	3–3
		Graduate Study *	14
			49

GRADUATE YEAR

At Works

Summer	6·904	Manufacturing Practice (General Electric Co.)	40 h.p.w.
Term		Seminar* and Thesis	10

At M. I. T.

First		General Study	3–3
Term		Graduate Study* & Thesis	42
			48

At M. I. T.

Second	6·502	Seminar	2–2
Term		General Study	3–3
		Graduate Study & Thesis	38
			48

Group B—Option 2. Public Utilities

THIRD YEAR

At Works

Summer	6·01T	Electrical Eng., Prin.	5–7
Term	6·911	Public Utility Practice (Edison Electric Ill. Co.)	40 h.p.w.
	6·921	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.	5–6
	6·761	Electrical Eng. Lab.	2–3
	6·77T	Electrical Eng. Lab.	6–6
	Ec12	Political Economy	3–3
	M31	Differential Equations	2–4
			21–27

At Works

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

*6·501 required some time before the second term of Graduate year.

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

FOURTH YEAR

At M. I. T.

Summer	2·07	Applied Mechanics	3–5
Term	6·04T	Electrical Eng., Prin.	6–9
	6·78T	Electrical Eng. Lab.	4–5
			13–19

At Works

First	2·40	Heat Engineering	4–5
Term	6·913	Public Utility Practice (Edison Electric Ill. Co.)	40 h.p.w.
	6·923	Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.
		Graduate Study	4

At M. I. T.

Second	1·64	Hydraulics	3–6
Term	2·371T	Testing Materials Lab.	2–1
	2·42	Heat Engineering	4–5
	15·63	Business Law & Org.	3–5
	G51	Biography in Science	3–3
		Graduate Study*	14
			49

GRADUATE YEAR

At Works

Summer	6·914	Public Utility Practice (Edison Electric Ill. Co.)	40 h.p.w.
Term	6·924	Public Utility Practice (Boston Elevated Ry.)	40 h.p.w.
		Seminar* & Thesis	10

At M. I. T.

First		General Study	3–3
Term		Graduate Study* & Thesis	42
			48

At M. I. T.

Second	6·502	Seminar	2–2
Term		General Study	3–3
		Graduate Study & Thesis	38
			48

Group B—Option 3. Communications

THIRD YEAR

At Works

Summer	6·01T	Electrical Eng., Prin.	5–7
Term	6·941	Communications Practice (Western Electric Co.)	40 h.p.w.

At M. I. T.

First	6·02T	Electrical Eng., Prin.	5–6
Term	6·76T	Electrical Eng. Lab.	4–4
	6·77T	Electrical Eng. Lab.	6–6
	8·50	Heat & Thermodynamics	3–4
	Ec12	Political Economy	3–3
	M31	Differential Equations	2–4
			23–27

At Works

Second	6·03T	Electrical Eng., Prin.	6–8
Term	6·942	Communications Practice (N. Y. Telephone Co.)	40 h.p.w.

*6·501 required before second term of Graduate year.

FOURTH YEAR

At M. I. T.

Summer	2·04	Applied Mechanics	3–5
Term	6·31	Electrical Com., Prin.	3–5
	6·330T	Electrical Com. Lab.	6–8
	6·781T	Electrical Eng. Lab.	2–3
			14–21

At Works

First	6·943	Communications Prac. (Bell Telephone Lab.)	40 h.p.w.
Term	8·05	Vibrations and Sound	3–6
		Graduate Study	4

At M. I. T.

Second	2·371T	Testing Materials Lab.	2–1
Term	6·32	Electrical Com., Prin.	3–5
	8·201	Electronics	3–5
	15·63	Business Law & Org.	3–5
	G51	Biography in Science	3–3
		Graduate Study*	14
			47

GRADUATE YEAR

At Works

Summer	6·944	Communications Practice (Bell Telephone System)	40 h.p.w.
Term		Seminar* & Thesis	10

At M. I. T.

First		General Study	3–3
Term		Graduate Study* & Thesis	42
			48

At M. I. T.

Second	6·502	Seminar	2–2
Term		General Study	3–3
		Graduate Study* & Thesis	38
			48

*6·501 required some time before second term of Graduate year.

VII. BIOLOGY AND PUBLIC HEALTH

THIS Department has as its objectives 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, three groups or options of professional studies have been established.

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, states, and cities, 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 schedule on page 58. To such students the degree of Bachelor of Science in Biology may be awarded on satisfactory completion of an approved program.

OPTION 2. INDUSTRIAL BIOLOGY. The course of studies in Industrial Biology is arranged primarily for those intending to follow the growing commercial or industrial applications of biologic processes as in food conservation and manufacture, industrial fermentations, and the control of biochemical processes.

The problems of utilization of microbes in productive enterprises and of the prevention of economic loss through the activity of micro-organisms in many branches of industry demand a knowledge of both microbiology and biochemistry which can be obtained here. Graduates in this option are especially well fitted to enter the industries dealing with food technology and conservation; the fisheries; the fermentation processes yielding glycerin, industrial alcohols, and other solvents, acids or commercial products; and the preservation of wood and textiles, and numerous other technical applications of biochemistry, enzymes, and microbiology.

This option leads to the degree of Bachelor of Science in Industrial Biology.

OPTION 3. PUBLIC HEALTH ENGINEERING. This option is arranged to meet the increasing demand for men who have knowledge of bacteriology and the principles of sanitation, public health, industrial hygiene, and public health administration, together with sound basic training in engineering. It prepares men for the type of work known as public health engineering. It includes the planning, supervising, and control of water supplies and waste disposal systems; the engineering supervision of milk suppply; the development of engineering projects for securing healthful environment through proper housing; the elimination of dangerous pests; drainage, etc. In addition the problems of industrial hygiene receive particular attention. This type of engineer will probably find a most useful field 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.

BIOPHYSICS. There is a recent trend in experimental biology which utilizes for investigation of biological phenomena the controlled applications of energy in various forms. The control of energy and measurement of its amount and to some degree its effects, have been the province of applied physics. In modern experimental biology, therefore, this new type of professional work is often referred to as Biophysics.

The approach of biophysics to the questions as to the nature of life processes appears likely to yield important results, one value of which is that they can be precisely defined in terms of physical units of measurement. Moreover since the work of the biophysicist is of necessity precise and susceptible of accurate definition, the important service of repetition and confirmation of results by independent workers becomes possible to a greater degree than is possible in the usual studies of a more descriptive nature.

A course of study may be arranged which is appropriate for one desiring to enter this wide field of combined border-line sciences. It comprises training in chemistry and physics, with emphasis on manipulative and experimental physics, the principles of electrical engineering, and a basic training in biology.

The problems in biology, pure and applied, which seem susceptible of profitable investigation by the

VII. Biology and Public Health Continued

trained biophysicist are highly diversified. They include the study of controllable dosages of the various forms of energy—including thermal, electrical, electromagnetic, magnetic, sonic, supersonic and chemical upon protoplasm; the study of the structure of protoplasms and their behavior under stimuli; vital chemistry; enzyme action; disease therapy; hormones, vitamins and nutrition. In the industrial field, biophysics may be applied to controlled microbiological processes for useful fermentations; to the prevention of spoilage of foods; and in other strictly industrial applications, as well as to health and life itself.

Successful experimenters and investigators in the biophysical field must be equipped with technical skill in designing and operating radio circuits, amplifiers, in optical measurements, in radiation sources and measurements, spectroscopy, ultra microscopy, temperature control, gaseous relations, scientific recording and the substitution of objective criteria for subjective sensory judgments should be in the equipment of the experimenter and investigator in this field.

So many diversified outlets and fields of more intensive specialization are possible in this general field that it is anticipated that electives will be appropriate in the final years of this curriculum in so far as possible. Guidance in selecting such a program of studies may be obtained from the registration officers in Biology or Physics.

VII. Biology and Public Health

Option 1 (a). Biology and Public Health
(b). Biology *

FIRST YEAR. See page 38

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	5·20	Chem. Water & Sewage*	4–1
	5·684	Physical Chemistry, Elem	3–3
	7·14	Comparative Anatomy	8–2
	7·301	Bacteriology	6–4
	7·50	Communicable Diseases	3–3
	Ec11	Political Economy	3–3
		General Study	2–2
			29–18
Second Term	5·25	Chemistry of Foods*	5–1
	7·08	Parasitology	2–4
	7·20	Physiology	6–4
	7·302	Bacteriology	5–3
	7·57	Municipal Sanitation*	4–3
	Ec12	Political Economy	3–3
		General Study	2–2
			28–20

FOURTH YEAR

First Term	7·22	Pers. Hygiene & Nutr.	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*	4–4
	7·542	Public Health Admin.*	2–3
	7·552	Serological Methods	6–1
		Thesis	16
		Elective	6
			47

Option 2. Industrial Biology

FIRST YEAR. See page 38

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

* 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

THIRD YEAR

First	5·20	Chem. Water & Sewage	4–1
Term	5·684	Physical Chemistry, Elem.	3–3
	7·15	Essentials of Anatomy	4–2
	7·301	Bacteriology	6–4
	7·701	Technol. Food Supplies	7–4
	Ec11	Political Economy	3–3
		General Study	2–2
			29–19
Second	5·25	Chemistry of Foods	5–1
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	Technol. Food Supplies	4–4
	Ec12	Political Economy	3–3
			29–20

FOURTH YEAR

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

Option 3. Public Health Engineering

FIRST YEAR. See page 38

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	2·04	Applied Mechanics	3–5
Term	5·20	Chem. Water & Sewage	4–1
	5·41	Organic Chemistry I	4–3
	7·301	Bacteriology	6–4
	7·50	Communicable Diseases	3–3
	7·53	Air Examination	3–0
	Ec11	Political Economy	3–3
		General Study	2–2
			28–21
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	Political Economy	3–3
		General Study	2–2
			24–24

FOURTH YEAR

First	1·41	Structures	3–6
Term	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	4–3
		General Study	2–2
		Thesis or Elective	3
			46
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	4–4
	7·542	Public Health Admin.	2–3
		Thesis	9
			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.

VIII. Physics Continued

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. For instance, work in biophysics can be arranged in collaboration with the biology department, starting with biology as well as physics in the second year and carrying both fields through the course. The registration officer should be consulted in regard to such rearrangements.

Industrial companies interested in applied physicists have arranged to give summer employment to a limited number of students in the summer between the third and fourth years, in coöperation with the department. Details regarding this coöperation can be arranged with the Director of Applied Physics.

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

Option 1. General Physics

FIRST YEAR. See page 38

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	6·00	Electrical Eng. Prin.	4–4
	6·75	Electrical Eng. Lab.	2–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
			24–26

THIRD YEAR

First Term	6·01T	Electrical Eng., Prin.	5–7
	8·09	Physical Measurements	3–2
	8·161	Optics	3–6
	8·162	Optical Measurements	3–2
	8·50	Heat and Thermodynamics	3–4
	Ec11	Political Economy	3–3
		Elective	6
			50
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	Political Economy	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	4–8
	8·471	Hist. Develop. Physics	3–6
		General Study	2–2
		Elective and Thesis	12
			49
Second Term	8·12	Experimental Physics	5–4
	8·13	Colloquium	2–2
	8·462	Int. Theoretical Physics	4–8
		General Study	2–2
		Elective and Thesis	20
			49

VIII. Physics Continued

Option 2. Applied Physics

FIRST YEAR. See page 38

Required during Summer

	5·11	Qualitative Analysis	7–2

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	6·00	Electrical Eng., Prin.	4–4
Term	6·75	Electrical Eng. Lab.	2–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
			24–26

THIRD YEAR

First	5·61	Physical Chemistry I	4–4
Term	5·611	(a) Physical Chem. Lab. I	4–0
	6·01T	Electrical Eng., Prin.	5–7
	6·761	(b) Electrical Eng. Lab.	2–3
	8·09	Physical Measurements	3–2
	8·161	Optics	3–6
	8·162	Optical Measurements	3–2
	Ec11	Political Economy	3–3
			(a) 25–24
			(b) 23–27
Second	3·61	Metallography	4–1
Term	5·62	Physical Chemistry II	4–4
	5·621	(a) Physical Chem. Lab. II	4–0
	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	Political Economy	3–3
		(b) General Study	2–2
			(a) 27–22
			(b) 25–24

FOURTH YEAR*

First	8·11	Experimental Physics	8–4
Term	8·461	Int. Theoretical Physics	4–8
		General Study	2–2
		Elective and Thesis	20
			48
Second	8·12	Experimental Physics	5–4
Term	8·13	Colloquium	2–2
	8·462	Int. Theoretical Physics	4–8
		General Study	2–2
		Elective and Thesis	20
			49

Biophysics. The substitution of certain subjects definitely in the field of physics may be arranged by the Registration Officer for those students of high standing who propose to pursue graduate work in Biophysics.

A statement about this program will be found under the Department of Biology and Public Health.

* For 1936–37 only. The permanent schedule includes Organic Chemistry and Organic Chemistry Laboratory.

IX-A. GENERAL SCIENCE

(Administered by a Committee of the Faculty)

THIS Course, largely elective in the senior year, is planned to offer first a substantial education along scientific lines, and to provide subsequently, through its electives, for a more intensive training in some one branch of science, or in closely interrelated sciences. There is, also, an opportunity to elect a considerable amount of humanistic studies.

Such a course possesses many advantages in view of the ever-increasing interrelations of the various sciences, and should prove particularly valuable to those who have not fully decided upon any particular line of specialization, or to those who intend to specialize in graduate work later. The choice of electives in the third and fourth years must in all cases be approved by the committee in charge of Course IX. The Course leads to the degree of Bachelor of Science in General Science.

FIRST YEAR. See page 38

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	2·501T	Heat Measurements	2–1
	5·41	Organic Chemistry I	4–3
	5·418	Organic Chemistry Lab.	6–0
	7·01	Biology, General	5–2
	12·01	Mineralogy	8–2
	Ec11	Political Economy	3–3
		Electives	10
			49
Second Term	12·30	Geology	4–1
	Ec12	Political Economy	3–3
	G64	Organic Evolution	2–2
		Elective	8
		Professional Elective	26
			49

FOURTH YEAR

First Term	12·31	Geology	5–3
		Elective and Thesis	38
		General Study	2–2
			50
Second Term		Elective and Thesis	46
		General Study	2–2
			50

IX-B. GENERAL ENGINEERING

(Administered by a Committee of the Faculty)

THIS Course is designed to meet the needs of those who desire training in fundamental engineering subjects, and who either do not wish to specialize in any particular branch of engineering, or who may wish to follow some line or lines of work not provided for by the schedule of any particular Course.

A schedule, except for that portion listed as elective, has been prepared and is offered as one suitable for a broad training in engineering. There is also opportunity for the election of economic and business subjects, or of courses in literature and modern languages. The choice of electives must be approved by the committee in charge of Course IX. The Course leads to the degree of Bachelor of Science in General Engineering.

FIRST YEAR. See page 38

SECOND YEAR

First Term	2·00T	Applied Mechanics	3–5
	2·701T	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
		Elective	5
			50

THIRD YEAR

First Term	2·04	Applied Mechanics	3–5
	2·40	Heat Engineering	4–5
	Ec11	Political Economy	3–3
		Electives	20
		General Study	2–2
			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	Political Economy	3–3
		Elective	3
		General Study	2–2
			50

FOURTH YEAR

First Term	2·686T	Engineering Laboratory	3–3
	6·85	Electrical Eng. Lab.	2–3
		Elective and Thesis	33
		General Study	2–2
			48
Second Term		Elective and Thesis	44
		General Study	2–2
			48

X. CHEMICAL ENGINEERING

THE needs of chemical industry for men competent to develop, design and operate new processes and to improve existing ones requires a training which combines knowledge both of the underlying chemical reactions and of the mechanical 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, organic and industrial 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 38

REQUIRED DURING SUMMER

	5·10	Qualitative Analysis	14–4

SECOND YEAR

First	5·12	Quantitative Analysis	7–2
Term	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	2·011	Applied Mechanics	3–5
Term	5·131	Quantitative Analysis	5–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	MS22	Military Science	3–0
		Language	3–5
		General Study	2–2
			25–23

Students not credited with German will take Elementary German. Students credited with German but not with French will take Elementary French. Other students will take Chemical Engineering Literature, 10·191 and 10·192.

THIRD YEAR

First	2·04	Applied Mechanics	3–5
Term	5·41	Organic Chemistry I	4–3
	5·416	Organic Chemistry Lab.	7–0
	5·61	Physical Chemistry I	4–4
	5·612	Physical Chem. Lab. I	2–0
	10·17	Industrial Chemistry	3–2
	Ec11	Political Economy	3–3
		General Study	2–2
			28–19
Second	2·371T	Testing Materials Lab.	2–1
Term	5·42	Organic Chemistry I	4–2
	5·426	Organic Chemistry Lab.	5–0
	5·62	Physical Chemistry II	4–4
	5·622	Physical Chem. Lab. II	2–0
	10·18	Industrial Chemistry	4–6
	10·28	Chemical Engineering	4–6
	Ec12	Political Economy	3–3
			28–22

FOURTH YEAR

First	6·40	Electrical Eng. Elem.	4–6
Term	10·21	Industrial Chemistry	2–2
	10·26	Industrial Chemical Lab.	5–1
	10·29	Chemical Engineering	3–6
	10·31	Chemical Engineering	5–4
	M41	Differential Equations	3–6
		Thesis	3
			50
Second	2·686T	Engineering Laboratory	3–3
Term	6·85	Electrical Eng. Lab.	2–3
	10·15	Thesis Reports	2–2
	10·32	Chemical Engineering	5–4
		Prof. Elective and Thesis	22
		General Study	2–2
			50

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 must 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 last part of the senior year. Students desiring to take this Course should apply in the first term of the fourth year and those accepted will spend the second term at the Field Stations of the School of Chemical Engineering Practice.

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

X-B. Chemical Engineering Practice Continued

Students desiring to take the work of the School of Chemical Engineering Practice as undergraduates may apply for admission during the first term of the fourth year of Course X. If accepted, they will substitute for the fourth year second term the program shown below.

FOURTH YEAR

SCHOOL CHEMICAL ENGINEERING PRACTICE

Second	10·30	Engineering Equipment	4–1
Term	10·32	Chemical Engineering	5–4
		*Field Station	12
		*Field Station	12
		Thesis	12
			50

*Students will take two of the following Stations:

10.84	Bangor	12
10.85	Boston	12
10.86	Buffalo	12

XI. SANITARY ENGINEERING

(ADMINISTERED BY THE DEPARTMENT OF CIVIL AND SANITARY ENGINEERING)

THE Course in Sanitary Engineering is arranged to train students in the principles of design and operation of water works and works for the disposal of sewage and other wastes. Although emphasis is placed upon the design and operation of such works, subjects of a fundamental and broad nature are also included in the curriculum to give the student a working knowledge of the whole field of sanitation and its relation to the public health.

The course of study includes those civil engineering subjects an understanding of which is required for complete engineering service in connection with the construction of sanitary engineering works, and also such subjects in mechanical and electrical engineering as are necessary to familiarize the student with the principles underlying the selection of pumping and treatment plant 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 design and operation of modern water works, water treatment plants, sewerage systems and sewage and waste disposal works.

Opportunities are offered to fourth year and graduate students for group inspection of nearby water and sewage works, and arrangements may be made which permit fourth year and graduate students to receive several days' training in the operation of both the water treatment plant of the City of Providence and the sewage treatment plant of the City of Worcester.

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 design and supervision of construction of water and sewage works; for employment with contractors or manufacturers engaged in the building of water and sewage plants or equipment therefor; and for entrance into the broader fields of city, state, or national public health work.

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

FIRST YEAR. See page 38

SECOND YEAR

First	5·11	Qualitative Analysis	7–2
Term	7·01	Biology	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	1·21	Rail. and High. Curves	2–2
Term	2·04	Applied Mechanics	3–5
	5·41	Organic Chemistry I	4–3
	6·40	Electrical Eng., Elem.	4–6
	6·89	Electrical Eng. Lab.	2–2
	Ec11	Political Economy	3–3
		General Study	3–3
			21–24

Second	1·22	Quantity Surveying	2–2
Term	1·40T	Structures	7–4
	1·62	Hydraulics	4–6
	2·371T	Testing Materials Lab.	2–1
	5·23	Sanitary Chemistry	8–1
	7·29	Bacteriology	5–2
	Ec12	Political Economy	3–3
			31–19

XI. Sanitary Engineering Continued

FOURTH YEAR

First Term	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
	6·89	Electrical Eng. Lab.*	2–2
		General Study*	2–2
		Thesis	2
			45
Second Term	1·42	Structures	2–4
	1·52	Structural Design	3–0
	1·58	Des. Reinf. Con. Struct.	6–0
	1·78	Sanitary Engineering	3–4
	1·802	Sanitary Design	5–0
	2·421	Heat Engineering	2–4
	2·687T	Hydraulic Laboratory	2–2
		Thesis	7
		General Study	3–3
			50

*For 1936–37 only. The permanent schedule for the fourth year includes 1·25T Engineering Construction and 5·684 Physical Chemistry.

XII. GEOLOGY

THE Course in geology is planned for students who wish to make geology, in its theoretical and practical aspects, their principal line of work. It, therefore, provides an adequate foundation of physics, chemistry, and mathematics, followed by the foundational courses of geology (mineralogy and general geology), which are in turn followed by the more advanced and specialized courses of the Department.

The Course is designed not only to meet the requirements of students seeking a broad general preparation but also to serve those intending to follow one of the several lines of specialization in the field of geology. The third and fourth years offer four options in Geology. All of these options have a desirable amount of flexibility by way of elective subjects to enable the individual student to secure the particular phases of work best suited to his requirements.

For students planning to enter the field of Engineering Geology, a combination of subjects is chosen from Options 1 and 2 and from Civil Engineering.

OPTION 1. GENERAL GEOLOGY AND STRATIGRAPHY. This option is planned for students who wish to acquire a broad general training in geology with emphasis of interest in paleontology, stratigraphy, sedimentation and allied fields. The students whose interests indicate professional work in the field of coal, petroleum, natural gas, should elect this option as foundation for their training.

OPTION 2. PHYSICAL AND ECONOMIC GEOLOGY. This option offers a broad general foundation in the subject and is designed for students whose interests and aptitudes lie in the direction of the physical and chemical aspects of geological processes and problems. This option should be elected by students interested in the application of physics and chemistry to fundamental research in geology and by students who plan to enter the field of geology as applied to ore deposits and non-metallic resources.

OPTION 3. MINERALOGY. This option, while offering a broad training in the field of geology, leads particularly to specialization in the field of mineralogy. It should be elected by students desiring to prepare themselves for specialization and research in the science of mineralogy. This field of interest has important relationships to many phases of industrial chemistry and metallurgy.

OPTION 4. GEOPHYSICS. This option is planned to provide fundamental training in both geology and geophysics. It is offered in recognition of the importance of training men along the combined lines of geology and geophysics and of the fact that exploration and development of mineral resources as well as certain phases of engineering will inevitably have a growing demand for the exploration engineer adequately trained in the essential phases of this work. Of equal importance, in the field of fundamental science, is the training of men for investigative work in those phases of geology dealing with seismology, the problems of the earth's interior, and other geophysical questions. This option should be elected by students desiring to enter the field of geophysics as applied to exploration for mineral and oil deposits and by those seeking adequate preparation for more advanced work in the theoretical phases of this subject.

All options lead to the degree of Bachelor of Science in Geology. (Continued on next page.)

XII. Geology Continued

Option 1. General Geology and Stratigraphy.

FIRST YEAR. See page 38

SECOND YEAR

First Term	7·01	Biology, General	5–2
	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
			27–20
Second Term	7·06	Botany	6–3
	8·04	Physics	6–4
	12·301	Geology	9–2
	E22	Literature and History	3–5
	MS22	Military Science	3–0
		Elective	8
			49

THIRD YEAR

First Term	12·211	Optical Crystallog.	4–2
	12·311	Historical Geology	3–3
	12·511	Paleontology	3–4
	Ec11	Political Economy	3–3
		Language	3–5
		General Study	2–2
		Elective	11
			48
Second Term	12·15	Petrography	8–2
	12·512	Paleontology	4–5
	12·70	Structural Geology	3–6
	Ec12	Political Economy	3–3
		Language	3–5
		General Study	2–2
			23–23

FOURTH YEAR

First Term	12·38	Geomorphology	3–6
	12·50	Stratigraphic Geology	4–5
		Elective and Thesis*	30
			48
Second Term	12·80	Geol. of Coal & Petrol.	4–3
		Elective and Thesis*	40
			47

*Total Thesis not less than 15 units.

Option 2. Physical and Economic Geology

FIRST YEAR. See page 38

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	8·04	Physics	6–4
	12·301	Geology	9–2
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Elective	6
			47

THIRD YEAR

First Term	5·61	Physical Chemistry I	4–4
	12·211	Optical Crystallog.	4–2
	12·311	Historical Geology	3–3
	Ec11	Political Economy	3–3
		General Study	2–2
		Elective	17
			47
Second Term	5·62	Physical Chemistry II	4–4
	12·15	Petrography	8–2
	12·40	Economic Geology	3–5
	12·70	Structural Geology	3–6
	Ec12	Political Economy	3–3
		General Study	2–2
			23–22

FOURTH YEAR

First Term	12·38	Geomorphology	3–6
	12·41	Economic Geology Lab.	8–0
		Language	3–5
		Elective and Thesis*	22
			47
Second Term	12·02	Mineralogy	5–1
	12·42	App. Economic Geology	3–6
	12·46	Econ. Geol. Non-Met. Dep.	3–3
		Language	3–5
		Elective and Thesis*	18
			47

*Total Thesis not less than 15 units.

XII. Geology Continued

Option 3. Mineralogy

FIRST YEAR. See page 38

SECOND YEAR

First	5·11	Qualitative Analysis	7–2
Term	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	5·12	Quantitative Analysis	7–2
Term	8·04	Physics	6–4
	12·301	Geology	9–2
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			31–19

THIRD YEAR

First	3·621	Metallography	9–3
Term	5·61	Physical Chemistry I	4–4
	12·211	Optical Crystallog.	4–2
	12·311	Historical Geology	3–3
	M23	Algebra and Geometry	3–6
		General Study	2–2
			25–20
Second	3·656	X-Ray Metallography	3–3
Term	5·62	Physical Chemistry II	4–4
	12·15	Petrography	8–2
	12·40	Economic Geology	3–5
	M24	Algebra and Geometry	3–6
		General Study	2–2
			23–22

FOURTH YEAR

First	5·061	Inorganic Chemistry	2–3
Term	12·41	Economic Geology Lab.	8–0
	Ec11	Political Economy	3–3
		Language	3–5
		Elective and Thesis*	20
			47
Second	5·062	Inorganic Chemistry	2–3
Term	12·02	Mineralogy	5–1
	Ec12	Political Economy	3–3
		Language	3–5
		Elective and Thesis*	24
			49

*Total Thesis not less than 15 units.

Option 4. Geophysics

FIRST YEAR. See page 38

SECOND YEAR

First	8·03	Physics	5–5
Term	12·01	Mineralogy	8–2
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
		Elective	9
			49
Second	8·04	Physics	6–4
Term	12·301	Geology	9–2
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Elective	6
			47

THIRD YEAR

First	12·311	Historical Geology	3–3
Term	Ec11	Political Economy	3–3
	M77	Vector Analysis	3–6
	M831	Analysis	3–6
		Language	3–5
		Elective	11
			49
Second	6·00	Electrical Eng., Prin.	4–4
Term	6·75	Electrical Eng. Lab.	2–2
	12·70	Structural Geology	3–6
	Ec12	Political Economy	3–3
	M832	Analysis	3–6
		Language	3–5
		General Study	2–2
			20–28

FOURTH YEAR

First	8·461	Int. Theoretical Physics	4–8
Term		General Study	2–2
		Elective and Thesis*	33
			49
Second	8·54	Electromagnetic Theory	3–6
Term	12·40	Economic Geology	3–5
	12·42	App. Economic Geology	3–6
	12·87	Int. Geophysical Prospect	2–2
		Elective and Thesis*	18
			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, proportion 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 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.

FIRST YEAR. See page 38

SECOND YEAR

First	2·00T	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	3–3
			24–24
Second	2·01	Applied Mechanics	3–5
Term	2·852	Machine Tool Practice	4–0
	8·04	Physics	6–4
	13·40	Ship Design	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	2·251T	Fluid Mechanics	5–3
	2·40	Heat Engineering	4–5
	13·01	Naval Architecture	3–5
	13·34T	Ship Construction	5–2
	Ec11	Political Economy	3–3
		General Study	2–2
			25–25
Second	2·06T	Applied Mechanics	3–5
Term	2·42	Heat Engineering	4–5
	2·683T	Engineering Laboratory	2–2
	13·02	Naval Architecture	3–5
	13·43T	Ship Design	3–0
	13·52	Marine Engineering	4–4
	Ec12	Political Economy	3–3
		General Study	2–2
			24–26

FOURTH YEAR

First	6·40	Electrical Eng., Elem.	4–6
Term	6·89	Electrical Eng. Lab.	2–2
	13·03	Naval Architecture	3–3
	13·45	Ship Design	8–0
	13·54	Marine Engineering	2–3
	13·61	Marine Engine Design	5–0
	15·11	Int. Business Management	3–3
		General Study	2–2
			29–19
Second	2·351	Materials of Eng.	2–2
Term	2·371T	Testing Materials Lab.	2–1
	2·684T	Engineering Laboratory	2–2
	13·55T	Marine Engineering	4–5
	13·62	Marine Engine Design	5–0
		Thesis and Elective	16
		General Study	2–2
			45

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 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 generally serve as cadets and 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 coördinate with the year at sea. In the second and third year, subjects are given in heat engineering, marine engineering, terminal operation, 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.

FIRST YEAR. See page 38

SECOND YEAR

First	2·00T	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
	G63	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
	13·83	Terminal Facilities	3–3
	15·61T	Law of Contracts	3–6
		Language	3–5
			19–29
Second	2·42	Heat Engineering	4–5
Term	2·685T	Engineering Laboratory	4–4
	13·021	Naval Architecture	2–3
	13·52	Marine Engineering	4–4
	15·52	Accounting	4–2
	G63	Economic Geography	3–3
		Language	3–5
			24–26

Beginning with the class of 1939, a student in this Course must have had a year's practical experience with a steamship company, nine months of which have been spent at sea, before he can take up the studies of the last year.

FOURTH YEAR

First	6·40	Electrical Eng. Elem.	4–6
Term	6·89	Electrical Eng. Lab.	2–2
	13·56	Marine Engineering	3–4
	13·81	Ship Operation	3–5
	Ec53	Corporations	3–4
		General Study	2–2
		Elective	6
			46
Second	2·685T	Engineering Laboratory	4–4
Term	2·854	Machine Tool Lab.	3–0
	13·47	Ship Design	6–0
	13·82	Ship Operation	2–4
		Thesis and Elective	22
		General Study	2–2
			49

The above schedules for third and fourth years are for 1936–37 only. The new permanent schedule for a given class includes only one year of Language and one course in Accounting and Economic Geography. In addition each class also studies Economics, Ocean Shipping Administration, and Ship Construction.

XIV. ELECTROCHEMICAL ENGINEERING

(Administered by the Department of Mining and Metallurgy)

ELECTROCHEMICAL Engineering is a composite Course in which most of the fundamental work of electrical engineering is combined with basic courses in chemistry as preparation for the more specialized work in electrochemistry and the related field of electrothermics. The Course aims primarily to prepare students to enter the various electrochemical, electrothermic and electrometallurgical industries. The instruction given in this Course is, however, of so broad a character that students completing it should be well prepared to enter various lines of electrometallurgical as well as electrochemical work, or to engage in research. The Course also offers a satisfactory foundation in the physical sciences for the subsequent study of patent law.

The electrical work begins in the second term of the second year and continues throughout the third year. The theory of direct and alternating currents and of direct and alternating current machinery is treated at length and the student becomes familiar in the laboratory with such electrical machinery as he is likely to meet in the practice of his profession. Courses dealing with the new and important subjects of electronics and electrical discharges in vacuo are also included. The instruction in chemistry includes the full course in qualitative analysis taken in the summer, followed by courses in analytical and organic chemistry.

Throughout the third year the principles of physical chemistry are treated from the kinetic and thermodynamic points of view both in lecture room and laboratory. The application of these principles to electrochemical processes is continued in the first term of the fourth year, the classroom work being accompanied by extended laboratory practice in electrochemical measurements. In the second term this work is concluded by a course in applied electrochemistry including electrodeposition, accumulators, electric furnaces and their products, electrolytic processes and electrometallurgy. Related to the work in electrometallurgy are courses in the examination of metals and alloys by the methods of metallography and x-ray analysis. The latter part of the Course is devoted principally to the preparation of a thesis on some electrochemicai topic.

In the fourth year elective studies are offered in the field of physics, chemistry, mathematics, metallurgy, and electrical engineering, for those who desire to specialize along particular lines of work.

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

FIRST YEAR. See page 38

Required during Summer

	5·10	Qualitative Analysis	14–4

SECOND YEAR

First	2·854	Machine Tool Lab.	3–0
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
			27–23
Second	6·10	Electrical Eng., Prin.	4–4
Term	6·82	Electrical Eng. Lab.	2–2
	8·04	Physics	6–4
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
			24–26

Students credited with Elementary and Intermediate French will take Elementary German. Students credited with Elementary and Intermediate German upon entrance will take Elementary French. Students credited with Elementary French and Elementary German upon entrance 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 as an elective in the third year.

THIRD YEAR

First	5·41	Organic Chemistry I	4–3
Term	5·418	Organic Chemistry Lab.	6–0
	5·61	Physical Chemistry I	4–4
	5·611	Physical Chemistry Lab. I	4–0
	6·11	Electrical Eng., Prin.	5–6
	6·83T	Electrical Eng. Lab.	4–4
	Ec11	Political Economy	3–3
			30–20
Second	5·62	Physical Chemistry II	4–4
Term	5·621	Physical Chem. Lab. II	4–0
	6·12	Electrical Eng., Prin.	5–6
	6·84	Electrical Eng. Lab.	5–5
	Ec12	Political Economy	3–3
		Elective	8
			47

FOURTH YEAR

First	2·50	Heat Measurements	3–1
Term	3·412	Metallurgy	3–3
	3·415	Metal. & Electroch. Lab.	4–0
	3·791	Electrochemical Lab.	9–3
	8·07	Precision of Measure	1–1
	8·82	Electrochemistry	3–6
		General Study	2–2
		Elective	8
			49
Second	3·656	X-Ray Metallography	3–3
Term	3·76	App. Electrochemistry	3–6
		General Study	2–2
		Elective	16
		Thesis	13
			48

XV. BUSINESS AND ENGINEERING ADMINISTRATION

THE Course in Business and Engineering Administration provides training for men who expect to attain managerial responsibilities in industrial, commercial, or financial enterprises where a scientific and engineering background is helpful.

In addition to the curriculum in business administration to be later described, the student in this Course is offered a choice of engineering electives, classified under two options:

(1) Engineering (including Civil, Mechanical, or Industrial Practice)

(2) Chemical Engineering.

In Option 1 (Engineering) basic subjects in applied mechanics, heat engineering, electricity and hydraulics, are complemented by further elective subjects grouped in three fields of concentration.*

(*a*) The Civil Engineering program meets the needs of students preparing for administrative positions in the transportation or construction industries.

(*b*) The Mechanical Engineering program qualifies students to deal with technical aspects of executive problems characteristic of mechanical and electrical manufacturing industries. Such establishments comprise a major cross-section of American industry.

(*c*) The Industrial Practice program differs chiefly from the Mechanical program by the requirement that the student enter supervised employment in industry for ten weeks during the Junior-Senior summer, and by the opportunity to elect most of the engineering subjects of the third and fourth years. In this way the student gains background in industrial methods which will be valuable in his senior business subjects, and the privilege of adjusting his technical curriculum more precisely to fit the personal interests clarified by summer employment. The number of students in Industrial Practice must of necessity be limited, and in the event of an excess of applicants the selection of candidates will be made by the staff of the Department.

In Option 2 (Chemical Engineering) students receive instruction in the important branches of theoretical and applied chemistry and in chemical engineering. This training has proved thoroughly adequate for men who expect ultimately to take executive positions in the manufacturing or commercial divisions of chemical industries such as paper, leather, rubber, heavy chemicals, pharmaceuticals, dyestuffs, paint and varnish, or other chemical industries. The Course should not be taken by men whose interests lie in research or other work of a highly technical nature.

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

These options offer the student much the same instruction in basic science and fundamentals of engineering as that provided by other Courses in the Institute. In the earlier years, he is also given fundamental courses in economics, statistics and banking. In the third and fourth years, instead of subjects involving design or highly specialized branches of engineering, the undergraduate takes a series of subjects dealing with problems in marketing, business law, production management, accounting, finance, labor relations and industrial policy which familiarize him with these business functions and their interrelationships. Instruction is given in such a way as to encourage the student to apply to business problems the habits of accurate observation and precise thinking which have been inculcated by his scientific and engineering training. In these later years, time is also reserved for a limited amount of specialization in a particular branch of engineering. Further requirements in language, literature, English composition, report writing, and cultural electives serve to develop the student's powers of expression and appreciation.

The objectives of the Course may best be illustrated by a brief description of the more important subjects. Executive problems of production and marketing are presented by the case method, classroom exercises being in the nature of business conferences. In the field of Finance, banking is considered from the standpoint of the business executive who as a customer makes use of banking facilities. The study of the financial organization of the corporation and its operating responsibilities relating to income, surplus and expansion emphasizes the problems of the individual establishment; and the treatment of securities and investments brings to the classroom the tested experience of coöperating lecturers from investment houses and banks. The instruction in Accounting is designed to provide future executives with an analytical instrument of control, rather than to train bookkeepers or professional accountants. In like manner, instruction in Business Law marks those areas of business relationships in which the executive may employ preventive rather than curative legal service. The subject of Labor Relations affords a grasp of trends in the fields of labor; and the study of the technique of executive control considers typical executive difficulties in the management of men. In the final term of the Senior year, a coördinative course in Industrial Problems is offered. This serves to give the student a broad picture of the responsibilities of the industrial administrator in unifying the operations of the various departments of a business.

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

XV. Business and Engineering Administration Continued

Option 1. Engineering

Group (a). Civil Engineering

FIRST YEAR. See page 38

SECOND YEAR

First	2·00T	Applied Mechanics	3–5
Term	8·03	Physics	5–5
	Ec11	Political Economy	3–3
	Ec31	Statistics	2–4
	E21	Literature and History	3–5
	M21	Calculus	3–6
	MS21	Military Science	3–0
			22–28
Second	2·01	Applied Mechanics	3–5
Term	8·04	Physics	6–4
	Ec12	Political Economy	3–3
	Ec40	Money and Banking	3–3
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			24–26

Required during Summer. At Camp Technology

1·041	Surveying	12–1
1·20	Rail. and High. Fieldwork	5–0
1·60	Hydrographic Survey	5–0

THIRD YEAR

First	1·21	Rail. and High. Curves	2–2
Term	2·04	Applied Mechanics	3–5
	6·40	Electrical Eng., Elem.	4–6
	6·89	Electrical Eng. Lab.	2–2
	15·61T	Law of Contracts	3–6
	15·81T	Marketing	3–6
	E35	Reports	2–4
			19–31
Second	1·22	Quantity Surveying	2–2
Term	1·40T	Structures	7–4
	1·62	Hydraulics	4–6
	15·50	Accounting	5–4
	15·70T	Production	3–6
		General Study	2–2
			23–24

FOURTH YEAR*

First	1·41	Structures	3–6
Term	1·48	Foundations	3–4
	2·371T	Testing Materials Lab.	2–1
	15·51	Industrial Accounting	4–3
	15·71	Production	3–3
	Ec53	Corporations	3–4
		General Study	2–2
		Thesis	3
			46
Second	1·421	Structures	2–4
Term	1·63	Hydraulics	2–3
	15·42	Corp. Finance & Invest.	3–5
	15·92	Industrial Problems	2–4
	Ec14	Current Economic Prob.	3–3
	Ec60	Labor Relations	4–4
		General Study	2–2
		Thesis	6
			49

Group (b). Mechanical Engineering

FIRST YEAR. See page 38

SECOND YEAR. Same as for Group (a)

THIRD YEAR

First	1·63	Hydraulics	2–3
Term	2·04	Applied Mechanics	3–5
	2·351	Materials of Eng.	2–2
	2·41T	Heat Engineering	3–5
	15·61T	Law of Contracts	3–6
	15·81T	Marketing	3–6
	E35	Reports	2–4
			18–31
Second	2·421	Heat Engineering	2–4
Term	2·74	Machine Design	4–0
	2·854	Machine Tool Lab.	3–0
	6·40	Electrical Eng., Elem.	4–6
	6·89	Electrical Eng. Lab.	2–2
	15·50	Accounting	5–4
	15·70T	Production	3–6
		General Study	2–2
			25–24

FOURTH YEAR*

First	1·63	Hydraulics	2–3
Term	2·686T	Engineering Laboratory	3–3
	2·74	Machine Design	4–0
	6·89	Electrical Eng. Lab.	2–2
	15·51	Industrial Accounting	4–3
	15·71	Production	3–3
	Ec53	Corporations	3–4
		General Study	2–2
		Thesis	3
		Professional Elective	2–2
			50
Second	15·42	Corp. Finance & Invest.	3–5
Term	15·92	Industrial Problems	2–4
	Ec14	Current Economic Prob.	3–3
	Ec60	Labor Relations	4–4
		Thesis	6
		Professional Elective	14
			48

Suggested Professional Electives

First	1·64	Hydraulics	3–6
Term	2·31	Foundry Practice	3–1
	2·651	Mech. Equip. of Bldgs.	2–2
	2·795	Automotive Vehicles	3–3
	2·871T	Manufacturing Eng.	3–6
	3·61	Metallography	4–1
	5·683	Physical Chemistry, Elem.	2–2
	15·73	Management Laboratory	4–2
	16·81	Aeronautics	3–1
Second	2·33	Welding Eng. & Practice	3–1
Term	2·65	Mech. Equip. Bldg. H. & V.	4–3
	2·796	Automotive Vehicles	3–3
	2·872T	Prep. for Manufacturing	3–3
	3·46	Metal. of Common Metals	3–3
	12·49	Geology of Materials	2–2

*Fourth year schedules are effective for 1936–37 only, and will be revised in the 1937 Catalogue.

XV. Business and Engineering Administration Continued

Group (c). Industrial Practice

FIRST YEAR. See page 38

SECOND YEAR. Same as Groups (a) and (b). See page 72

THIRD YEAR

First	6·40	Electrical Eng., Elem.	4–6
Term	6·89	Electrical Eng. Lab.	2–2
	15·61T	Law of Contracts	3–6
	15·81T	Marketing	3–6
	E35	Reports	2–4
		Engineering Elective †	3–6
			17–30
Second	15·50	Accounting	5–4
Term	15·70T	Production	3–6
		Engineering Electives †	24
		General Study	3–3
			48

Required during Summer

Employment in Industry for not less than ten weeks. In order to satisfy this requirement the character of the work must be acceptable to the Department.

FOURTH YEAR*

First	15·51	Industrial Accounting	4–3
Term	15·71	Production	3–3
	Ec53	Corporations	3–4
		Thesis	3
		General Study	2–2
		Approved subjects ‡	22
			49
Second	15·42	Corp. Finance & Invest.	3–5
Term	15·92	Industrial Problems	2–4
	Ec14	Current Economic Prob.	3–3
	Ec60	Labor Relations	4–4
		General Study	2–2
		App. Subjects ‡ & Thesis	16
			48

† Engineering Electives must be approved by a committee of the Department and must form a coördinated program for thorough study in a chosen field of science or engineering.

‡ Approved subjects. These subjects must be approved by a committee of the Department, and must form a coördinated program in some elected branch of science or engineering.

Option 2. Chemical Engineering

FIRST YEAR. See page 38

SECOND YEAR

First	5·11	Qualitative Analysis	7–2
Term	8·03	Physics	5–5
	E21	Literature and History	3–5
	Ec11	Political Economy	3–3
	M21	Calculus	3–6
	MS21	Military Science	3–0
		General Study	2–2
			26–23
Second	5·12	Quantitative Analysis	7–2
Term	8·04	Physics	6–4
	E22	Literature and History	3–5
	Ec12	Political Economy	3–3
	Ec31	Statistics	2–4
	Ec40	Money and Banking	3–3
	MS22	Military Science	3–0
			27–21

THIRD YEAR

First	5·41	Organic Chemistry I	4–3
Term	5·416	Organic Chemistry Lab.	7–0
	5·61	Physical Chemistry I	4–4
	15·50	Accounting	5–4
	15·61T	Law of Contracts	3–6
	E35	Reports	2–4
		General Study	2–2
			27–23
Second	6·40	Electrical Eng., Elem.	4–6
Term	10·201	Industrial Chemistry	4–4
	10·28	Chemical Engineering	4–6
	15·70T	Production	3–6
	15·81T	Marketing	3–6
		General Study	2–2
			20–30

FOURTH YEAR*

First	6·89	Electrical Eng. Lab.	2–2
Term	10·21	Industrial Chemistry	2–2
	10·26	Industrial Chem. Lab.	5–1
	10·35	Industrial Chem. Eng.	3–6
	15·51	Industrial Accounting	4–3
	15·71	Production	3–3
	Ec53	Corporations	3–4
		Thesis	3
		General Study	2–2
			50
Second	2·686T	Engineering Lab.	3–3
Term	10·36	Industrial Chem. Eng.	3–6
	15·42	Corp. Finance & Invest.	3–5
	15·92	Industrial Problems	2–4
	Ec14	Current Economic Prob.	3–3
	Ec60	Labor Relations	4–4
		Thesis	6
			49

*Fourth year schedules are effective for 1936–37 only, and will be revised in the 1937 Catalogue.

XVI. AERONAUTICAL ENGINEERING

(Administered by the Department of Mechanical 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 of all types of aircraft 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 some related professional field, such as internal combustion engines and meteorology. In this connection attention is invited to the work preparatory to graduate specialization in Meteorology, offered by the Department of Physics.

On account of the large number of students who wish to take the Course in Aeronautical Engineering, and on account of the limited facilities available, it has been found necessary to limit the number of men who may transfer into it from other institutions or from other Courses at the Institute. 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 whose work has been unsatisfactory may be required to withdraw from the course at any time in favor of better qualified men. Students not enrolled in the course are admitted to aeronautical subjects only when facilities permit and if their records are good.

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. This requirement may be waived, at the discretion of the head of the Course, for students holding degrees from accredited colleges and universities.

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, with the exception of 16·20, 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.

FIRST YEAR. See page 38

SECOND YEAR

First	2·00T	Applied Mechanics	3–5
Term	5·683	Physical Chemistry, Elem.	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	8·04	Physics	6–4
	10·16	Applied Chemistry	2–2
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
		Language	3–5
			23–27

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	2·35T	Materials of Eng.	3–3
	2·40	Heat Engineering	4–5
	2·701T	Machine Drawing	6–0
	6·40	Electrical Eng., Elem.	4–6
	16·01	Int. Aero. Mechanics	6–4
			26–23
Second	2·37	Testing Materials Lab.	4–2
Term	2·42	Heat Engineering	4–5
	2·686T	Engineering Laboratory	3–3
	6·89	Electrical Eng. Lab.	2–2
	16·02	Int. Aero. Mechanics	6–4
	16·10	Aerodyn. Airplane Des.	3–3
	16·20	Structures	3–5
			25–24

FOURTH YEAR

First	16·11	Aerodyn. Airplane Des.	6–4
Term	16·17	Airplane Des. Practice	8–0
	16·21	Structures	3–5
	16·62	Aeronautical Laboratory	4–3
	Ec11	Political Economy	3–3
		Elective	8
			47
Second	16·22	Aircraft Structures	3–5
Term	16·75	Const. Details Aircraft	7–2
	Ec12	Political Economy	3–3
		General Study	3–3
		Thesis & Elective*	18
			47

* Thesis not less than 10 units.

XVI. Aeronautical Engineering Continued

ELECTIVES

First	1·135	Int. to Vibration Theory	3–2
Term	2·791	Automotive Engines	4–4
	3·61	Metallography	4–1
	15·11	Int. Business Manage.	3–3
	16·901	Meteorology, Introduct.	2–2
		General Study	2–2

ELECTIVES

Second	2·792	Automotive Engineering	4–4
Term	15·12	Int. Business Manage.	3–3
	16·14	Airplane Des. Problems	6–6
	16·63	Aero. Lab. & Res. Meth.	4–2
	Ec56	Econ. of Transportation	2–4

XVII. BUILDING ENGINEERING AND CONSTRUCTION

(ADMINISTERED BY THE DEPARTMENT OF CIVIL AND SANITARY ENGINEERING)

THIS Course is intended to provide the student with the fundamental engineering training necessary to enable him to choose a career in one of four fields of activity related to building; (1) in Building Construction itself; (2) in Management and Planning as related to the management of buildings and realty developments; (3) in Research in Materials and (4) in Structural Engineering as a profession.

The prescribed Course schedule includes the subjects generally recognized as necessary for a basic engineering education, together with the specialized subjects that will provide all students with a practical knowledge of materials and the manner and sequence in which they are used in the construction of buildings in wood, masonry, reinforced concrete and structural steel, together with a basic understanding of quantity surveying, job management and business relations.

During his third and fourth years the student is encouraged to develop a career by choosing one of the four fields for which the Course prepares and he is given the opportunity to elect such subjects as he feels will best equip him for his work and in which he will be thoroughly interested. Such selection will also prepare students desiring to continue their studies in graduate work.

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

The Electives specified in the schedules may be selected in any one of four fields related to building.

1. In Building Construction itself for those who are interested directly in the contracting phases and job work.
2. In Management and Building as related to the management of buildings, estate and the planning of real estate and civic developments.
3. In Research in Materials which may be centered around metals, masonry or wood and which would lead to laboratory research, sales or manufacture.
4. In Building Engineering in which the student would have his activities center around structural engineering as a profession.

FIRST YEAR. See page 38

SECOND YEAR

First	2·00T	Applied Mechanics	3–5
Term	5·844	Engineering Chemistry	5–1
	8·03	Physics	5–5
	17·21	Building Construction	5–1
	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	8·04	Physics	6–4
	17·20	Building Forms & Details	2–2
	17·22	Building Construction	4–1
	17·73	Materials	2–1
	E22	Literature and History	3–5
	M22	Differential Equations	3–6
	MS22	Military Science	3–0
			26–24

REQUIRED DURING SUMMER. AT CAMP TECHNOLOGY

1·042	Surveying	22–1

THIRD YEAR

First	2·04	Applied Mechanics	3–5
Term	17·31	Building Construction	6–2
	17·51	Structural Analysis	5–1
	17·74	Materials	4–2
	Ec11	Political Economy	3–3
		General Study	2–2
		Elective	10
			48
Second	1·40T	Structures	7–4
Term	12·49	Geology of Materials	2–2
	17·32	Building Construction	6–2
	17·52	Structural Analysis	5–1
	Ec12	Political Economy	3–3
		Elective	13
			48

FOURTH YEAR

First	1·41	Structures	3–6
Term	2·371T	Testing Materials Lab.	2–1
	17·41	Building Construction	6–2
	17·53	Structural Analysis	5–1
		General Study	3–3
		Elective	12
		Thesis	4
			48
Second	1·42	Structures	2–4
Term	17·42	Building Construction	6–2
	17·50	Job Management	2–0
	17·54	Structural Analysis	5–1
		Thesis	10
		General Study	3–3
		Elective	10
			48

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 men who desire to study more mathematics than is contained in the professional Courses. It is well adapted to serve as a preparation for specialization in pure mathematics, in mathematical physics, or along lines of engineering requiring proficiency in mathematics.

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. Such a student will have to make up the subjects of Algebra and Geometry.

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

FIRST YEAR. See page 38

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
	M24	Algebra and Geometry	3–6
	MS22	Military Science	3–0
		Language	3–5
			21–26

THIRD YEAR

First Term	Ec11	Political Economy	3–3
	M731	Mechanics	3–6
	M77	Vector Analysis	3–6
	M831	Analysis	3–6
		Language	3–5
		General Study	2–2
		Elective	4
			49
Second Term	Ec12	Political Economy	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	8·461	Int. to Theoret. Physics	4–8
	M441	Projective Geometry	3–6
	M841	Analysis	3–6
		Elective and Thesis	18
			48
Second Term	8·462	Int. to Theoret. Physics	4–8
	M442	Elem. Diff. Geometry	3–6
	M842	Analysis	3–6
		Elective and Thesis	18
			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-eight years of age and who enter the Institute as first-year students, are required to complete satisfactorily the entire basic Course. Similarly qualified students who enter in the second year are required to complete the second year of the basic course. 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.

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 materiel 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 thereafter, 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.

In addition to the subjects prescribed for the particular unit in which enrolled, all students in the advanced Course are required to take MS98, Military History and Policy of the United States which is a 2–0 subject given in the First Term, and to register for MS31, MS32, MS41 and MS42 at one of the hours prescribed for MS11 or MS12.

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.

Reserve Officers' Training Corps Continued

Coast Artillery Unit

Open to students in all Courses. Students whose Institute Courses do not inciude surveying and who are unable to demonstrate proficiency in this subject will be required to take one of the Institute Surveying subjects. Omissions and other approved changes in Course schedules are noted on page 79 under the number of the Course.

THIRD YEAR

First	MS31	Leadership	1–0
Term	MS311	Fire control and gunnery for heavy artillery	3–2
Second	MS32	Leadership	1–0
Term	MS321	Fire control and gunnery for antiaircraft artillery	3–2

FOURTH YEAR

First	MS41	Leadership	1–0
Term	MS411	Artillery materiel; organization, administration, and duties of the Coast Artillery Corps	2–1
Second	MS42	Leadership	1–0
Term	MS421	Tactical employment of antiaircraft and heavy artillery	2–1

Engineer Unit

Open only to students in Courses I, II, III, IV-A, VI, VI-A, VII_3, IX-B, XI, XV_1a & b, XVI, and XVII. Approved changes in schedules are noted on page 79 under the number of the Course.

THIRD YEAR

First	MS31	Leadership	1–0
Term	MS312	Combat principles of small units; organization and duties of engineer units	2–2
Second	MS32	Leadership	1–0
Term	MS322	Military Engineering; fortifications, bridging, roads	2–2

FOURTH YEAR

First	MS41	Leadership	1–0
Term	MS412	Military engineering and tactical problems	1–1
Second	MS42	Leadership	1–0
Term	MS422	Military engineering and tactical problems	1–1

Signal Unit

Open only to students in Courses VI, VI-A, VI-B, VI-C, VIII, IX-B, XIV, XV_1b, XV_1c, and XVI. 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	MS31	Leadership	1–0
Term	MS313	Signal Corps tactics; message centers; elements of crypt analysis; code practice	3–2
Second	MS32	Leadership	1–0
Term	MS323	Military telegraphy and telephony; radio sets	3–3

FOURTH YEAR

First	MS41	Leadership	1–0
Term	MS413	Training methods; Reserve Corps regulations; procurement	1–1
Second	MS42	Leadership	1–0
Term			

Ordnance Unit

Open only to students in Courses II_1, $_2$, $_3$, $_5$, III_3, $_4$, V, VIII, X, X-B, XIV, XV_1b, XV_2 and XVI. 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	MS31	Leadership	1–0
Term	MS314	Storage and handling of ammunition	1–1
Second	MS32	Leadership	1–0
Term	MS324	Cannon construction and recoil mechanisms	1–1

FOURTH YEAR

First	MS41	Leadership	1–0
Term	MS414	Organization and duties of the Ordnance Department	1–1
Second	MS42	Leadership	1–0
Term	MS424	Organization and duties of the Ordnance Department	1–1

Chemical Warfare Unit

Open only to students in Course V, VII, X, X-B, XIV 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	MS31	Leadership	1–0
Term	MS316	Combat principles of infantry and the chemical platoon	2–2
Second	MS32	Leadership	1–0
Term	MS326	Tactics and technique of chemical warfare	2–2

FOURTH YEAR

First	MS41	Leadership	1–0
Term	MS416	Tactical employment of infantry and chemical troops	2–2
Second	MS42	Leadership	1–0
Term	5·43	Powder, Explosives, and War Agents	2–2

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.*	*Units*	*Change*	
II	3	2	C. A. C.; C. E.	Omit: General Study	2–2
	4	1	C. A. C.	Omit: Testing Materials Lab. 2·37	4–2
				Add: Testing Materials Lab. 2·371T	2–1
III_1	4	2	C. A. C.	Omit: General Study	2–2
III_2	3	2	C. A. C.; C. E.	Omit: General Study	2–2
	4	2	C. A. C.	Omit: Elective	3
III_3	3	2	C. A. C.; C. E.	Omit: General Study	3–3
III_4	3	2	C. A. C.; C. E.	Omit: General Study	2–2
V	4	1	C. A. C.	Omit: Elective	4
	4	2	C. A. C.; C. W. S.	Omit: Elective	4
			C. W. S.	Add: *Powder, Explosives and War Agents* 5·43	2–2
VI	3	1	C. A. C.; C. E.; S. C.	Omit: Applied Mechanics 2·04	3–5
			C. E.; S. C.	Add: Storage Batteries 6·29	1–1
	3	2	C. A. C.; C. E.; S. C.	Omit: Applied Mechanics 2·07	3–5
			C. A. C.; C. E.	Omit: Professional Elective	3–6
				Add: Applied Mechanics 2·04	3–5
			S. C.	Omit: Hydraulics 1·64	3–6
				Add: Applied Mechanics 2·04	3–5
	4	2	C. A. C.; C. E.; S. C.	Omit: Professional Elective	3–6
				Add: Applied Mechanics 2·07	3–5
			C. E.; S. C.	Add: Elec. Equip. Bldgs. 6·48	1–2
VII_1	3	1	C. A. C.; C. E.	Omit: General Study	2–2
VII_2	3	1	C. A. C.; C. E.	Omit: General Study	2–2
	4	1	C. A. C.	Omit: General Study	2–2
VIII	4	1	S. C.	*Include an elective that meets Signal Corps requirements*	3–6
	4	2	C. A. C.	Omit: General Study	2–2
			S. C.	*Include an elective that meets Signal Corps requirements*	3–6
IX-B	4	1	S. C.	*Include an Electrical Communications Subject or other elective approved by the Signal Unit*	3–6
	4	2	S. C.	*Include an Electrical Communications Subject or other elective approved by the Signal Unit*	3–6
X	4	2	C. A. C.; C. W. S.	Omit: Professional Elective	4
			C. W. S.	Add: *Powder, Explosives and War Agents* 5·43	2–2
XIII	4	2	C. A. C.	Omit: General Study	3–3
XIV	4	1	C. A. C.	Omit: Elective	3
	4	2	C. A. C.	Omit: Elective	2
			C. W. S.	Omit: Elective	4
				Add: *Powder, Explosives and War Agents* 5·43	2–2
XV_1a	4	1	C. A. C.	Omit: General Study	2–2
XV_1b	3	1	C. A. C.; C. E.; S. C.	Omit: General Study	2–2
	4	1	C. A. C.	Omit: Professional Elective	2–2
XV_1c	3	2	C. A. C.; C. E.	Omit: Approved Subjects	2–2
XV_2	4	1	C. A. C.	Omit: General Study	2–2
XVI	4	1	C. A. C.	Omit: Elective	4
	4	2	C. A. C.	Omit: Elective	4
XVII	3	2	C. A. C.; C. E.	Omit: General Study	2–2
XVIII	4	1	C. A. C.	Omit: Elective	4
	4	2	C. A. C.	Omit: Elective	4

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 at Huntington Hall, in the Architectural School Building. Each request for programs or tickets should be accompanied by a stamped, self-addressed envelope and mailed to Prof. W. H. Lawrence, Curator of the Lowell Institute, 491 Bolyston Street, Boston.

THE LOWELL INSTITUTE SCHOOL

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

The School comprises three courses — Mechanical Course, Electrical Course and Buildings Course, each extending over two years.

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

A circular giving detailed information regarding the nature of the entrance examinations and other requirements may be obtained by sending a stamped, addressed envelope to Prof. Charles F. Park, Director, The Lowell Institute School, Massachusetts Institute of Technology, Cambridge.

STAFF OF THE LOWELL INSTITUTE SCHOOL

REGULAR COURSES

CHARLES FRANCIS PARK, S.B.
Director; Mechanism and Internal Combustion Engines

RALPH RESTIEAUX LAWRENCE, S.B.
Applied Electricity II

GEORGE EDMOND RUSSELL, S.B.
Hydraulics

THEODORE HOWARD TAFT, S.B.
Thermodynamics and Steam Power

WILLIAM HENRY LAWRENCE, S.B.
Structural Design

RALPH GORTON HUDSON, S.B.
Electric Wiring and Lighting, and Electronics

IRVING HENRY COWDREY, S.B.
Materials, and Testing Materials Laboratory

ADDISON FRANCIS HOLMES, S.B.
Structural Mechanics and Graphic Statics

CARLTON EVERETT TUCKER, S.B.
Electric Machinery Laboratory, and Telephone Transmission

WILLIAM HENRY JONES, S.B.
Steam and Hydraulic Laboratory

RALPH GUY ADAMS, S.B.
Applied Mechanics

JAMES HOLT, S.B.
Heating and Ventilating, Power Plant Design and Air Conditioning

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 BALSBAUGH, S.M.
Applied Electricity I

ALVIN SLOANE, B.S.
Mechanism Design

JOHN DONALD MITSCH, S.B.
Reinforced Concrete

ROSS FRANCIS TUCKER, S.B.
Building Construction

ROY GIBSON BURNHAM, S.B.
CARL LOUIS SVENSON, S.M.
ROBERT BUTTERFIELD CHENEY
HERBERT CARLTON MOORE, S.M.
JAMES EDWARD MULLIGAN, S.M.
CLIFFORD EUGENE HENTZ
CARL MAGNUS FRITHIOF PETERSON, S.M.
WALTER WALERY SOROKA, S.M.
ROBERT WESTON VOSE, S.M.
CARL NEITZERT, SC.D.
GEORGE BURNHAM HOADLEY, S.M.
GORDON STANLEY BROWN, S.B.
ARTHUR EUGENE FITZGERALD, E.E., S.M.
JOHN ANTHONY HRONES, S.B.
CHARLES WINTERS MACGREGOR, PH.D.
HERMAN GUSTAV PROTZE, S.M.
CHARLES MATTHEW CURL, S.B.
JAMES ALBERT WOOD, JR., PH.D.
JACOB JOSEPH JAEGER, S.M.
DAVID ALFRED MOONEY, S.B.
DAVID DELL TERWILLIGER, S.M.
HENRY ARNOLD RAHMEL, S.M.

SUPPLEMENTARY COURSES

GEORGE WRIGHT SWETT, S.B.
Alignment Charts

ROBERT SEATON WILLIAMS, PH.D.
Metallurgy

IGOR NICHOLAS ZAVARINE, SC.D.
Heat Treatment

KARL DICKSON FERNSTROM, S.B.
Industrial Management

WYMAN PARKHURST FISKE, A.B., M.B.A., LL.B.
Accounting

ROBERT FAIRCHILD ELDER, A.B.
Marketing

ERNEST NAPOLEON GELOTTE, A.B.
Advanced Structural Design

HENRY FRANCIS KING, SC.D.
Diesel Engines

THE GRADUATE SCHOOL

ARCHITECTURE, ENGINEERING, SCIENCE

ADMINISTRATION OF THE GRADUATE SCHOOL

PRESIDENT KARL T. COMPTON, D.Sc., D.Eng., Ph.D., LL.D.
VICE-PRESIDENT VANNEVAR BUSH, D.Eng., Sc.D.
DEAN OF THE GRADUATE SCHOOL,* HARRY M. GOODWIN, Ph.D.

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B. A. THRESHER, S.B., A.M., *Director of Admissions, Secretary Ex-Officio*

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Professor of Biochemistry and Physiology

L. B. CHAPMAN, S.B.
Professor of Marine Transportation and Marine Engineering

O. G. C. DAHL, S.M.
Professor of Electric Power Transmission

W. M. FIFE, S.M.
Associate Professor of Civil Engineering

W. P. FISKE, A.B., M.B.A., LL.B.
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R. E. FREEMAN, M.A., B.Litt.
Professor of Economics

C. E. FULLER, S.B.
Professor of Theoretical and Applied Mechanics

W. S. HUTCHINSON, S.B.
Professor of Mining

W. H. LAWRENCE, S.B.
Professor of Architectural Engineering

J. F. NORRIS, Ph.D., Sc.D.
Professor of Organic Chemistry

H. B. PHILLIPS, Ph.D.
Professor of Mathematics

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

CHAIRMAN † OF DEPARTMENT AND COURSE COMMITTEES ON GRADUATE STUDENTS

Aeronautical Engineering	R. H. SMITH
Architectural Engineering	W. H. LAWRENCE
Architecture	WILLIAM EMERSON
Biology and Public Health	J. W. M. BUNKER
Business and Engineering Administration	E. H. SCHELL
Chemical Engineering	T. K. SHERWOOD
Chemistry	J. F. NORRIS
Civil and Sanitary Engineering	W. M. FIFE
Economics and Social Science	R. E. FREEMAN
Electrical Engineering	E. L. MORELAND
Electrochemical Engineering	W. S. HUTCHINSON
Geology	H. W. SHIMER
Mathematics	H. B. PHILLIPS
Mechanical Engineering	C. E. FULLER
Mining and Metallurgy	W. S. HUTCHINSON
Naval Architecture and Marine Engineering	L. B. CHAPMAN
Physics	J. C. SLATER

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

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

THE GRADUATE SCHOOL

HISTORY AND ORGANIZATION. The Graduate School of the Massachusetts Institute of Technology, including Science, Engineering, and Architecture, 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.

In 1884 courses leading to the degrees of Master of Science and Doctor of Philosophy were announced. The former degree was first conferred in 1886 and the latter in 1907, both to students in the Department of Chemistry. The first degree of Doctor of Science was conferred in the Department of Electrical Engineering in 1911. The degree of Doctor of Public Health was established in 1924 in the Department of Biology and was first conferred in 1925. In 1921 the degree of Master of Science for students in the Department of Architecture was changed to Master in Architecture. The degree of Doctor of Engineering, established in 1902, was discontinued in 1919.

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 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, Meteorology, Chemical Engineering, Civil Engineering, Electrical Engineering, Electrochemical Engineering, Mechanical Engineering, Mining Engineering, Petroleum Engineering, Metallurgy, Ceramics, Naval Architecture and Marine Engineering, Sanitary Engineering, the degree of Doctor of Science; in the Department of Biology and Public Health, the degree of Doctor of Public Health.

The registration in the Graduate School for 1935–1936 was 522 students, approximately one-fifth of the total registration of the Institute. Of these, 197 were pursuing courses leading to the Doctorate, 281 to the degree of Master of Science, 13 to the degree of Master in Architecture, and 31 were taking special work.

The cosmopolitan character of the School is indicated by the fact that the students were graduates from 182 universities, technical schools, or institutions of higher learning, distributed among 40 states and 15 foreign countries.

The work of the Graduate School is administered as follows: The Dean of the Graduate School is executive officer and chairman ex-officio of a 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.

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 Daniel Guggenheim Aeronautical Laboratory 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.

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 years' course of a college, university or technical school of recognized standing, and his scholarship records and credentials must be such as to indicate that he has the ability to meet the requirements of a higher degree. Applicants whose scholastic rating is low will not be admitted. Students who are pursuing courses leading towards a higher degree will be classified as graduate students. College graduates who pursue courses of study lead-

ing to the Bachelor's degree will be registered as undergraduates and those admitted without reference to meeting the requirements of any degree as special students.

Correspondence relating to the Graduate School should be addressed to the Dean of the Graduate School. The graduate work of each department is in charge of a Departmental Committee on Graduate Students, one member of which, usually the Chairman, is the representative of the Department of the Committee on the Graduate School. Inquiry regarding specific subjects of instruction, prerequisites and programs of work, should be addressed to the chairman of the Departmental Committee concerned.

Applications for admission to the Graduate School are to be made in duplicate on blanks obtainable from the Secretary of the Graduate School, except those of Naval Constructors appointed by the United States Government. Applications should, if possible be filed with the Secretary not later than May 1, in order that applicants may be advised regarding their standing before the beginning of the Summer Session. Frequently it is very desirable that deficiencies in undergraduate work be made up during the summer; in any case applications and credentials should be submitted *not less than three weeks before the opening of the term* in which the student expects to register. Applications from students who have not previously been in residence at the Institute must be accompanied by a certified transcript of their college records and letters from three or more professors acquainted with their work. As soon as applications for admission have been acted upon students will be notified. All new students other than Institute graduates should plan to reach Cambridge several days before the opening of the term and, upon their arrival at the Institute, *should consult the Dean of the Graduate School before filing their registration cards.* The Dean is the general consulting officer for graduate students on all matters pertaining to graduate work. Institute graduates should consult the chairman of the Committee on Graduate Students of the Department in which they elect their major work before registering.

Coöperation with Harvard University. Graduate students are given the opportunity of taking at Harvard University a limited number of courses 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 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 in person to the Dean of the Harvard Graduate School.

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. 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.

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 one year. 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 courses of study, 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.

Members of the instructing staff of the Institute may meet the requirements for the Master's degree by taking approved programs of work as described on page 86.

Requirements

Undergraduate Prerequisites

An applicant for the Master's degree, except in Architecture,* is expected to meet requirements in the following undergraduate subjects common to all curricula. 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 departmental committee in behalf of an applicant desiring to work toward an advanced degree in a specialized field within a department.

* For requirements in Architecture see page 96.

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 place of this requirement, the applicant may satisfy the Department in which he wishes to take advanced work that he has a good reading knowledge of scientific French or German.*

In exceptional cases Spanish may be accepted as meeting the language requirement. This will be allowed, however, only by petition which must have the endorsement 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 by examination.

MATHEMATICS. The equivalent of the Institute subjects in Mathematics in the first and second years, namely: differential and integral 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. One 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 courses in these subjects.

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 below under each Department respectively. Deficiencies in required undergraduate subjects must be removed before proceeding with dependent graduate work.

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. 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 specification 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 supervision of a member of the Institute Staff.

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 taking his principal work 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 more advanced in character than those required for the degree of Bachelor of Science. They are presented for mature 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 119–177. 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 178–204.

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 taken as preparation for graduate studies will not be considered as counting towards a higher degree. Sub-

* Both languages are required in certain departments as indicated below under the respective departments.

† For definition of "Unit" see page 38.

jects 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, 2 units are devoted to classroom work and 4 units are assigned for outside preparation. The subject would therefore count for 6 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 a connected 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 by the Committee on the Graduate School at its meeting in May, October, December, or February, and will be presented to the Faculty at its next following meeting with recommendation concerning the granting of a degree. 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. This course is open only to graduates of the Naval Academy, assigned to that duty by the Navy Department.

A one-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 and one-half years' duration in Chemical Engineering Practice (X-A) leading to the degree of Master of Science in Chemical Engineering Practice.

A course of one and one-half years' duration leading to the degree of Master of Science, for Chemical Warfare Officers detailed to the Institute by the United States Army, and similarly for Army Ordnance Officers and Army Engineers.

A five-year coöperative course is offered 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 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 was 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 needed for completing the requirements will depend upon the amount of work undertaken.

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

* The specific requirements for the degree of Doctor of Public Health are given on page 107.

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. These degrees will be conferred only upon candidates who have not only breadth of scientific attainment, but have also shown 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 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 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 work 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 the Departmental Committee on Graduate Students should be followed in these cases, but a student may not register for both degrees at the same time.

REQUIREMENTS

Students proceeding towards the doctorate will be under the general supervision of the Committee on Graduate Students of the Department in which they elect their "major" work.

The work for the degree consists mainly of scientific research and of the preparation of a thesis describing it. This must be supplemented, however, 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 taken 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. 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.

LANGUAGE. All candidates for the Doctor's degree must possess a good reading knowledge of scientific French and scientific German as shown by a reading test given by the Department of Modern Languages. *This test must be passed not less than seven months before the award of the degree.*

Students desiring an examination should consult the head of the Department of Modern Languages at least one week before the date set for the test. In the case of a student working for the degree of Doctor of Science in the field of engineering exception may be made and only one of the above languages required if approved by the Departmental Committee on Graduate Students in charge of the student's Major work.

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.

When 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 his Departmental Committee, 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 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 those candidates who receive their degree in person at 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. 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 Water Power Engineering (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 a 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, U. S. 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.

Advanced courses in Railway and Highway Transportation such as experimental work in the Highway 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 purification and other treatment of water, the disposal of sewage, and the treatment and disposal of industrial wastes and garbage. A course in Advanced Sanitary Design is given in connection with the study of the theoretical principles involved in the foregoing fields and designs are worked out for typical problems.

Arrangements have been made for graduate stu-

Civil and Sanitary Engineering Continued

dents in Sanitary Engineering to spend several days at the Providence water treatment plant, during which time they are instructed in the principles of coagulation, the chemical treatment of water and the operation of modern rapid sand filters. A similar short course is offered at the Worcester sewage treatment plant, where instruction is given in the operation of racks, grit chambers, Imhoff tanks, dosing tanks, trickling filters, secondary settling tanks and sludge drying beds. Both of these short courses include practice in routine laboratory tests.

Opportunities are also provided the student for inspecting typical plants in the vicinity of Boston 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
12·32	Geology
1·40T, 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
  - 1·42 Structures
  - 1·502 Structural Design
  - 1·58 Reinforced Concrete Design
- (*b*) Transportation Engineering
  - 1·25 Engineering Construction
  - 1·271, 1·272 Transportation Engineering
- (*c*) Hydroelectric Engineering
  - 6·40 Elements of Electrical Engineering
  - 1·70, 1·71 Water Power Engineering
- (*d*) Water Supply and Sewage Works
  - 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 subject, Elements of Electrical Engineering, 6·40, 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
5·23	Chemistry
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.

Summer	1·22	Quantity Surveying	2–2
Term	1·25T	Eng. Const. & Estimates	3–2
	1·402	Structures	4–8
	1·68	Theory of Models	2–4
	1·691	River Hydraulic Lab.	9–0
	2·38T	Testing Materials Lab.	3–2
			41
First	1·271	Transportation Eng.	6–5
Term	1·411	Structures	3–6
	1·491	Soil Mechanics	3–6
	1·541	Reinforced Concrete Des.	6–2
	1·70	Water Power Eng.	7–4
		Thesis	5
			53
Second	1·272	Transportation Eng.	5–4
Term	1·492	Soil Mechanics	3–6
	1·51	Adv. Structural Theory	3–6
	1·71	Water Power Eng.	6–3
		Thesis	17
			53

Civil and Sanitary Engineering Continued

GRADUATE SUBJECTS IN CIVIL AND SANITARY ENGINEERING

"A" Subjects. Primarily for Graduates

Available for graduates in either Civil or Sanitary Engineering.

First	1·141	Geodesy, Adv.	2–4
Term	1·301	Railway Trans. Adv.	2–4
	1·32	Design of Harbor Works	4–3
	1·371	Highway Trans. Adv.	2–4
	1·491	Soil Mechanics	3–6
	1·541	Reinf. Concrete Des., Adv.	6–2
	1·551	Structural Design, Adv.	6–0
	1·561	Structural Theory, Adv.	4–8
	1·571	Statically Indeter. Struct.	3–6
	1·59	Concrete Research	Time arr.
	1·66	Hydraulics Advanced	2–6
	1·68	Theory of Models	2–4
	1·691	River Hydraulic Lab.	9–0
	1·731	Water Power Eng., Adv.	3–6
	1·811	Sanitary Eng., Adv.	3–6
	1·851	Water Power Design, Adv.	8–0
	1·881	Sanitary Design, Adv.	6–0
Second	1·136	Vibration Problems	3–6
Term	1·142	Geodesy, Adv.	3–6
	1·302	Railway Trans. Adv.	2–4
	1·372	Highway Trans. Adv.	2–4
	1·492	Soil Mechanics	3–6
	1·51	Structural Theory Adv.	3–6
	1·542	Reinf. Concrete Des., Adv.	6–0
	1·552	Structural Design, Adv.	6–0
	1·562	Structural Theory, Adv.	2–6
	1·572	Statically Indeter. Struct.	3–6
	1·59	Concrete Research	Time arr.
	1·692	River Engineering	2–4
	1·732	Water Power Eng., Adv.	3–6
	1·812	Sanitary Eng., Adv.	3–6
	1·852	Water Power Design, Adv.	8–0
	1·882	Sanitary Design, Adv.	6–0
	1·90	Prof. Practice in Civil Eng.	1–2

"B" Subjects. Open to Graduates and Undergraduates

First	1·135	Intr. to Vibration Theory	3–2
Term	1·138	Seismological Lab.	Time arr.
	1·25T*	Engineering Construction	3–2
	1.271	Transportation Eng.	6–5
	1·34	Municipal Engineering	3–4
	1·41	Structures	3–6
	1·411	Structures	3–6
	1·48	Foundations	3–4
	1·501	Bridge Design	8–0
	1·531	Reinf. Concrete Design	10–0
	1·70	Water Power Eng.	7–4
	1·75	Hydraulic & San. Eng.	4–6
	1·801	Hydraulic & Sanitary Design	3–0
Second	1·138	Seismological Lab.	Time arr.
Term	1·16	Aerial Surveying	2–2
	1·26	Railway Signaling	2–3
	1·272	Transportation Eng.	5–4
	1·28	Railway Design	5–0
	1·38	Highway Design	5–0
	1·42	Structures	2–4
	1·421	Structures	2–4
	1·502	Structural Design	6–0
	1·52	Structural Design	3–0
	1·532	Reinf. Concrete Design	8–0
	1·58	Des. Reinf. Conc. Struct.	6–0
	1·71	Water Power Engineering	6–3
	1·76	Sanitary Engineering	2–3
	1·78	Sanitary Engineering	3–4
	1·79	Sanitary Design	2–0
	1·802	Sanitary Design	5–0
Summer	1·07†	Geodetic Surveying (B)	10–0
	1·25T	Engineering Construction (B)	3–2
	1·41	Structures (B)	3–6
	1·68	Theory of Models (A)	2–4
	1·691	River Hydraulic Lab. (A)	9–0

* Not offered 1936–37.

† Given if sufficient number of students apply.

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, 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 to complete the requirements for the Doctor's degree.

M.I.T. ANNUAL CATALOGUES AND BULLETINS
1936/37

02
OF
03

Mechanical Engineering Continued

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 six ice-making machines of different types, a number of refrigerator units with considerable auxiliary equipment and a constant-temperature room.

An Air Conditioning Laboratory containing air washers, humidifying and refrigerating equipment, oil-fired and gas-fired boilers, auxiliary equipment, and a special insulated room for the study of air conditioning and heating and ventilating 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 -40° 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.

A Metal Processing Laboratory, equipped with more than thirty welding machines representing practically all of the methods used in gas and electric welding. This laboratory is in close coöperation with the laboratories in testing materials, heat treatment and metallography, a foundry fully equipped for molding and casting iron and non-ferrous metals, and a forge shop.

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%. This laboratory also contains completely equipped photoelastic apparatus, extensometers and special strain measuring devices of extreme sensitivity.

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 Departmental machine shop, manned by expert machinists.

In addition to the foregoing laboratories, there are available, in connection with research work in physical metallurgy and heat treatment, the extensive laboratories of the Mining Engineering 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	Res. Photoelas.	Time arr.
	2·131	Dynamics of Engines	2–4
	2·201	Adv. Mech. & Th. of Elast.	3–9
	2·221	Plasticity	3–6
	2·222	Adv. Plasticity Prob.	Time arr.
	2·271T	Hydromechanics	3–6
	2·273	Adv. Hydromech. Prob.	Time arr.
	2·391	Dyn. Strength of Metals	5–3
	2·461	Refrigeration, Adv.	3–9
	2·53T	Heat Measurements	Time arr.
	2·57	Power Plants, Adv.	3–6
	2·63T	St. & Trans. of Foodstuffs	3–6
	2·671	Air Conditioning, Adv.	3–6
	2·751	Machine Design, Adv.	8–2
	2·801T	Auto. Engine Prob., Adv.	Time arr.
	2·803	Automotive Engineering	Time arr.
	2·88T	Met. & Dimens. Eng. Stand.	3–6
	2·905	Textile Tech. Anal.	3–5
	2·907	Textile Microscopy	5–2
	2·911	Textile Research Lab.	6–0
		Research	
Second Term	2·125	Research in Photoelasticity	Time arr.
	2·202	Adv. Mech. & Th. of Elast.	3–9
	2·221	Plasticity	3–6
	2·222	Adv. Plasticity Prob.	Time arr.
	2·272	App. Hydromechanics	3–6
	2·273	Adv. Hydromech. Prob.	Time arr.
	2·392	Dyn. Strength of Metals	5–3
	2·45	Eng. Thermodynamics, Adv.	3–6
	2·462	Heat Transmission, Adv.	3–9
	2·64T	Refrigeration Eng.	3–6
	2·672T	Heating & Vent. Design	4–4
	2·692	Refrig. & Air Cond. Lab.	4–6
	2·752	Machine Design, Adv.	8–2
	2·802T	Auto. Eng. Prob., Adv.	Time arr.
	2·804	Automotive Eng.	Time arr.
	2·906	Textile Tech. Anal.	3–5
	2·908	Textile Microscopy	5–2
	2·912	Textile Research Lab.	6–0
		Research	

Mechanical Engineering Continued

A number of Group A subjects listed in other Courses may be taken for credit in the field of Mechanical Engineering. Such, for example, as:

First Term	1·59	Concrete Research	Time arr.
	3·651	Physical Metallurgy, Adv	Time arr.
	13·73	Mechanical Vibration	3–6
	M36	Calculus, Adv.	3–6
Second Term	1·59	Concrete Research	Time arr.
	3·652	Physical Metallurgy, Adv.	Time arr.
	13·74	Mechanical Vibration	3–6
	M37	Calculus, Adv.	3–6

"B" Subjects. Open to Graduates and Undergraduates

First Term	2·081	Applied Mechanics	3–5
	2·10T	Ordnance Engineering	3–3
	2·121	Applied Photoelasticity	3–2
	2·37	Testing Materials Lab.	4–2
	2·43	Heat Engineering	3–5
	2·44T	Thermodynamics of Mixtures	2–4
	2·51T	Heat Measurements	3–3
	2·55T	Power Plant Engineering	3–3
	2·621	Refrigeration Engineering	3–3
	2·66	Heat., Vent. & Air Cond.	3–5
	2·681	Engineering Lab.	3–3
	2·732	Machine Design	4–2
	2·791	Automotive Engines	4–4
	2·793	Automotive Eng. Des.	6–0
	2·795	Automotive Vehicles	3–3
	2·797	Automotive Vehicle Des.	6–0
	2·871T	Manufacturing Eng.	3–6
	2·901T	Prin. of Fabric Structure	3–5
	2·903	Elem. of Textile Manufact.	3–5
Second Term	2·082	Applied Mechanics	3–5
	2·11	Industrial Plant Eng.	3–3
	2·121	Applied Photoelasticity	3–2
	2·34T	Welding Eng., Adv.	4–2
	2·52T	Heat Measurements	5–2
	2·56T	Power Plant Engineering	3–3
	2·58T	Heat Eng. in Ind. Plants	3–5
	2·622T	Refrigeration Eng.	3–5
	2·681	Engineering Lab.	3–3
	2·682	Engineering Lab.	3–3
	2·69	Refrig. & Air Cond. Lab.	6–6
	2·691T	Refrigeration Lab.	2–2
	2·792	Automotive Engines	4–4
	2·794	Automotive Engine Des.	3–0
	2·796	Automotive Vehicles	3–3
	2·798	Automotive Vehicle Des.	3–0
	2·82	Diesel Engine Design	6–0
	2·83T	Steam Turbine Eng.	4–2
	2·872T	Preparation for Manufac.	3–3
	2·902	Prin. of Fabric Structure	3–6
	2·904	Prin. of Textile Manufac.	3–6

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 2·801T, 2·802T, 2·803, 2·804, 2·131, 2·871T, 2·872T, 3·714, 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 2·53T, 2·671, 2·672T, 2·692, 7·531 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, 2·63T, 2·64T, 2·692 and such other subjects as may be approved by the Department Committee on Graduate Students.

Textile Engineering. To meet the demand for opportunities to study advanced textile questions the Institute has fully equipped a Textile Laboratory where the physical study of textile fibers, yarns and fabrics is carried out in detail. Students desiring to specialize in Textile Engineering for a year of graduate study leading to the degree of Master of Science in Mechanical Engineering, should register for subjects 2·905, 2·906, 2·907, 2·908, 2·911 and 2·912, and such other subjects as may be approved by the Department Committee on Graduate Students.

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 Term	2·151	Dynamics	2–4
	2·201	Adv. Mech. and Th. Elas.	3–9
	2·352	Materials of Engineering	1–2
	2·59T	Torpedoes	2–4
	2·761	Machine Design	6–2
	2·781T	Automatic Machinery	3–3
	3·713	Heat Treatment	3–2
	3·731	Physical Metallurgy, Adv.	4–4
			24–30
Second Term	2·122	Applied Photoelasticity	3–1
	2·152	Dynamics	2–4
	2·202	Adv. Mech. and Th. Elas.	3–9
	2·762	Machine Design	6–2
	2·782	Automatic Machinery	4–4
	3·732	Physical Metallurgy, Adv.	8–2
	5·75	Thermodynamics	2–2
			28–24

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 Term	2·05	Applied Mechanics	4–6
	3·413	Production Metallurgy I	3–3
	5·04	Chemistry	4–5
	5·412	Organic Chemistry and Lab.	6–4
	M75	Mathematics	4–6
			21–24
First Term	2·71	Theory and Appl. of Mech.	6–8
	3·414	Production Metallurgy II	3–3
	3·65	Physical Metallurgy	4–6
	5·413	Organic Chem. and Lab.	6–0
	6·42	Electrical Eng., Elem.	5–5
	10·38	Explosives Plant Engineering	6–4
			30–26
Second Term	2·203	Theory of Elasticity	3–5
	3·653	Physical Metallurgy, Adv.	3–5
	6·85	Electrical Eng. Lab.	2–3
	10·39	Theory of Interior Ballistics	3–5
		Thesis	25
			54

MINING AND METALLURGY

Including Petroleum Engineering, Electrochemical Engineering, and Ceramics

Graduates of other colleges taking subjects leading to the Master's degree in these fields must, in addition to the undergraduate requirements for the Master's degree, have taken other subjects in drawing, science and engineering equivalent in quantity and quality, broadly interpreted, to those in the curriculum of the option in which they desire to specialize. Deficiencies in these subjects may be made up in the summer or during the regular school year.

In order to register for "A" subjects in Mining Engineering, Petroleum Engineering, Metallurgy or Physical Metallurgy, the candidate must have taken the undergraduate professional subjects set up as required preparation; without these or their equivalent, he will be required to take additional undergraduate work which will be credited as "B" subjects or not, according as the rules require.

Opportunity is offered for graduate study and research in Ceramics, leading to the degree of Master or Doctor of Science. The purpose is to give the student broad training in the fundamentals of this subject so that he may be fitted to take a responsible position in the industry. Students intending to take advanced work in Ceramics should take 3·94, Optical Ceramics, and 3·93, Ceramics, in the fourth year.

Mining Engineering

Graduate instruction in mining engineering is dependent upon the subjects covered in the undergraduate courses of that name and students wishing to enter the graduate subjects should have had the equivalent of the undergraduate course and a certain amount of experience in mining practice as well. Instruction is offered in advanced mining engineering, mine valuation, mining economics, mining law, and in special branches of ore dressing. Such studies may lead to the degree of Master of Science or Doctor of Science.

"A" Subjects. Primarily for Graduates

First	3·061	Mining Eng., Adv.	Time arr.
Term	3·101	Mine Valuation	3–8
	3·241	Ore Dressing, Adv.	Time arr.
	3·251	Th. & Prac. of Flot.	Time arr.
	3·26	Ore Dressing Econ.	Time arr.
	3·271	Ore Dressing Des.	Time arr.
	3·331	Fire Assay., Adv. Research	Time arr.
Second	3·062	Mining Eng., Adv.	Time arr.
Term	3·102	Mine Valuation	3–8
	3·12	Econ. of Mining, Adv.	Time arr.
	3·242	Ore Dressing, Adv.	Time arr.
	3·252	Th. & Prac. of Flotation	Time arr.
	3·26	Ore Dressing Econ.	Time arr.
	3·272	Ore Dressing Des.	Time arr.
	3·332	Fire Assay., Adv. Research	Time arr.

"B" Subjects. Open to Graduates and Undergraduates

First	3·03	Economics of Mining	2–4
Term	3·13	Appl. of Science to Prospect.	4–2
	3·412	Met: Copper & Lead	3–3
Second	3·04	Principles of Mining	2–4
Term	3·07	Mining Eng.	2–6
	3·21	Ore Dressing	3–2
	3·22	Ore Dressing Lab.	7–2
	3·42	Met: Gold & Silver	5–2

Petroleum Engineering

The petroleum engineer finds it necessary to be conversant not only with his own specialty but with other branches of science and engineering. If engaged in operating, he is faced almost daily with problems calling for a comprehensive knowledge of geology, chemistry, civil engineering, mechanical engineering, electrical engineering, and sanitation and health.

Generally a student having completed the regular course of four years finds it advantageous to begin practice in the oil fields. After such experience in practical work the graduate may desire to enter upon postgraduate studies which may lead to the degree of Master of Science or Doctor of Science.

"A" Subjects. Primarily for Graduates

First	3·901	Oil & Gas Land Val.	3–8
Term	3·911	Petroleum Eng. Adv.	Time arr.
	3·921	Oil & Gas Law Research	2–4
Second	3·12	Econ. of Mining, Adv.	Time arr.
Term	3·902	Oil & Gas Land Val.	3–8
	3·912	Petroleum Eng., Adv.	Time arr.
	3·922	Oil & Gas Law Research	2–4

The following "A" subjects offered in other departments are related to Petroleum Production and may be included as a part of a program of study leading toward the Master's degree in this field.

First	10·37	Flow of Fluids	3–6
Term	10·64	Applied Colloid Chemistry	3–6
	10·68	Corrosion	2–4
	12·351	Geological Survey, Adv.	4–4
	12·521	Paleontology, Adv.	4–3
	12·54	Micropaleontology	4–2
	12·581	Sedimentation	4–4
	Ec37	Adv. Economic Statistics	2–6
Second	10·44	Distillation & Absorption	3–6
Term	10·61	Thermodyn. of Hydrocarbons	3–6
	12·352	Geological Survey, Adv.	4–4
	12·522	Paleontology, Adv.	4–3
	12·53	Index Fossils	6–2
	12·582	Sedimentation	4–4
	12·81	Geology of Petroleum, Adv.	3–2
	Ec38	Statis. Meth. for Quality Control	2–6

"B" Subjects. Open to Graduates and Undergraduates

First	3·03	Economics of Mining	2–4
Term	3·13	Appl. of Science to Prospect.	4–2
	3·69	Cor. & Heat Resisting Alloys	2–4
	3·85	Petroleum Production	4–4
Second	3·04	Principles of Mining	2–4
Term	3·86	Petroleum Production	3–4

Mining and Metallurgy Continued

Metallurgy

Graduate work leading to the degrees of Master of Science and Doctor of Science in the field of Metallurgy may be carried out along a number of lines. The broad divisions are Ferrous Metallurgy, covering the various phases of the metallurgy of iron and steel, and Non-Ferrous Metallurgy, with its numerous subdivisions, gold, silver, copper, lead, zinc, aluminum, nickel, etc. In the case of all these metals there are numerous fields of investigation regarding the methods and processes of metal production, the production of alloys and investigation of their properties, the effects of impurities on the metals and methods for their removal, and the effects of heat treatment and mechanical work on structures and properties.

In the metallurgical laboratories facilities are provided for the preparation of metals and alloys, the roasting and special treatment of ores, the extraction of metals from their ores by both smelting and wet extraction or leaching methods, also for advanced work in the theory and practice of fire assaying, the heat treatment of metals and alloys, and for advanced metallographic work.

"A" Subjects. Primarily for Graduates

First Term	3·331	Fire Assaying, Adv.	Time arr.
	3·501	Met. Iron & Steel, Adv.	Time arr.
	3·511	Metal. Plant Design	13–0
	3·53	Non-Fer. Metal., Adv.	Time arr.
	3·54	Gold & Silver Met., Adv.	Time arr.
	3·651	Phys. Metallurgy, Adv.	Time arr.
		Research	
Second Term	3·332	Fire Assaying, Adv.	Time arr.
	3·502	Met. Iron & Steel, Adv.	Time arr.
	3·512	Metal. Plant Design	13–0
	3·52	Metallurgy, Gen., Adv.	Time arr.
	3·55	Metallurgical Calc., Adv.	2–6
	3·652	Phys. Metallurgy, Adv.	Time arr.
	3·74	Th. of Metal Hardening	2–4
		Research	

"B" Subjects. Open to Graduates and Undergraduates

Summer	3·60	Metallurgical Plant Visits	3–1
First Term	3·411	Metallurgy of Copper & Lead	4–3
	3·43	Metallurgy of Iron & Steel	7–3
		or	
	3·41	Metallurgy of Copper & Lead	8–3
	3·431	Metallurgy of Iron & Steel	3–3
	3·56	Metallurgical Plants	3–3
	3·66	App. of Metallography	6–2
Second Term	3·21	Ore Dressing	3–2
	3·22	Ore Dressing Lab.	7–2
	3·42	Metal. Gold & Silver	5–2
	3·44	Met. Gen. Zinc & Minor Metals	4–3
	3·45	Heat Treatment of Steel	2–1
	3·56	Metallurgical Plants	3–3
	3·66	App. of Metallography	6–2

Physical Metallurgy

In recent years the field of Metallurgy has come to be divided into the closely related branches of Production Metallurgy (see under **Metallurgy**) and Physical Metallurgy. The first division deals chiefly with the production of metals from their ores and their refining. Physical Metallurgy is concerned with the properties and uses of the finished metals and their alloys. This branch of Metallurgy is less than forty years old and only in the last few years has it developed to an extent that would justify its consideration as a distinct field of study. Its value both to science and industry has been definitely established and its application to all processes in which metals are involved is rapidly increasing.

The laboratories are equipped with gas and electric furnaces for the making of alloys in small quantities and through coöperative arrangements alloys may be made on a commercial or 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. Through coöperation with the Department of Mechanical Engineering, physical testing of all sorts is possible.

In addition to these possibilities for investigation in the general field of Physical Metallurgy, opportunity is given for study and research in more specialized subjects such as welding, heat and corrosion resisting alloys, the light alloys, nitriding and the properties of cast iron. 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.

"A" Subjects. Primarily for Graduates

First Term	3·501	Met. of Iron & Steel, Adv.	Time arr.
	3·53	Non-Fer. Metal., Adv.	Time arr.
	3·651	Phys. Metallurgy, Adv.	Time arr.
	3·673	Physics of Metals, Adv.	Time arr.
	3·72	Ferromagnetism	2–4
		Research	
Second Term	3·502	Met. of Iron & Steel, Adv.	Time arr.
	3·652	Phys. Metallurgy, Adv.	Time arr.
	3·673	Physics of Metals, Adv.	Time arr.
	3·74	Th. of Metal Hardening	2–4
		Research	

"B" Subjects. Open to Graduates and Undergraduates

Summer	3·60	Metallurgical Plant Visits	3–1
First Term	3·66	App. of Metallography	6–2
	3·67	Physics of Metals	2–4
	3·69	Cor. & Heat Resisting Alloys	2–4
Second Term	3·422	Met. of Gold & Silver	2–2
	3·643	Light Alloys	2–4
	3·66	App. of Metallography	6–2

Mining and Metallurgy Continued

Electrochemical Engineering

The field of Electrochemical Engineering offers many opportunities for graduate work leading to the degrees of Master of Science or Doctor of Science in Electrochemical Engineering. Two general lines of advanced study are possible, the first dealing with the general applications of electricity to the production of important inorganic and organic chemicals and the second having to do with various branches of electrometallurgy and electrothermics. In the group of electrometallurgical processes are included problems of the production of metals from their solution of fused salts and the high temperature reactions involving the electric furnaces.

The electrochemical division includes one large laboratory and two smaller research rooms. The large laboratory deals essentially with high temperature problems. High frequency induction, arc and vacuum type furnaces with adequate A.C. and D.C. supply are available for the study of electrometallurgical and other electrothermic processes.

Undergraduate subjects, which may be taken at the Institute or elsewhere, but may not be counted for an advanced degree:

2·50	Heat Measurements
6·11, 6·12	Electrical Engineering Principles
6·83T, 6·84	Electrical Engineering Laboratory

"A" Subjects. Primarily for Graduates

First Term	3·80	Electrochemistry, Adv.	3–6
		Research	
Second Term		Research	

"B" Subjects. Open to Graduates and Undergraduates

First Term	3·412	Met., Copper Lead, Zinc	3–3
	3·791	Electrochemistry Lab.	9–3
	3·792	Electric Furnaces	3–2
	8·82	Electrochemistry	3–6
Second Term	3·76	App. Electrochemistry	3–6

Ceramics

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.

"A" Subjects. Primarily for Graduates

First Term	3·951	Fund. Ceramic Processes	7–4
	3·961	Sp. Problems in Ceramics	Time arr.
		Research	
Second Term	3·952	Phys. Prop. of Ceramic Prod.	5–4
	3·962	Sp. Problems in Ceramics	Time arr.
		Research	

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	2·53T	Heat Measurement II	Time arr.
	10·42	Drying	2–4
	10·70	Prin. of Combustion	4–6
Second Term	8·28	X-ray Diffraction	2–4
	8·29	Lat. Th. of the Solid State	2–4
	10·74	Furnace Design	3–6

"B" Subjects. Open to Graduates and Undergraduates

First Term	3·03	Economics of Mining	2–4
	3·94	Optical Ceramics	6–2
Second Term	3·04	Principles of Mining	2–4
	3·93	Ceramics	4–5

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.

Hereafter 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 of high grade to be prepared during the summer following the two terms of graduate work. At the discretion of the School of Architecture one or more students may be chosen annually from those

Architecture Continued

completing graduate requirements to continue a year of study in Architecture without being required to pay tuition on the condition that they render at least two problems in the course of the academic year of a grade not below that of second medal.

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.

While the following courses in the fields of Architecture, Composition, and History 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 both by the Dean of the Graduate School and of the School of Architecture.

2·031T	Structural Mechanics
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
4·331	Theory of Architecture
4·332	Theory of Architecture
4·421	Architectural History
4·422	Architectural History
4·811	Construction
4·812	Construction
M111	Calculus

Foreign Language: The applicant should satisfy the School that he has a good reading knowledge of architectural French or an equivalent acquaintance with some other of the Romance Languages.

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. 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 of high grade to be prepared during the summer following the two terms of graduate work. 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 with the Institute degree of Bachelor in Architecture or its equivalent, 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 required 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.

In addition, graduates of engineering courses such as Civil or Sanitary Engineering may elect A and B subjects in City Planning offered by the School of Architecture for which they have had the required preparation, as part of a program of work leading to the degree of Master of Science without designation of department.

GRADUATE SUBJECTS IN ARCHITECTURE AND CITY PLANNING

"A" Subjects. Primarily for Graduates

First Term	4·053	Freehand Drawing	6–0
	4·491	European Civilization and Art	2–4
	4·661	City Planning Research	2–4
	4·691	City Planning Design, Adv.	36–0
	4·761	Architectural Design VI	36–0
Second Term	4·054	Freehand Drawing	6–0
	4·492	European Civilization and Art	2–4
	4·63	City Planning Admin.	2–4
	4·662	City Planning Research	2–4
	4·692	City Planning Design, Adv.	36–0
	4·762	Architectural Design VI	36–0
Summer		Graduate Thesis	

Architecture Continued

"B" Subjects. Open to Graduates and Undergraduates

First	1·34	Municipal Engineering	3–4
Term	4·051	Freehand Drawing	6–0
	4·091	Color. Comp., Th. & App.	1–4
	4·481	European Civilization and Art	2–3
	4·53	Professional Relations	1–2
	4·651	Th. & Prac. City Planning	3–3
	4·681	City Planning Design	25–0
	4·751	Architectural Design V	30–0
Second	4·052	Freehand Drawing	6–0
Term	4·092	Color. Comp., Th. & App.	1–4
	4·482	European Civilization and Art	2–3
	4·642	Th. & Prac. City Planning	3–3
	4·652	Th. & Prac. City Planning	3–3
	4·672	City Planning Design	18–0
	4·682	City Planning Design	12–0
	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.

Architectural Engineering

While no advanced work in Engineering is offered directly by the School of Architecture, the graduates of IV-A can fulfil the requirements for a Master's degree in Architectural Engineering through a course selected from the following allied subjects offered by the Engineering Departments.

The minimum requirements in undergraduate professional subjects which a student must present as a prerequisite for acceptance as a candidate for the Master's degree in the field of Architectural Engineering are as follows:

1·02	Surveying
1·40T	Structures
1·41	Structures
1·42	Structures
1·48	Foundations
1·531	Reinforced Concrete Design
1·532	Reinforced Concrete Design
2·351	Materials of Engineering
2·371T	Testing Materials Laboratory
2·38T	Testing Materials Laboratory (concrete)
2·65	Mechanical Equipment of Buildings, Heating and Ventilation
4·22	Architectural Practice
4·25	Estimating & Management of Construction Operation
4·423	Architectural History
4·424	Architectural History
4·78	Planning Principles
4·911	Structural Analysis
4.912	Structural Design
4·921	Structural Design
4·922	Structural Design

"A" Subjects. Primarily for Graduates

First	1·491	Soil Mechanics	3–6
Term	1·551	Structural Design, Adv.	6–0
	1·561	Structural Theory, Adv.	4–8
	1·571	Stat. Indet. Structures	3–6
	1·59	Concrete Research	Time arr.
	2·201	Adv. Mech. & Th. of Elas.	3–9
Second	1·492	Soil Mechanics	3–6
Term	1·552	Structural Design, Adv.	6–0
	1·562	Structural Theory, Adv.	2–6
	1·572	Stat. Indet. Structures	3–6
	1·66	Hydraulics, Adv.	2–6
	2·202	Adv. Mech. & Th. of Elas.	3–9

"B" Subjects. Open to Graduates and Undergraduates

First	4·481	European Civilization and Art	2–3
Term	4·53	Professional Relations	1–2
Second	4·482	European Civilization and Art	2–3
Term	M54	Mathematical Laboratory	3–6

For descriptions of "A" and "B" subjects, see under Departments of Architecture, Civil Engineering, Mechanical Engineering and Mathematics.

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.

Complete language requirement	
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 Chemical Laboratory
5·424	Organic Chemical Laboratory
5·61	Physical Chemistry I
5·62	Physical Chemistry II

(Differential Equations M22 is not required of students specializing in Inorganic or Organic Chemistry.)

Chemistry Continued

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 in October of the last academic 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 without tuition charge, except a five dollar registration fee.

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 graduate work is an essential preparation for positions in connection with these laboratories. Since the work in such laboratories is of a widely varying nature, a student considering the possibilities in this field of work should endeavor to pursue that sort of 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 four 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 pressure to obtain special data for extending the theoretical treatment of equilibria, and on heats of reaction in solution, (c) on liquid solutions, and (d) on the absorption of radiation by gases and the chemical reactivity induced as related to atomic structure.

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 potentials at the junctions of salt solutions, 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.

Chemistry Continued

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, 5·741T, 5·742T, 5·79, 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 oral examinations in modern languages, should be passed during the first year. The minor may be completed and optional subjects taken during the second year in order that the third year may be left free as possible for research.

FIRST YEAR

5·76	Thermodyn. & Chemistry*	3–6
5·77	Thermodyn. & Chemistry	2–4
5·79	Theory of Solutions	2–4

SECOND YEAR

5·741T	Adv. Radiation Chemistry	2–4
5·742T	Kinetic Th. & Statis. Mech.	2–4

THIRD YEAR

5·931	Jour. Meet. in Phys. Chem.	1–1
5·932	Jour. Meet. in Phys. Chem.	1–1

Attendance at subjects 5·931 Journal Meetings in Physical Chemistry, 1–1, and 5·943 Research Conferences in Physical Chemistry, 1–1, is required in the first term of each year.

Attendance at subjects 5·932 Journal Meetings in Physical Chemistry, 1–1, and 5·944 Research Conferences in Physical Chemistry, 1–1, is required in the second term of each year.

It is generally advisable to postpone the beginning of Research (5·98) until the oral examination in modern languages and the subjects of the Minor have been completed.

* Students whose preparation in physical chemistry is not equivalent to courses 5·61, 5·62, 5·63T will take 5·71, 5·72T and postpone 5·76 and 5·77 until the second year.

The Research Laboratory of Organic Chemistry

A number of rooms are specially equipped for work in organic chemistry. The laboratories are open at all times. The division is well supplied with vacuum pumps, thermostats, electrical measuring instruments, mercury arcs, electrically heated closets and combustion furnaces, autoclaves, standardized thermometers, etc. A large variety of organic chemicals is available.

The offering of a number of advanced courses in organic chemistry makes it possible for the student to devote attention to those branches of the subject in which he is particularly interested.

Researches in Progress. Investigations in Organic Chemistry are directed by members of the instructing corps whose special interests lie in widely different fields. The chief investigations now in progress are as follows:

A comprehensive study is being made of the factors influencing the reactivity of atoms and groups in organic compounds. The problem is being investigated from the point of view of physical chemistry. Attention is being centered at present on the study of the reactivity of the chlorine atom, the hydroxyl group, the hydrogen of the hydroxyl group, and the hydrogen atoms in hydrocarbons.

The correlation of the properties and reactions of organic compounds in the form of an analytic procedure has been studied for many years. The results already published have proved invaluable to chemists concerned with the identification of organic substances. This 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. Particular attention is now being given to the systematic separation and identification of the components of mixtures.

Urea, thiourea and guanidine and their derivatives are being actively investigated with the result that considerable new information has been gained about the reactions of the simpler organic compounds of nitrogen such as cyanic acid and cyanamide. It has been shown that many reactions consist in the direct combination and subsequent breaking apart of molecules, and physico-chemical methods are showing the factors which determine the ease and extent of such reactions. An understanding of the mechanism in these cases has made possible a number of new syntheses. Other researches are devoted to the factors which determine the possibility of tautomerism and to the effect of groups on the reactivity of quinones and to the effect of polarized light in the synthesis and in the decomposition of asymmetric molecules.

The following subjects, in addition to those noted above, are being investigated.

Oxidation of meta-diphenols.
Complex metal-pyridine compounds.
The physical and chemical properties of tri-arylmethyls.
Action of ultra-violet radiation on organic reactions.
The chemistry of diphenic acid and its derivatives.
Catalysis in homogeneous systems.
Auto-oxidation reactions in organic chemistry.
Mechanism of the Friedel-Crafts reaction.
Raman and absorption spectra.
The chemistry of fluorenone and its derivatives.
Chemiluminescence.
Dehydrogenation reactions.
Low temperature pyrolysis of hydrocarbons.

Chemistry Continued

Structure of the guanidonium ion.
Cycloparaffines.
Anologues of carbonyls.
Condensations under the influence of sodium.
Color of carbonium salts.
Cancer producing hydrocarbons.
Synthesis and transformations of vitamin A.
The chemistry of natural vitamin D.
The chemistry of sex hormones.
Organic peroxides.
Effect of electric discharges on organic compounds.

The Research Laboratory of Inorganic 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.

Some of the subjects which have been investigated recently are as follows:

The preparation and properties of various halides of silicon and silico-organic compounds.
The reactions of the anhydrous halides of thorium in liquid ammonia and the study of the possibility of formation by thorium of lower valence compounds.
The action of fluorine with oxides and hydroxides.
The preparation and properties of the hydrides of boron.
The preparation of metal carbonyls and nitrosyl-carbonyls at ordinary temperature and atmospheric pressure.
Chemical reactions induced by the electrodeless discharge in gases; the dissociation of ammonia and of carbon dioxide.
Chemical reactions induced by sonic and supersonic vibrations.
Preparation of rare earth metals and pure compounds.
Artificial radioactivity and the isolation of elements heavier than uranium.
Organo-metallic compounds of indium (1936–37).
Elaboration of the chemistry of rhenium.
The thermal decomposition of thionyl chloride.
The equilibrium of the reaction between ferric ion and silver.

The analytical aspects of inorganic chemistry have been represented in the study of the methods of analysis of ores, alloys and steels for zirconium and for selenium, electrometric methods of analysis, and the analysis and purification of gas mixtures.

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.

GRADUATE SUBJECTS

"A" Subjects. Primarily for Graduates

First	5·071	Seminar Inorg. Chemistry	2–3
Term	5·08	Inorganic Lab., Adv.	6–0
	5·18	Qualitative Anal., Adv.	9–1
	5·51	Organic Chemistry II	2–2
	5·53	Organic Chemistry III	2–4
	5·55	Ident. Org. Compounds	10–0
	5·562	The Carbohydrates	2–4
	*5·574	Free Rad. & Org. Met. Comp.	2–2
	*5·58	Org. Subs. in Metab. Proc.	2–4
	5·581	Organic Lab., Adv.	6–1
	†5·584	Mol. St. of Carbon Comp.	2–4
	5·71	Physical Chemistry	4–6
	5·741T	Adv. Radiations Chem.	3–6
	5·76	Thermodyn. & Chemistry	3–6
	†5·852	Organic Physical Chem.	2–2
	†5·855	Th. & App. of Catalysis	2–2
	*5·90	Logic of Science	2–2
	5·911	Jour. Meet. Inorg. Chem.	1–1
	5·98	Research	Time arr.
Second	5·072	Seminar Inorg. Chemistry	2–3
Term	5·08	Inorganic Lab., Adv.	6–0
	5·52	Organic Chemistry II	2–2
	5·54	Organic Chemistry III	2–4
	†5·56	Chem. Heterocyclic Comp.	2–4
	*5·57	Chemistry of Dyes	2–2
	5·582	Organic Lab., Adv.	5–1
	5·72T	Physical Chemistry	2–4
	5·742T	Kinet. Th. & Statist. Mech.	2–4
	5·75	Thermodynamics	2–2
	5·77	Thermodyn. & Chemistry	2–4
	*5·79	Theory of Solutions	2–4
	5·851	Meth. Electrochem. Anal.	4–2
	5·912	Jour. Meet. Inorg. Chem.	1–1
	5·98	Research	Time arr.

"B" Subjects. Open to Graduates and Undergraduates

First	5·061	Inorganic Chemistry	2–3
Term	5·251	Chemistry of Foods	3–1
	5·26	Food Analysis	5–0
	5·63T	Int. to Thermodynamics	3–5
	5·842	Optical Methods	2–1
Second	5·062	Inorganic Chemistry	2–3
Term	5·251	Chemistry of Foods	3–1
	5·26	Food Analysis	5–0
	5·43	Powd. Expls., & War Agents	2–2
	5·64T	Int. to Radiation Chem.	2–3
	5·66	Surface & Colloid Chem.	2–3
	5·83	History of Chemistry	2–2
	5·842	Optical Methods	2–1

* Offered in alternate years (1936–37).
† Offered in alternate years (not 1936–37).

No grades are given in the following subjects: 5·591, 5·592, 5·921, 5·922, 5·931, 5·932, 5·941, 5·942, 5·943, 5·944. Units are not accepted as requirements for the Master's degree.

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 84–88, while such special rules as apply to the Department of Electrical Engineering are given below.

It is expected that only properly qualified students of more than average capacity will enter upon courses of advanced study. In order to be accepted for graduate study in the Department of Electrical Engineering a candidate must have completed the fundamental requirements common to all courses, and in addition must have covered the substantial equivalent of the undergraduate professional subjects in Electrical Engineering as offered in Course VI, in the Illuminating Engineering Option, VI-B or the Communications Option, VI-C.

It is expected that the student entering upon graduate work in Electrical Engineering will have completed professional subjects in engineering other than Electrical Engineering to an extent substantially equivalent in total amount to that contemplated in the undergraduate curriculum of any of the options of Course VI. It is also expected that he will have completed non-technical subjects to a similar extent, and that he will have a knowledge of general economics substantially equivalent to that gained by a year's study of this subject at the ordinary rate. In case a student registers for graduate work while deficient in any one of these respects, the Department Committee on Graduate Study will ordinarily insist that he remove such deficiencies by special study while in residence.

It is expected that the candidate for the Master's degree in Electrical Engineering will, at the time that he is recommended for the degree, be able to read either technical French or technical German to an extent sufficient to enable him to consult freely, along the lines of his graduate work, the literature in the language concerned. An entering student who offers the equivalent of elementary and intermediate French or German will be considered to have satisfied this requirement, but in cases of doubt the Department will test proficiency in modern language by special examination. Proficiency in this regard may often be obtained while in residence, by special study and reading.

The Department is especially insistent that a student's preparation in mathematics and physics be excellent. He should have fully covered the equivalent of first-year and second-year mathematics and physics as given in Course VI. In addition he should offer further work in mathematics substantially equivalent to that covered in the subject M31. In the absence of such special preparation, he will be expected to remove this deficiency while in residence.

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. 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 this matter.

Students working for the Master's degree are expected to devote themselves to a few subjects, not more than three, in addition to their seminar and research. The subjects of study are wholly elective, with the exception of Electrical Engineering Seminar, as stated below, 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.

Simultaneously with the lecture courses the student carries on research work, thus beginning his training as an independent investigator. He selects his own research subject, which should be one in which he is vitally interested, and submits 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. This outline must be approved before work is commenced.

In thesis work graduate students are expected in the main to rely on their own resourcefulness, the professor in 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.

All graduates in the Department who have not had equivalent experience 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.

The entire work of each student is carefully scrutinized to determine whether he is obtaining in full measure the advantages which should be derived from

Electrical Engineering Continued

advanced study and research, and he is advised accordingly. Students should realize that the fulfillment in a merely routine manner of the requirements for the degree as stated in this catalogue is not considered by the department as a satisfactory realization of the advantages which should accrue from advanced study.

Students working for advanced degrees in electrical engineering are encouraged to acquire additional training in mathematics and physics. Those proceeding toward the doctorate may well elect one of these fields as a minor. The advanced mathematics subjects are listed on page 118, those in physics on page 110 of this catalogue. The Chairman of the Departmental Committee on Graduate Study should be consulted by the student when planning his work.

Facilities for Research

The Graduate Laboratory of Electrical Engineering was established in 1913 as an educational agency to stimulate the students and the staff by bringing them into contact with problems on the front line of their profession and to train the students in methods of research. Most of the graduate students and a number of undergraduates utilize the facilities of this laboratory. The direction of the research work is not confined to any particular group of professors, but many members of the instructing staff aid in the work and are actively interested in the laboratory as a whole and particularly in those researches which lie within their own special fields of endeavor. The laboratory equipment is of a comprehensive nature, permitting all of the ordinary, and many unusual, electrical measurements to be made with facility.

Though the Graduate Laboratory was established as a purely educational agency, noteworthy contributions to knowledge have been made and to date one hundred twenty bulletins describing the researches have been published.

Each year there are usually a limited number of appointments as research assistants which are available for persons especially qualified by training and natural endowment for the work of investigation. These assistants may study toward an advanced degree, and may utilize the work covered by their research as a portion of their thesis.

The problems assigned to research assistants and also those elected by the students working for the doctorate are such as require for their solution a high degree of scientific skill and long-continued investigation. Frequently these problems are suggested by engineers in practice, thus bringing the department into additional touch with the advanced problems of the profession.

An idea of the scope of the research work carried on under the general supervision of the Department may be gained by reference to the research bulletins previously mentioned. The following paragraphs describe a few of the major research problems which have received and are receiving the attention of the laboratory and which in general have resulted in the design and construction of permanent laboratory equipment of great utility.

As a result of much study given to the problem of constructing artificial transmission lines and cables with distributed constants, a method of design has been developed and several lines constructed, single-phase as well as three-phase. These lines are used for studies of direct- and alternating-current transients, and now comprise part of the equipment of a special laboratory used for both research and instruction purposes.

Extensive investigations were made to demonstrate the feasibility of representing entire power systems artificially. This has resulted in the construction of the M. I. T. Network Analyzer adequate for the single-phase representation on a 60-cycle, 200-volt, 1.0 ampere basis of systems embodying as many as twelve generating stations with their loads and interconnecting circuits. The network analyzer gives the Laboratory an exceptional facility for the study of steady-state problems such as voltage regulation, power interchange, power-factor regulation, and 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. The network analyzer 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, have been analyzed mathematically and the results checked experimentally. 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 instruments, including a nine-element oscillograph. In the alternating-current machines, provision is made for the use of solid cylindrical, squirrel-cage, slip-ring induction, and salient-pole rotors.

An important outgrowth of the machine-transients laboratory is the development of stroboscopes of high light intensity by means of which the behavior of rapidly moving bodies can be observed and photographed. The Department has a diversified collection of high-speed motion-picture machines which

Electrical Engineering Continued

are available for use in various investigations. Cameras are available for taking motion pictures up to 6,000 per second with exposures of less than 1/100,000th of a second. These cameras make use of accurately-controlled intense sources of stroboscopic light.

An important problem, various phases of which have occupied the attention of the laboratory for a number of years, is the study of the fundamental properties of insulation.

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.

Mechanical and electrical methods for the solution of differential and integral equations are actively investigated in the laboratory. The complexity of many problems of engineering and physics is such that satisfactory progress in their solution is often dependent upon graphical methods. The Differential Analyzer, which originally was developed here, is designed to perform mechanically the necessary operations required in the solution of differential equations. The coefficients of the equation may be constant or variable, and may be functions of any of the variables. By means of this machine and the product integraph which preceded it, the analysis of numerous problems has been successfully accomplished. These problems include the determination of the transient behavior of transmission lines, power systems, and electrical machinery, the operating characteristics of non-linear circuits, the design of structures, and investigations of certain field distributions in acoustics, and functions of wave mechanics. In addition another machine, utilizing light radiation in its operation, is available for the purpose of solving an integral equation of the type involving the product of two functions with a variable parameter under the integral sign.

The increasing need and interest in higher voltages for power engineering led to the development of a departmental high-voltage research program and a high-voltage research laboratory for experimental investigations employing direct-current voltages up to 750,000. This research program is at present primarily directed toward investigating the properties of high-vacuum insulation and the possibilities in power engineering of rotating vacuum electrostatic machinery. Research in the field of high-energy radiations, direct-current corona, material-insulation breakdown, spark discharges in gases, and other allied fields can be conducted in this laboratory.

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 Collection. This collection comprising thirty-five thousand 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 of the world. It is merged with the other works on electrical subjects in the Central Library, but distinguished by a special binding stamp and a special bookplate. The total is now over 40,000 volumes and 20,000 pamphlets. In the collection 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 collection 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 collection is kept up to date by the addition of all important publications in the field, and books not in the 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 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

Electrical Engineering Continued

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 plant or manufacturing plant, electrical measurements, illumination, electronics, railroad electrification as it affects the electrical engineer.

The colloquia of 1935–36 are listed below:

"The Patent System and Its Relation to Engineering," by Mr. M. R. Jenney of Fish, Hildreth, Cary and Jenney.

"Recent Developments in Mercury-Arc Rectifiers," by Mr. H. D. Brown and Mr. C. C. Herskind of the General Electric Company.

"Recent Developments in Turbo-Generator Design," by Mr. L. P. Shildneck of the General Electric Company.

"Some Recent Developments in Applied Acoustics," by Mr. Frank Massa of the R. C. A. Manufacturing Company, Inc.

"Interesting Features Found in Electrical Indicating Instruments," by Mr. H. L. Olesen and Mr. Frank X. Lamb of the Weston Electrical Instrument Corporation

"Engineering of Railroad Diesel Motive Power," by Mr. A. H. Candee of the Westinghouse Electric and Manufacturing Company.

"Recent Research in Magnetic Alloys," by Dr. R. M. Bozorth of the Bell Telephone Laboratories, Inc.

GRADUATE SUBJECTS IN ELECTRICAL ENGINEERING

"A" Subjects. Primarily for Graduates

First Term	6·501	Elec. Eng. Seminar	2–10
	6·511	Electric Power Circuits	3–7
	6·513T	Power System Stability	3–7
	6·515	Power Systems Laboratory	Time arr.
	6·521	Alt. Cur. Machinery	5–5
	6·531	Org. & Adm. Pub. Ser. Cos.	3–7
	6·541	Power Gen. Stations	3–6
	6·551	Railroad Elec. Traction	3–6
	6·561	Adv. Network Theory	5–5
	6·571	Illuminating Eng., Prin.	5–4
	6·58	Trans. Anal. by Lap. Trans.	3–7
	6·59	Communications Lab.	Time arr.
	6·60	Math. Anal. by Mech. Meth.	2–4
	6·61	Super. High-Volt Eng.	2–4
	6·631	Engineering Electronics	3–7
	6·651	Electric Power Dist.	3–6
	6·661	Electric Machine Dev. Prin.	4–6
	6·671	Vibrations	4–6
	6·73	Elec. Meas. Lab., Adv.	Time arr.
	6·74	Elec. Eng. Lab., Adv.	Time arr.
		Research	
Second Term	6·502	Elec. Eng. Seminar	2–2
	6·512T	Electric Power Circuits	3–7
	6·514	Power System Stability	3–7
	6·515	Power Systems Laboratory	Time arr.
	6·522	Alt. Cur. Machinery	5–5
	6·532	Org. & Adm. Pub. Ser. Cos.	3–7
	6·542	Power Gen. Stations	3–6
	6·552	Railroad Elec. Traction	3–6
	6·562	Adv. Network Theory	3–5
	6·572	Illuminating Eng., Prin.	5–4
	6·58	*Trans. Anal. by Lap. Trans.	3–7
	6·59	Communications Lab.	Time arr.
	6·62	Elec. Com. Prin.	5–5
	6·632	Engineering Electronics	3–7
	6·652	Elec. Power Distribution	3–6
	6·662	Elec. Machine Dev. Prin.	4–6
	6·67	Vibrations	4–6
	6·69	Sound in Elec. Com.	5–5
	6·73	Elec. Meas. Lab., Adv.	Time arr.
	6·74	Elec. Eng. Lab., Adv.	Time arr.
		Research	

"B" Subjects. Open to Graduates and Undergraduates

First Term	6·211	App. of Elec. in Industry	3–6
	6·221	Central Stations	3–6
	6·241	Electric Railways	3–6
	6·251	Elec. Mach. Design	3–6
	6·26	Elec. Ins. & Its Behavior	5–4
	6·271	Illuminating Eng., Prin.	5–4
	6·281	Prin. Wire Com.	3–6
	6·31	Electrical Com., Prin.	3–5
	6·80	Electrical Eng. Lab.	Time arr.
Second Term	6·04T	†Electrical Eng. Prin.	6–9
	6·20	Power Trans. Equip.	3–6
	6·212	App. of Elec. in Industry	3–6
	6·222	Central Stations	3–6
	6·242	Electric Railways	3–6
	6·252	Elec. Mach. Design	3–6
	6·272	Illuminating Eng., Prin.	5–4
	6·282	Prin. Radio Com.	3–6
	6·32	Electrical Com., Prin.	3–5
	6·80	Electrical Eng. Lab.	Time arr.

* Usually repeated in second term.

† Only for students specializing in Communications.

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
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
Doctor of Science
Doctor of Philosophy
Doctor of Public Health
A Certificate in Public Health is also awarded.

Minimum Requirements for Admission to Graduate Work

All graduate degrees: In addition to the general requirements the following professional prerequisites, or their equivalents, as judged by the Department Committee on Graduate Students, are necessary for admission to graduate work.

Biology and Public Health Continued

OPTION 1. BIOLOGY, OR BIOLOGY AND PUBLIC HEALTH (S.M., PH.D., SC.D., DR.P.H.)

5·12	Quantitative Analysis
5·41	Organic Chemistry I
5·428	Organic Chemistry Lab.
7·01	General Biology
7·06	Botany
7·10T	Invertebrate Zoölogy
7·14	Comparative Anatomy
7·20	Physiology
7·22	Personal Hygiene & Nutrition
7·301	Bacteriology
*7·302	Bacteriology
*7·50	Communicable Diseases
*7·57	Municipal Sanitation
*7.80	Biochemistry

* May be counted as "B" subject for S.M. in this option by permission.

OPTION 2. INDUSTRIAL BIOLOGY. (S.M., PH.D., SC.D.)

5·12	Quantitative Analysis
5·20	Chemistry of Water & Sewage
5·25	Chemistry of Foods
5·41	Organic Chemistry I
5·428	Organic Chemistry Lab.
5·684	Physical Chemistry, Elem.
7·01	General Biology
7·15	Essentials of Anatomy
7·20	Physiology
7·301	Bacteriology
*7·302	Bacteriology
7·361	Industrial Microbiology
*7·362	Industrial Microbiology
*7·80	Biochemistry

* May be counted as "B" subject for S.M. in this option by permission.

OPTION 3. PUBLIC HEALTH ENGINEERING. (S.M., SC.D.)

1·041	Surveying
1·25T	Eng. Construction
1·401	Structures
1·41	Structures
1·60	Hydrographic Surveying
1·62	Hydraulics
1·75	Hydraulic and Sanitary Eng.
1·78	Sanitary Engineering
1·801	Hydraulic and Sanitary Design
1·802	Sanitary Design
5·20	Chemistry of Water & Sewage
7·301	Bacteriology
*7·302	Bacteriology
7·34	Limnological Field Work
*7·50	Communicable Diseases

* May be counted as "B" subject for S.M. in this option by permission.

In certain cases where the applicant has had experience in a related professional field, or has other special qualifications, the "B" subjects, and those starred in the above lists, may be taken during the work toward the Master's degree and may be credited as "B" subjects in the requirements for that degree.

REQUIREMENTS FOR THE CERTIFICATE IN PUBLIC HEALTH. A candidate for the Certificate in Public Health 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. 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	Serological 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 oral examination covering the general field.

Students taking the Certificate in Public Health in the field of Health Education may substitute for 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.

The Massachusetts Institute of Technology subjects available as electives include:

"A" subjects. Epidemiology, Advanced Bacteriology, Health Hazards in Special Industries, Advanced Parasitology, Pathology, Public Health Problems, Public Health Field Work, School Health Administration.

"B" subjects. Biochemistry, Food Chemistry, Industrial Hygiene, Theoretical Biology, Parasitology.

For other available electives refer to the Departments of Biology, Chemistry and Physics.

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.

REQUIREMENTS FOR THE DEGREES OF DOCTOR OF SCIENCE OR DOCTOR OF PHILOSOPHY IN BIOLOGY, OR IN BIOLOGY AND PUBLIC HEALTH. 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.

Biology and Public Health Continued

REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PUBLIC HEALTH. For this degree the requirements are of the same standard as for the degree of Doctor of Philosophy or Doctor of Science, and will in general presuppose a period of three years of graduate work for those entering upon this course of study directly from college work. To students who have received a Bachelor's degree from an institution of recognized standing or who have received the M.D. degree from Class A medical schools with at least two years of college training before entering the medical school, this degree is open on the same basis as the Doctor of Science or Doctor of Philosophy.

To be accepted as a candidate for the degree the student must pass a general examination in all the subjects required for the degree, given in four groups, at least seven months before the degree is conferred. In view of the wide range of subjects in which the candidate must qualify in his general examination, a special *minor* requirement may be waived.

The time required in preparation for the general examination may be reduced in the case of those who have had extensive public health experience involving knowledge of the subjects regarded as essential to this degree, but each case will be considered individually on its merits and no general classes of applicants can be established on the basis of experience.

For those who enter upon graduate work for the degree of Doctor of Public Health without actual practical experience it is recommended that a portion of the time in the period preceding the general examination be spent in practical health work, under the direction of the Faculty, in some health department which is willing to coöperate with the Institute in this respect by employing such men on a part-time basis or by offering facilities for securing experience in special fields of public health administration or procedure.

Medical officers of the United States Army who are graduates of accepted medical schools and who have in addition had the basic course in public health at the Army Medical School, the special courses required for sanitary officers, and at least five years of practical public health administration in the army, are accepted as applicants for the degree on a one-year basis, but to be accepted as candidates they must pass a general examination in the field of Public Health not less than six months previous to the time it is expected the degree will be received. Their period of residence is devoted largely to advanced professional research.

THE BIOLOGICAL LABORATORIES

The Biological Laboratories offer facilities for advanced work in bacteriology, biochemistry, zymology, industrial hygiene, municipal sanitation, and food conservation and control. Special opportunities for training for the profession of Public Health and for investigation of methods of public health education and administration are available.

BIOPHYSICS

The substitution of certain subjects definitely in the field of biology may be arranged by the Registration Officer for those students of high standing who propose to pursue graduate work in Biophysics.

GRADUATE SUBJECTS IN BIOLOGY

"A" SUBJECTS. PRIMARILY FOR GRADUATES

First Term	7·18	Tech. Aspects of Entom.	2–3
	7·321	Bacteriology, Adv.	3–4
	7·35	Planktonology	2–3
	7·371	Industrial Microbiology	5–4
	7·601	Health Education	2–4
	7·66	Epidemiology	2–6
	7·67	Functional Pathology	3–4
	7·72	Food Technology, Adv.	3–3
	7·81	Zymology	6–3
	7·94	Research Problems. Time arr. Research	
Second Term	7·09	Parasitology, Adv.	4–4
	7·132	Histology, Adv.	4–2
	7·201	Physiology, Advanced	9–3
	7·322	Bacteriology, Adv.	5–2
	7·372	Indust. Microbiology	4–4
	7·602	Health Education	4–6
	7·604	School Health Adm.	1–2
	7·63	Public Health Field Work	2–4
	7·64	Public Health Problems	2–4
	7·65	Health Haz. in Spec. Ind.	2–5
	7·68	Pathology	6–2
	7·82	Biochemistry, Adv.	6–3
	7·94	Research Problems. Time arr. Research	

"B" SUBJECTS. OPEN TO GRADUATES AND UNDERGRADUATES

First Term	7·131	Histology, Adv.	4–2
	7·22	Personal Hyg. & Nutrition	2–2
	7·50	Communicable Diseases	3–3
	7·531	Air Examination	3–2
	7·541	Public Health Admin.	2–3
	7·551	Public Health Lab. Meth.	8–3
	7·58	Vital Statistics	2–3
	7·59	Sanitation	4–3
	7·711	Tech. of Food Products	6–4
	7·80	Biochemistry	8–5
Second Term	7·03	Theoretical Biology	2–3
	7·08	Parasitology	2–4
	7·23	Applied Nutrition	1–2
	7·302	Bacteriology	6–3
	7·362	Industrial Microbiology	4–4
	7·52	Industrial Hygiene	4–4
	7·542	Public Health Admin.	2–3
	7·552	Serological Methods	6–1
	7·57	Municipal Sanitation	4–3
	7·712	Tech. of Food Products	5–4

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 in Physics

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 new George Eastman Research Laboratories, and the adjoining Spectroscopy Laboratory. One field of great interest at present is nuclear research, including the following: nuclear research and high voltage, carried on both in Cambridge and at the high voltage laboratory at Round Hill, and making close contact with the Electrical Engineering Department; a cosmic ray research program, both theoretical and experimental; and radioactive investigations, with particular reference to the age of the earth.

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 spectograph, microphotometers, and various interferometers for work requiring high resolving power. Among the researches in progress are investigations in the line spectra of the elements; the band spectra of molecules; and hyperfine structure and interferometry. Developments of automatic methods of measuring and analyzing spectra, in conjunction with unusually fine diffraction gratings, have made possible new standards of precision in wave length 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, 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. In addition to the Eastman laboratories, several branches of teaching and research in classical and applied physics are located in Buildings 4 and 8, and collectively form the Rogers Laboratory of Physics.

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); me-

Physics Continued

chanical 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 mining and 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. Electrochemistry, in the department of Mining and Metallurgy, is closely associated with physics, and may well be pursued by a student of applied physics. 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 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.

Biophysics

The substitution of certain subjects definitely in the field of physics may be arranged by the Registration Officer for those students of high standing who propose to pursue graduate work in Biophysics.

A statement about this will be found under Department of Biology and Public Health.

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
8·50	Heat and Thermodynamics or
5·61	Physical Chemistry I

Undergraduate subjects which may be counted as "B" subjects toward an advanced degree:

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 first part of the general examination consists of two written papers, one a three hour examination, to be taken without the use of books, and the other a home paper, each question consisting of a small investigation to be made with the use of books and references. There will be different written papers for the degrees in the field of pure physics and in that of applied physics. These written papers are regarded as qualifying examinations, candidates passing them successfully being permitted to take an oral general examination. These examinations are given twice a year, during the latter part of October and the first of May. 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.

Physics Continued

GRADUATE SUBJECTS IN PHYSICS

"A" Subjects. Primarily for Graduates

First	8·21	Electronic Phenomena	2–4
Term	8·212	Experimental Electronics	4–3
	*8·213	Advanced Electronics	3–9
	8·215	Sp. Prob. in Electronics	Time arr.
	*8·26	Polar Molecules	3–6
	8·32	Line Spectra	3–6
	8·341	Spectroscopy Seminar	1–1
	8·343	Sp. Prob. in Spectros	Time arr.
	8·441	Sp. Prob. in Nuclear Res.	Time arr.
	*8·481	Advanced Mechanics I	3–9
	8·521	Quantum Mechanics	3–9
	8·56	Electromagnetic Wave Theory	3–9
	*8·58	Theory of Relativity	3–9
	8·591	Theoretical Seminar	1–1
	8·60	Sp. Prob. in Theoret. Physics	Time arr.
Second	8·181	Optics Seminar	2–2
Term	*8·214	Advanced Electronics	3–9
	8·28	X-Ray Diffraction	2–4
	*8·29	Lattice Theory, Solid State	2–4
	8·30	Sp. Prob. in Crystal Physics	Time arr.
	8·342	Spectroscopy Seminar	1–1
	8·343	Sp. Prob. in Spectroscopy	Time arr.
	8·35	Excitation of Spectra	5–4
	8·42	Seminar in Nuclear Physics	1–2
	8·442	Sp. Prob. in Nuclear Res.	Time arr.
	*8·463	Int. to Theoret. Phys. III	4–8
	*8·482	Advanced Mechanics II	3–9
	*8·491	Meth. of Theoret. Physics	3–9
	8·512	Statistical Mechanics	3–9
	8·592	Theoretical Seminar	1–1

"B" Subjects. Open to Graduates and Undergraduates

First	8·11	Experimental Physics	8–4
Term	8·171	Advanced Optics	2–3
	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	Hist. Develop. of Physics	3–6
	8·82	Electrochemistry	3–6
Second	8·12	Experimental Physics	5–4
Term	8·13	Undergrad. Colloquium	2–2
	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	Time arr.
	8·346	Quantitative Spectroscopic Analysis	1–1

* Not offered 1936–37.

CHEMICAL ENGINEERING

Because of the breadth of the field of Chemical Engineering the undergraduate course must be devoted to essentials and there is little opportunity for specialization. Therefore, in this field, postgraduate work is of peculiar importance and value.

The Department offers three types of opportunity for graduate study: first, subjects of instruction designed to broaden and deepen the knowledge and analytic power of the student without emphasis on on any special field of application; second, the School of Chemical Engineering Practice, the purpose of which is to develop the student's ability to apply his training to the solution of industrial problems; and third, a group of subjects in Fuel Engineering designed to meet the needs of the engineer who wishes to specialize in that field.

School of Chemical Engineering Practice

In addition to the regular graduate work, the Department of Chemical Engineering offers a course leading to the degree of Master of Science in Chemical Engineering Practice.

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., Boston, Mass., and Buffalo, N. Y. At these stations six different concerns open their plants for the instruction of students who at each station are under the direct charge of a member of the Institute faculty and his assistants. The time being 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 larger 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

Chemical Engineering Continued

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.

Students from other institutions will, in general, spend one scholastic year at the Institute before taking the field station work in order to meet the science and engineering requirements for graduate study in the department. The student's program is so dependent on previous training and experience that individuals interested in this field are requested to communicate directly with the department.

Fuel Engineering

The industries involving the processing and utilization of fuels constitute a large and important group. Since many phases of fuel engineering are distinctly chemical in nature, the training and viewpoint of the chemical engineer can be used to advantage.

Although some problems demand all the chemical knowledge and laboratory technique of the chemist and chemical engineer, many are not so exacting in the necessity for chemical training, and men who have majored in a non-chemical branch of engineering may prepare themselves adequately for fuel engineering practice by graduate study.

The Department offers a group of subjects in fuel processing and utilization which forms the basis of a program of graduate study in fuel engineering, the balance of the program being made up of subjects in science, engineering or economics. Since the program arranged will depend on undergraduate training and industrial experience, any one interested is requested to furnish this information that his case may receive 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, and emphasis will be placed on basic training in the sciences.

The preparation required above that common to all courses of the Institute is outlined below:

Mathematics. Differential Equations equivalent to the undergraduate subjects M22 or M41.

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	Indust. Stoichiometry	2–4
Term	10·251	Industrial Chemistry	3–3
	10·33	Anal. Treat. of Chem. Eng. Processes	3–6
	*10·37	Flow of Fluids	3–6
	†10·42	Drying	2–4
	†10·45	Distillation and Absorption	4–8
	10·52	Chemical Engineering II	3–6
	10·53	Chem. Engineering Design	3–9
	10·54	Econ. Bal. in Chem. Indus.	5–7
	10·62	App. Chem. Thermodyn	3–6
	*10·64	App. Colloid Chem.	3–6
	10·661	Int. to Colloid Chemistry	2–4
	10·671	Colloid Seminar	1–3
	10·68	Corrosion	2–4
	10·70	Principles of Combustion	4–6
	10·72	Fuel Engineering Practice	20–0
	10·73	Fuel Engineering Design	3–6
	10·74	Furnace Design	3–6
	10·79	Automotive Fuels	2–4
	Sch. Chem. Eng. Practice		
	10·81	Bangor Station	12
	10·82	Boston 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
Second	10·41	Distillation	3–5
*Term**	10·44	Distillation and Absorption	3–6
	10·46	Absorption and Extraction	3–6
	10·50	Heat Transmission	2–4
	10·55	Economic Balance	3–6
	*10·61	Thermodyn. of Hydrocarbons	3–6
	10·62	App. Chem. Thermodyn	3–6
	10·63	App. Colloid Chemistry	3–6
	10·65	High Pressure Processes	2–4
	10·662	Colloid Chemistry	2–4
	10·672	Colloid Seminar	1–3
	10·71	Fuel Engineering	3–6
	10·74	Furnace Design	3–6
	10·76	Seminar in Rad. Heat Trans.	2–4
	Sch. Chem. Eng. Practice		
	10·81	Bangor Station	12
	10·82	Boston 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	10·21	Industrial Chemistry	2–2
Term	10·26	Industrial Chem. Lab.	5–1
	10·29	Chemical Engineering	3–6
	10·31	Chemical Engineering	5–4
Second	10·32	Chemical Engineering	5–4
Term	10·78	Fuel Engineering Lab.	4–2

* Specially arranged for graduate students in Petroleum Production and not ordinarily to be taken by graduate students in Chemical Engineering.

† Not offered 1936–37.

Chemical Engineering Continued

FOR CHEMICAL WARFARE OFFICERS

Course Leading to the Degree of Master of Science

Summer Preceding Graduate Year

The work begins with the Summer Session in June. The summer work is normally devoted to the completion of professional subjects necessary as preparation for the more advanced work of the Course, in which the student's preparation may be deficient.

GRADUATE YEAR

Required Work

First	10·21	Industrial Chemistry	2–2
Term	10·25	Industrial Stoichiometry	2–4
	10·28	Chemical Engineering	4–6
	10·31	Chemical Engineering	5–4
	M41	Differential Equations	3–6
Second	5·424	Organic Chemistry Lab.	9–0
Term	5·43	Powder, Explo. & War Agents	2–2
	10·29	Chemical Engineering	3–6
	10·32	Chemical Engineering	5–4

Optional Subjects

First	5·061	Inorganic Chemistry	2–3
Term	5·51	Organic Chemistry II	2–2
	5·55	Ident. Organic Compounds	10–0
	10·54	Economic Balance	5–7
	10·68	Corrosion	2–4
Second	2·686T	Engineering Lab.	3–3
Term	5·062	Inorganic Chemistry	2–3
	5·52	Organic Chemistry II	2–2
	10·63	App. Colloid Chemistry	3–6
	10·65	High Pressure Proc.	2–4

The optional subjects listed are especially fitted to meet the need of the Chemical Warfare Officers. Subject to the approval of the Department, other subjects may be chosen from the lists available for credit for the Master's degree.

SUMMER AND FIRST TERM FOLLOWING GRADUATE YEAR

School Chem. Eng. Practice	36
Thesis	30

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 year for their special fields of interest in keeping with the four options offered by the Department. In the field of Geology they must present a record of attainments satisfactory to the Departmental Committee on graduate work. Reading knowledge of French or German is required.

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 Students that he is qualified to undertake the course of advanced study and research.

Each candidate is given a preliminary examination which may be partly oral and partly written, 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.
	12·351	Geological Survey, Adv.	4–4
	12·431	Economic Geol. Lab., Adv.	4–1
	12·433	Economic Geol. Sem., Adv.	2–2
	12·521	Paleontology Adv.	4–3
	12·54	Micropaleontology	4–2
	12·551	Organic Evolution, Adv.	3–3
	12·581	Sedimentation	4–4
	*12·631	Geological Climates Sem.	2–5
	12·632	Physical Geology Seminar	2–5
	12·64	Geology of North America	2–4
	12·75	Metamorphic Geology	3–6
	12·851	Theoret. Geophysics, Adv.	3–6
		Research	

Geology Continued

Second	12·16	Petrological Seminar	2–4
Term	12·17	Petrographic Research	4–1
	12·352	Geological Survey, Adv.	4–4
	12·432	Economic Geol. Lab., Adv.	4–1
	12·434	Economic Geol. Sem., Adv.	2–2
	12·522	Paleontology, Adv.	4–3
	12·53	Index Fossils	6–2
	12·552	Organic Evolution, Adv.	3–3
	12·582	Sedimentation	4–4
	12·71	Structural Geology, Adv.	3–6
	12·81	Geology of Petroleum, Adv.	3–2
	12·852	Theoret. Geophysics, Adv.	3–6
		Research	

* Offered in alternate years. Not 1936–37.

Subject to the approval of the Departmental Committee on Graduate Students, other subjects for which a student has adequate preparation may be elected from the subjects primarily for graduates offered by the Mining Department, and by other 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	12·25	Crystallography	3–2
Term	12·41	Economic Geology Lab.	8–0
	12·50	Stratigraphic Geology	4–5
	12·61	Diastrophism & Vulcanology	2–3
	12·86	Seismology, Elem.	2–2
Second	12·02	Mineralogy	5–1
Term	12·42	App. Economic Geology	3–6
	12·44	Economic Geology of Fuels	1–1
	12·46	Economic Geol. of Non-Met. Deposits	3–3
	12·80	Geol. Coal and Petroleum	4–3
	12·87	Intro. Geophys. Prospect	2–2

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 complete curriculum is given below.

REQUIRED DURING SUMMER PRECEDING JUNIOR YEAR (July to September)

M73	Review of Mathematics (Algebra, Plane and Solid Geometry, Trigonometry, Elementary Calculus, Differential Equations)	20–0

JUNIOR YEAR

First	2·04	Applied Mechanics	3–5
Term	2·351	Materials of Engineering	2–2
	13·01	Naval Architecture	3–5
	13·11	Theory of Warship Design	4–10
	13·21	Warship Design	5–0
	M36	Advanced Calculus	3–6
			20–28
Second	2·06T	Applied Mechanics	3–5
Term	2·371T	Testing Materials Lab.	2–1
	13·02	Naval Architecture	3–5
	13·12	Theory of Warship Design	4–10
	13·22	Warship Design	5–0
	M37	Advanced Calculus	3–6
			20–27

REQUIRED DURING SUMMER

Work arranged by Postgraduate School

SENIOR YEAR

First	2·251T	Fluid Mechanics	5–3
Term	13·03	Naval Architecture	3–3
	13·13	Theory of Warship Design	3–6
	13·23	Warship Design	5–0
	13·58	Marine Engineering	3–4
	Ec15	Economic Principles	3–5
	M731	Mechanics	3–6
			25–27
Second	3·432	Metallurgy	2–1
Term	13·14	Theory of Warship Design	3–8
	13·24	Warship Design	5–0
	13·48	Model Making	2–0
	13·64	Marine Engine Design	3–0
	Ec60	Labor Relations	4–4
	M732	Mechanics	3–6
		Memoirs	0–3
		General Study	2–2
			24–24

REQUIRED DURING SUMMER

Work arranged by Postgraduate School

GRADUATE YEAR

First	1·451	Structures	3–6
Term	2·72	Mechanism	2–3
	3·61	Metallography	4–1
	13·15	Theory of Warship Design	3–6
	13·25	Warship Design	6–0
	15·61T	Law of Contracts	3–6
	16·811	Aeronautics	3–1
	L11	Elementary German	3–5
			27–28
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	13
			17–30

Elementary French L51 and L52 may be substituted for German L11 and L12.

BUSINESS AND ENGINEERING ADMINISTRATION

The course leading to the Master's degree in Business and Engineering Administration is primarily designed for the engineering graduate who wishes to prepare himself for executive work in industry or trade. The graduate curriculum therefore requires some training in each of the major functions of business; production, marketing, finance, accounting, law, and labor relations. It also permits a certain latitude for more specialized work in one or more of these fields.

Instruction is carried on mainly through small group conferences, based on individual investigation and reading. Emphasis is placed on the development of analytical reasoning and sound business judgment.

Students who can satisfy prerequisites in undergraduate business and engineering subjects may obtain the Master's degree in one year. If only the engineering prerequisites are offered, the undergraduate business requirements usually may be met by attendance at the summer session preceding the graduate year.

Applications for advanced work in this field are expected only from students who in point of personality as well as intellect show promise of success in administrative activities.

Requirements for the Degree of Master of Science

In addition to the undergraduate requirements* for the Master's degree common to all courses, candidates should have taken a substantial number of engineering units as prescribed in any one of 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 as prerequisites for graduate work:

15·42	Corporate Finance and Investment
15·50	Accounting
15·70T	Production
15·81T	Marketing
Ec11, Ec12	Political Economy
Ec31	Statistics
Ec40	Money and Banking
Ec53	Corporations

(Requirements in Ec53 and 15·42 are waived if the graduate student elects to take the "A" subjects, Financial Administration of Industry 15·45 and 15·46.)

Deficiencies in these subjects may be removed in the summer school.

The following undergraduate subjects are also required, but as these are open to both graduate and undergraduate students, they may be elected in part as "B" subjects, in a program leading to a Master's degree:

15·51	Industrial Accounting
15·61T	Law of Contracts
15·71	Production
15·92	Industrial Problems
Ec14	Current Econ. Problems
Ec60	Labor Relations

* M22 Differential Equations is not included as prerequisite for graduate work in this Department.

GRADUATE SUBJECTS IN BUSINESS AND ENGINEERING ADMINISTRATION

"A" Subjects. Primarily for Graduates

First	15·25	Indust. Traffic Manage.	3–5
Term	15·45	Fin. Admin. of Industry	3–6
	15·55	Prob. in Account. Policy	3–6
	15·75	Manufacturing Analysis	3–5
	15·85	Industrial Marketing	3–5
	15·97	Stand. Meas. in Ind. Man.	3–5
	Ec17	Economic Theory	3–6
	Ec37	Adv. Econ. Statistics	3–6
	Ec47	Investment Finance	3–6
	Ec57	Pub. Util.: Org. & Finance	3–6
	Ec59	International Econ. Relations	3–6
	Ec67	Labor Economics	3–6
Second	15·46	Fin. Admin. of Industry	3–6
Term	15·56	Anal. of Bus. Statements	3–6
	15·58	Control through Bus. Rec.	3–5
	15·86	Market. of Consumer Goods	3–5
	15·88	Advertising	2–6
	15·98	The Business Audit	3–5
	*Ec18	Math. Approach to Econ.	3–6
	Ec28	Business Cycles	3–6
	Ec38	Statistical Meth. for Qual. Control	3–6
	Ec48	Investment Analysis	3–6
	Ec58	Pub. Util.: Rates and Reg.	3–6
	Ec68	Labor Org. & Industry	3–6
	Ec78	Govt. Control of Industry	3–6

"B" Subjects. Open to Graduates and Undergraduates

First	15·11	Int. to Bus. Manage. I	3–3
Term	15·51	Industrial Accounting	4–3
	15·61T	Law of Contracts	3–6
	15·71	Production	3–3
	15·83	Marketing Research	3–6
	Ec15	Economic Principles	3–5
	Ec45	Monetary & Bank. Prob.	2–4
Second	2·872T	Prep. for Manufacturing	3–3
Term	15·12	Int. to Bus. Manage. II	3–3
	15·51	Industrial Accounting	4–3
	15·62T	The Law of the Market	3–6
	15·64	Law of Business Org.	3–6
	15·82T	Sales Management	3–6
	15·92	Industrial Problems	2–4
	Ec14	Current Economic Prob.	3–3
	Ec56	Economics of Transportation	2–4
	Ec60	Labor Relations	4–4
	Ec82	Principles of Sociology	3–3
	M54	Mathematical Laboratory	3–6

* Not offered in 1936–37

AERONAUTICAL ENGINEERING

Emphasis is laid upon individual study and research rather than upon formal classroom exercises. Each student must follow a consistent program of work directed toward some particular part of the aeronautical field such as aerodynamics, structures or power plants. Since most phases of the graduate work in Aeronautical Engineering rest heavily upon mathematics and mechanics, especial aptitude in these subjects is very desirable.

Meteorological Division

The Institute maintains a laboratory for synoptic meteorology with radio receiving and transmitting equipment for the collection and exchange of weather data. 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 selected 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 about forty sounding balloon meteorographs for stratosphere investigations and a microscope for evaluation of sounding balloon records. A calibration chamber suitable for pressure-temperature calibrations at temperatures as low as $-76°C$ has been constructed and also a humidity calibration chamber.

In coöperation with the United States Air Corps the Institute maintains an aerological station at the East Boston Airport. Daily flights are made to an altitude of 20,000 feet. Students are given an opportunity to participate in the aerological work at the airport.

Close coöperation is maintained with the Blue Hill Observatory of Harvard University and the Mount Washington Observatory.

The Daniel Guggenheim Aeronautical Laboratory

All of the aeronautical equipment, except for the engine laboratory and the smallest of the three wind tunnels, is located in the Daniel Guggenheim Aeronautical Laboratory. This is a four-story building of ample proportions, housing not only laboratory and research facilities but also classrooms, conference rooms, and offices for the staff.

The principal aeronautical equipment consists of three wind tunnels, 4, 5, and 7½ feet in throat diameter respectively, each equipped with balances and the necessary auxiliary equipment for making tests of airplane models or any other objects which are to be submitted to a current of air moving at known speed. The large tunnel is capable of handling an airplane model 40 inches in span. The maximum wind speed atainable is 90 miles per hour in the 7½-foot tunnel, 100 m. p. h. in the 5-foot tunnel, and 60 m. p. h. in the 4-foot tunnel.

The laboratories of the Department of Mechanical Engineering are used for the investigation of mechanical and structural problems. A considerable amount of special equipment for the preparation and testing of structural shapes is available.

The facilities of the Internal Combustion Laboratory (see page 92) are available to students in Aeronautical Engineering for study and research in the field of aeronautical power plants.

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 from other engineering Courses at the Massachusetts Institute of Technology or from non-aeronautical courses in other accredited technical 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 *unless these already have been 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 under Schedule I, if the degree with specification of field is undertaken, or under Schedule II, if the degree without specification is undertaken, or must take these subjects during their first year of residence at the Institute. Exceptions or additions may be made in individual cases.

Aeronautical Engineering Continued

Schedule I

NOT COUNTED AS "B" SUBJECTS

2·701T	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

Schedule II

NOT COUNTED AS "B" SUBJECTS

2·351	Materials of Engineering (S)
2·42	Heat Engineering (S)
16·10	Aerodynamics of Airplane Design (S)
16·20	Structures
	Intermediate French or German (S) (Unless offered for Entrance)

COUNTED AS "B" SUBJECTS

16·11	Aerodynamics of Airplane Design
16·21	Structures
16·62	Aeronautical Laboratory

(Subjects marked (S) are usually offered during the Summer Session as well as during the regular academic year.)

GRADUATE SUBJECTS

"A" SUBJECTS. PRIMARILY FOR GRADUATES

First	†2·132	Dyn. of Aircraft Engines	2–2
Term	16·03	Hydrodyn. & App. to Aero.	3–6
	16·07	Adv. Topics in Aeromechan.	3–6
	16·31	Airship Theory	2–3
	16·55T	Aero. & Meteor. Instruments	3–6
	16·57	Aero. & Meteor. Inst. Lab.	2–4
	16·60	Adv. Aeronautical Prob.	Time arr.
	16·911	Synoptic Meteorology	2–4
	16·921	Meteorological Lab.	10–0
	*16·931	Dynamic Meteorology	5–10
	*16·941	Meteorological Seminar	2–4
	16·961	Phys. Oceanography	2–4
Second	16·04	Hydrodyn. & App. to Aero.	3–6
Term	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
	16·52	Aircraft Propeller Design	4–4
	16·56T	Aeronautical Instruments	3–6
	16·59	Sp. Prob. Aero. & Meteor. Insts.	Time arr.
	16·60	Adv. Aeronautical Prob.	Time arr.
	16·68	Aeronautical Seminar	2–2
	16·912	Synoptic Meteorology	2–4
	16·922	Meteorological Lab.	8–0
	16·932	Dynamic Meteorology	5–10
	16·942	Meteorological Seminar	2–4
	16·962	Phys. Oceanography	2–4
		Thesis	20–40 hours per week

* Required preparation not covered in Course XVI.
† For Naval Officers only.

"B" SUBJECTS. OPEN TO GRADUATES AND UNDERGRADUATES

First	2·791	Automotive Engines	4–4
Term	16·01	Int. to Aero. Mechanics	6–4
	16·11	Aerodyn. of Airplane Des.	5–3
	16·17	Airplane Design Prac.	8–0
	16·21	Structures	3–5
	16·62	Aeronautical Lab.	4–3
	16·81	Aeronautics	3–1
	16·901	Introduct. Meteorology	2–2
Second	2·792	Automotive Engines	4–4
Term	16·02	Int. to Aero. Mechanics	6–4
	16·14	Airplane Design Prob.	6–6
	16·22	Aircraft Structures	3–5
	16·58	Meteorological Instruments	4–4
	16·63	Aero. Lab. & Res. Methods	4–2
	16·75	Const. Details of Aircraft	7–2
	16·81	Aeronautics	3–1

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 registration officer.

ECONOMICS AND SOCIAL SCIENCE

The Department of Economics and Social Science offers subjects to graduates who are studying for advanced degrees in other departments. The subjects included in the program of study for the master's degree in Business and Engineering Administration are mentioned on a preceding page. Advanced students may also submit Economics as their minor requirement 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. It is suggested that all candidates for the doctorate include "Economic Theory" among the subjects submitted.

For a description and explanation of the five-year program leading to the degree of Bachelor of Science in the professional course and to the degree of Master of Science in Economics and Engineering or Natural Science, see the following page.

Economics and Social Science Continued

"A" Subjects. Primarily for Graduates

First	Ec17	Economic Theory	3–6
Term	Ec37	Advanced Economic Statistics	3–6
	Ec47	Investment Finance	3–6
	Ec57	Pub. Util.: Organ. & Fin.	3–6
	Ec59	Internat. Economic Relations	3–6
	Ec67	Labor Economics	3–6
	Ec85	Plan. & Hous. Legislation	2–3
Second	*Ec18	Math. Approach to Econ.	3–6
Term	Ec28	Business Cycles	3–6
	Ec38	Statistical Methods for Quality Control	3–6
	Ec48	Investment Analysis	3–6
	Ec58	Pub. Util.: Rates & Regu.	3–6
	Ec68	Labor Organ. & Industry	3–6
	Ec78	Govt. Control of Industry	3–6

* Not offered in 1936–37.

"B" Subjects. Open to Graduates and Undergraduates

First	Ec15	Economic Principles	3–5
Term	Ec45	Monetary & Bank. Prob.	2–4
	Ec82	Principles of Sociology	3–3
Second	Ec14	Current Economic Prob.	3–3
Term	Ec56	Economics of Transport	2–4
	Ec60	Labor Relations	4–4
	Ec82	Principles of Sociology	3–3
	Ec84	Soc. Factors in City Plan.	2–3
	Ec86	Methods of Soc. Invest.	2–3

The Five-Year Curriculum in Economics and Engineering or Economics and Natural Science

A Five Year Course leading to the degree of Master of Science in Economics and Engineering or Economics and Natural Science together with the degree of Bachelor of Science in the professional Course in which undergraduate work was taken. Students pursuing this special program are expected to make their choice at the beginning of the third year. About two-thirds of the time will be devoted to advanced work in Economics and other social sciences, and the remainder of the graduate work will be carried on in the field of Science or Engineering, according to the individual's undergraduate course. The subject for the Master's thesis preferably shall be chosen in the field of joint interest for the social sciences and for the professional (Natural Science or Engineering) course pursued, that is, such subjects shall preferably involve the economic or social aspects of a scientific or engineering problem. (The Bachelor's thesis is not required in this five year program.) The usual requirements as to "A" and "B" subjects apply to this curriculum.

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, including thesis, in the field of Economics equivalent to that required in the five years' course. 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.

THIRD YEAR

Twelve Units of Studies in Economics or other Social Science are taken by postponing an equivalent amount of work in the professional course. These may be chosen from the following list:

First	15·52	Accounting	4–2
		or	
Term	15·11	Int. to Bus. Manage.	3–3
		and	
Second	Ec40	Money and Banking	3–3
		or	
Term	15·12	Int. to Bus. Manage.	3–3

FOURTH YEAR

Senior or Undergraduate Thesis omitted in five year program. Eighteen Units of Studies in Economics or other Social Sciences are taken by postponing an equivalent amount of work in the professional Course. These may be chosen from the following list:

First	Ec17	Economic Theory	3–6
Term	Ec53	Corporations	3–4
	Ec31	Statistics	2–4
Second	Ec14	Current Economic Prob.	3–3
Term	Ec60	Labor Relations	4–4
	Ec72	American Government	3–6
	Ec31	Statistics	2–4

FIFTH YEAR

Forty units are given to a thesis; twenty-nine units to technical subjects which have been postponed in earlier years or to graduate subjects; and twenty-seven units to graduate subjects in Economics and Social Science from the following list:

First	Ec37	Adv. Economic Statistics	3–6
Term	Ec45	Monetary & Banking Prob.	2–4
	Ec47	Investment Finance	3–6
	Ec57	Pub. Util.: Org. & Fin.	3–6
	Ec59	Internat. Econ. Rel.	3–6
	Ec67	Labor Economics	3–6
	Ec82	Prin. of Sociology	3–3
Second	Ec18	Math. Approach to Econ.	3–6
Term	Ec28	Business Cycles	3–6
	Ec38	Stat. Meth. for Quality Cont.	3–6
	Ec48	Investment Analysis	3–6
	Ec58	Pub. Util.: Rates & Reg.	3–6
	Ec68	Labor Org. & Ind.	3–6
	Ec82	Prin. of Sociology	3–3
	Ec86	Meth. of Soc. Invest.	2–3

DEPARTMENT OF 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. A candidate for the degree of Master of Science will be expected to offer the equivalents of M23, M24 Algebra and Geometry; M831, M832, M841, M842 Analysis; M441, M442 Geometry. Equivalent work may be substituted for any of these subjects.

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 fill the requirements stated above for Master of Science with the exception of a master thesis and spend at least an additional year in research.

"A" Subjects. Primarily for Graduates

First	M36	Calculus, Adv.	3–6
Term	M381	Calculus, Adv.	3–6
	M451	Fourier's Ser. & Integrals	3–9
	*M461	Theory of Numbers	3–9
	*M551	Funct. of a Real Variable	3–9
	M561	Funct. of a Complex Variable	3–9
	M571	Differential Equations	3–9
	M581	Continuous Groups	3–9
	*M641	Differential Geometry, Adv.	3–9
	M651	Analytical Mechanics	3–9
	M661	Algebra of Quant. Theory	3–9
	M671	Potential Theory	3–9
	*M681	Calculus of Variations	3–9
	*M691	Characteristic Value Prob.	3–9
	M791	Th. & App. Elasticity	3–9
	M90	Mathematical Reading	Time arr.
Second	M37	Calculus, Adv.	3–6
Term	M382	Calculus, Adv.	3–6
	M452	Fourier's Ser. & Integrals	3–9
	*M462	Theory of Numbers	3–9
	*M552	Funct. of a Real Variable	3–9
	M562	Funct. of a Complex Variable	3–9
	M572	Differential Equations	3–9
	M582	Continuous Groups	3–9
	*M642	Differential Geometry, Adv.	3–9
	M652	Analytical Mechanics	3–9
	M662	Algebra of Quant. Theory	3–9
	M672	Potential Theory	3–9
	*M682	Calculus of Variations	3–9
	*M692	Characteristic Value Prob.	3–9
	M76	Theory of Probability	3–9
	M792	Th. & App. Elasticity	3–9
	M90	Mathematical Reading	Time arr.

Summer Session

	M563	Funct. of a Complex Variable	3–6

"B" Subjects. Open to Graduates and Undergraduates

First	M331	Math. Th. of Statistics	3–6
Term	M441	Projective Geometry	3–6
	M731	Mechanics	3–6
	M77	Vector Analysis	3–6
	M831	Analysis	3–6
	M841	Analysis	3–6
Second	M332	Math. Th. of Statistics	3–6
Term	M442	Elem. Differential 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 1936–37.

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. SURVEYING AND TOPOGRAPHICAL DRAWING. A course in surveying consisting of fieldwork, computations and the making of 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. Breed and Hosmer's *Principles and Practice 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, Vols. I and II.* This subject satisfies the requirements in surveying for Courses III_3, IV-A, IV-B, 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 III_3, IV-A, IV-B, 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 III_3, IV-A, IV-B, VI, VI-A, IX-B.

1·07. GEODETIC SURVEYING (B). At Camp Technology. Three weeks of field and office work. The measurement of a base line; triangulation with repeating and with direction instrument; precise and trigonometric leveling; observations for time, latitude and longitude with astronomical transit; and magnetic observations for declination, dip and intensity. (Elective for a limited number of students in Course I who have satisfactorily completed the third year. Given if a sufficient number of students apply.)

1·10. SURVEYING. At Summer Mining Camp, Dover, New Jersey. The fieldwork consists of plane, topographic, magnetic dip-needle, magnetometer and mine surveying. Plans and maps, both surface and under ground, are made from the notes taken in the field. Discussions of surveying methods are supplemented by numerous problems. Breed and Hosmer's *Principles and Practice of Surveying, Vol. I.*

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. Nonharmonic 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. Laboratory exercises with stroboscope and

Civil and Sanitary Engineering Continued

shaking machines demonstrate validity of theoretical analysis.

1·138. Seismological Laboratory (B). Course 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 observations; and application of least squares to the adjustment of geodetic surveys.

1·15. Navigation. Includes a study of the use of the compass, log, sextant and charts, and the dead reckoning and astronomical methods used in locating the position of a ship at sea.

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 complete location survey for a section of a railway or highway; together with a systematic drill in laying out curves by different methods, 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.

1·25T. 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. (Not offered in 1936–37.)

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. *Notes on Railway Signaling.*

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 including turnouts and yards, 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 including I. C. C. accounting, coördination of the different forms of transportation.

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 control; 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.

Civil and Sanitary Engineering Continued

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.*

1·40T. 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 abridgment of 1·40T for students in Courses IV-A, VII_3, IX-B. 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, 1·42. Theory of Structures (B). An extended subject, in continuation of 1·40T. 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, 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 Courses VII_3, XV_{1a}. The elementary theory of reinforced concrete, stability of masonry walls, deflection of trusses and the theory of least work. Spofford's *Theory of Structures.*

1·44. Stationary Structures. For students in Mining Engineering, designed to give them a knowledge of the fundamentals of the theory and design of structures. Spofford's *Theory of Structures.*

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.

1·48. Foundations (B). A study of the methods of constructing foundations for bridges, buildings and other structures based on modern research in Soil Mechanics. 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. Principles of soil classification; analyses of variations in structure and density; studies of the laws of permeability and capillarity; the quicksand phenomenon; compressibility, consolidation, intrinsic pressure, internal friction, cohesion, elasticity, plasticity; and correlation of these factors with problems in earthwork engineering. *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; bearing capacity and settlement of foundations; piles and pile groups; earth and masonry dams, with special reference to stability, seepage, and piping effect; highway subgrades; and special types of foundations. *Mimeographed Notes.*

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.

1·502. Structural Design (B). An extension of 1·501 including the design of a riveted steel truss highway bridge, and a steel building frame.

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, Hardy Cross procedure.

1·52. Structural Design (B). Application of the theory of structures to the design of a steel truss highway bridge.

1·531. Reinforced Concrete Design (B). Covers by lecture and problem work the design of reinforced concrete floor systems, columns and footings. Special attention is given to the consideration of costs and economical design.

1·532. Reinforced Concrete Design (B). A continuation of 1·531 consisting of the complete design of a typical cross-section for a building, including flat slab and ribbed floor systems, also simple and combined footings. Lectures and problems cover moments at beam and column connections.

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 having already 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 structure, 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

Civil and Sanitary Engineering Continued

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 statically indeterminate 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.

1·58. Design of Reinforced Concrete Structures (B). 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's Lake the student is instructed in the method of making soundings, including instruction in the use of the sextant.

1·62. Hydraulics. The elementary principles of Hydrostatics and Hydrodynamics, including the laws governing static and dynamic pressure, and the flow of water through orifices, tubes, nozzles, weirs, pipe lines and open channels. Special attention is given to the laws of hydraulic friction and accompanying losses; to the practice of water measurement in pipes and open channels; and to such important occurrences as back water in channels, the hydraulic jump and water hammer. Includes a discussion of the fundamental theory underlying the design and operation of hydraulic turbines and centrifugal pumps. 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. Special treatment of pipe flow (including air, water and oil), the alternate stages of flow in open channels, design of transitions, the hydraulic jump, laws of hydraulic similitude and model experimentation are among the subjects included. Russell's *Hydraulics;* Gibson's *Hydraulics, and professional papers.*

1·68. 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.

1·691. 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.

1·692. 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. *Waterway Engineering,* O. Franzius.

1·70. Water Power Engineering (B). This subject and 1·71 treats of the problems involved in the location, design and construction of hydroelectric developments as a foundation for practice in this field, or for the advanced studies of the graduate year. The subjects include a thorough study of hydrology: precipitation, run-off, water losses and their relations; the analysis of stream flow data as a basis for estimates of water power, flood flow, storage and pondage problems, followed by the theory and practice of hydraulic turbines and general plant arrangement. Barrows' *Water Power Engineering.*

1·71. Water Power Engineering (B). Continuing from 1·70 the elements of design of the main features of a hydroelectric development—the dam, waterway and power house are studied. The work of both terms is also accompanied by drafting room exercises, consisting of computations, reports and problems of design. 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 treatment works are included and a limited number of students may be per-

Civil and Sanitary Engineering Continued

mitted to receive several days' instruction in the operation of the water treatment plant of the City of Providence. 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. Babbitt and Doland's *Water Supply Engineering;* Metcalf and Eddy's *Sewerage and Sewage Disposal, a Textbook.*

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 and a limited number of students may be permitted to receive several days' training in the operation of the sewage treatment plant of the City of Worcester. Metcalf and Eddy's *Sewerage and Sewage Disposal, a Textbook.*

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 disposal of industrial wastes and municipal refuse and garbage. Opportunities are offered for group inspection of nearby sewage works and may be offered for several days' training in the operation of the City of Worcester sewage treatment plant. Metcalf and Eddy's *Sewerage and Sewage Disposal, a Textbook.*

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 and may be offered for several days' training in the operation of the water treatment plant of the City of Providence. *Notes prepared by Professor Camp and textbooks and professional 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 and may be offered for several days' training in the operation of the sewage treatment plant of the City of Worcester. *Notes prepared by Professor Camp and textbooks and professional papers by various authors.*

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.

1·90. Professional Practice in Civil Engineering (A). Supplements the technical subjects offered by the Civil Engineering Department. It covers the professional, financial, quasi-judicial, and ethical obligations of the engineer to clients, contractors, the public, and to other engineers. Engineering costs, fees, salaries, accounting methods, reports, contracts for engineering service and the preparation of contract documents for the various types of engineering projects, are considered at length. The subject is illustrated by numerous examples taken from practice.

The following subject is offered as a General Study. For description see Division of General Studies.

G10. Development of Transportation.

MECHANICAL ENGINEERING

SUBJECTS 2·00 TO 2·99

2·00T, 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 2·00T and 2·01.

2·02T. APPLIED MECHANICS. Applications of graphical and analytical methods in the solution of problems in kinematics and dynamics which are of especial importance to the mechanical engineer, including cams, gearing, linkwork and other mechanisms; string polygons and stress diagrams for simple trusses and frames; graphical differentiation and integration; nomographic charts. *Elements of Mechanism*, Schwamb, Merrill and James.

2·031T. STRUCTURAL MECHANICS, ELEMENTARY. Arranged for students in Courses IV and IV-B. 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 strength of materials arranged for students in Courses IV and IV-B. 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.

2·05. APPLIED MECHANICS. A study of statics, dynamics and strength of materials. (For U. S. Army Officers only.)

2·06T. 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.

2·07. 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.

2·081. APPLIED MECHANICS (B). A study of the forces in machinery due to work applied and inertia of the moving parts. Graphical and analytical methods of determining accelerations in plane motion, with applications to crank and connecting rod mechanisms, speed regulation by means of fly-wheels, etc. Harmonic motion and other types of motion produced by cams of various forms are included. A portion of the course is devoted to the theory of free and forced vibrations in elastic bodies, with and without damping. A study of dynamometers for the measurement of power is also included.

2·082. APPLIED MECHANICS (B). A study of advanced engineering problems in mechanics, including stresses in moving parts of machinery, dynamic balance, critical speeds, friction losses, applications of the theory of least work, stresses in transmission lines and tramways, and various other problems in the field of mechanical engineering.

2·10T. 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, together with lectures on modern photoelastic theory, materials, and methods.

2·122. APPLIED PHOTOELASTICITY. A combined lecture and laboratory course on the analysis of problems in elasticity by the photoelastic method, based on the temporary double refraction of transparent materials when stressed. (For U. S. Army and Naval Officers only.)

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.

Mechanical Engineering Continued

Application is made chiefly to the types of engines used in automobiles.

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.)

2·221. Plasticity (A). Mechanics of the plastic state of materials with particular emphasis on engineering applications. Mohr's representation of stress and strain. General laws of plastic flow as applied to torsion, bending and buckling of bars, rotating discs, tubes under internal pressure, residual stresses, creep, relaxation of stresses, etc.

2·222. Advanced Plasticity Problems (A). Special problems are chosen in consultation with the instructor. Further development of various branches of the theory given in 2·221 with practical applications.

2·251T. Fluid Mechanics. Physical properties of fluids, hydrostatics, stream line flow, circulation, dynamics of perfect fluids, compressibility and viscosity, laws of similitude, dynamics of real fluids, laminar and turbulent flow, friction, losses, flow measurements, principles of hydraulic machinery.

2·252. Fluid Mechanics. Continuation of 2·251T. Physical fundamentals governing heat transfer in convection based on fluid mechanics and similitude with engineering applications. Application of laws of viscous flow to lubrication mechanics. Application of theory of compressible fluids to engineering acoustics. Sound intensity, propagation and absorption. Flow of fluids at sonic velocity.

2·253. Fluid Mechanics. The content of 2·251T and 2·252 compressed into one term. (Open to students in Course II-A only.)

2·271T. 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 2·271T. 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.

2·273. Advanced Hydromechanics Problems (A). Special problems are selected in consultation with the instructor, theoretical or practical research, design of hydraulic machinery. The hours are arranged to suit the individual cases.

2·31. Foundry Practice. A study of the principles involved in the production of cast metal parts. Laboratory work consists of demonstrations, practice, and reports on hand and machine molding, core making, sand testing, cupola operation, oil and gas furnace melting of ferrous and non-ferrous metals, permanent mold casting, the thermit process, and the testing and examination of cast materials. Lectures cover foundry raw materials and equipment, metallurgy of cast metals, centrifugal casting, die casting, casting design, heat treatment, and test and inspection methods.

2·311. Foundry Practice. An abridgment of 2·31.

2·312. Advanced Foundry Practice. A continuation of 2·31 or 2·311 including detailed study of factors influencing the structure and properties of cast metals. Consideration is given to the relations between chemical composition, constitution, and properties of the important ferrous and non-ferrous cast alloys. Experimental studies in the foundry and sand control laboratories are supplemented by correlated physical testing and metallographic examination. *Cast Metals Handbook* and *Current Technical Literature.*

2·32T. Mechanical Processes. A study of the fundamentals of metal processing as applied in manufacturing and construction. Lectures, demonstrations, practice, and reports on hammer and drop forging, shearing, bending, deep drawing, extrusion, wire drawing, hot and cold rolling, spinning, metal working calculations, and testing and examination of wrought metals. Similar exercises are given in welding including 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.

2·321. Forging. An abridgment of 2·32T including only the exercises in mechanical working of metals.

2·33. Welding Engineering and Practice. An elective subject for other than mechanical engineering students covering lectures and laboratory instruction in welding processes only.

2·34T. Advanced Welding Engineering (B). A continuation of 2·32T or 2·33 in which the lectures and laboratory exercises cover recent developments in the field of welding and the engineering applications of welding and cutting in manufacturing, construction, and maintenance. Consideration of welding codes, the qualification of operators, welding costs, and the general problem of designing for welding is included.

2·35T. Materials of Engineering. The production and engineering properties of metals, their alloys, and the more important non-metallic materials. Emphasis is

Mechanical Engineering Continued

placed on the fundamental relationships between constitution and physical properties. Laboratory exercises to illustrate the effects on alloys of change in composition, hot and cold work, and heat treatment are designed to familiarize the student with the techniques and methods of the metallurgist. Consideration is given to the suitability for engineering work of various materials and to their specification in design.

2·351. MATERIALS OF ENGINEERING. An abridgment of 2·35T, with omission of laboratory work, for other than mechanical engineering students.

2·352. MATERIALS OF ENGINEERING. Discussion of the testing and specifications of materials. (Open only to officers of the United States Navy.) *Materials of Construction*, Mills; *Engineering Steel*, Aitchinson.

2·37. TESTING MATERIALS LABORATORY (B). Covers the various laboratory methods for determining the physical properties of engineering materials, including the microscopic and macroscopic examination of metals, photoelastic methods, X-ray examination and testing of fabrics. *Materials Testing*, Cowdrey and Adams.

2·371T. TESTING MATERIALS LABORATORY. Methods of making physical tests for the properties of the more common engineering materials, and a study of their behavior under stress. The first part is of routine nature and is common for all students. The last part is varied for the different Courses to adapt the work to their needs. *Materials Testing*, Cowdrey and Adams.

2·38T. TESTING MATERIALS LABORATORY (CONCRETE). A study of the materials used in concrete, both plain and reinforced; the selection of a proper aggregate from materials that may be available, their treatment for various purposes and methods of proportioning. Instruction is supplemented by excursions to concrete jobs, concrete products companies and central mixing plants.

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 laws of thermodynamics. Heat equations. Physical properties of fluids, especially of air and steam. Laws of heat flow by radiation, conduction and convection. Flow through composite walls and concentric cylinders. Film concept. Surface coefficients. Mean temperature difference. The fundamental laws governing the flow of fluids with application to orifices and nozzles. *A Standard Textbook on Thermodynamics, The Temperature Entropy Diagram*, Berry; *Steam Tables*.

2·41T. 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.

2·411. HEAT ENGINEERING. An abridgment of 2·41T.

2·42. HEAT ENGINEERING. Discussion of turbine and reciprocating engine cycles. Study of losses in real engines. Hirn's analysis. Heat flow to and from cylinder walls. Method of minimizing heat losses. Multiple fluid, reheat and regenerative cycles. Hot air and internal combustion engine cycles. Humidity and air conditioning problems. Theory and calculation of cooling towers. *Textbooks same as for* 2·40.

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. The descriptive work will be continued as in 2·41T. *Elementary Engineering Thermodynamics*, Taft; *Steam Tables*, Keenan.

2·43. HEAT ENGINEERING (B). Power absorbing processes. Air compressors,—efficiency, displacement, etc. Heat pumps. Kelvin warming engine. Refrigeration processes. Comparison of ammonia, carbon dioxide, water and air compression refrigeration cycles. Refrigeration at different levels. Voorhees multiple effect compressor. Elementary discussions of absorption refrigeration systems. Heat flow problems in condensers, interchanges, etc.

2·44T. THERMODYNAMICS OF MIXTURES (B). A study of the fundamentals of thermodynamics of mixtures and applications to engineering problems.

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.

2·461. 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 application of Fourier's series of cases involving fluctuating 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 available heat insulating materials.

Mechanical Engineering Continued

2·501T. Heat Measurements. Same as 2·50, omitting the lectures.

2·51T. 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.

2·52T. Heat Measurements (B). Lectures and laboratory exercises in temperature measurement including thermo-couples, resistance thermometry, optical and radiation pyrometry. The effect of radiation on true temperature measurement is treated. The study of heat transfer includes the actual determination of the coefficients of thermal conductivity by usual methods at high and low temperatures for different types of materials. The total radiation loss from low temperature surfaces is also experimentally determined.

2·53T. Heat Measurements II (A). An advanced subject consisting of selected experiments followed by a laboratory investigation of problems connected with the industrial application of heat such as thermal conductivity, thermal expansion, specific heat, ceramics, etc.

2·55T. 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 2·55T and 2·56T particularly adapted to students in the Coöperative Course (II-A).

2·56T. Power Plant Engineering (B). A continuation of 2·55T with application to problems. Will also include the fundamentals of the Diesel and Hydraulic power plant.

2·57. Power Plants Advanced (A). An advanced course 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 deaerators, evaporators, condensers, heater, etc., including turbine and machinery foundations and layouts. Lectures and problems will be supplemented by trips.

2·58T. 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.

2·59T. 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, 2·601T. 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.

2·622T. Refrigeration Engineering (B). A study of the operation of various types of compressors, evaporators, condensers, and automatic controls used in commercial and household refrigerating systems. The application of refrigeration in the manufacture of water ice, eutectic ice, and dry ice. Time required to freeze ice. Ice formation on pipe surfaces. Manufacture of ice-cream. Students present a paper on the application of refrigeration to an industry not covered in the lectures.

2·63T. Storage and Transportation of Foodstuffs (A). A continuation of 2·621 with a study of the refrigeration load and necessary equipment. Trips to nearby plants will be made, where it is possible, to supplement classroom study.

2·64T. Refrigeration Engineering (A). A study of thermal, physical, and toxic properties of the chief refrigerants. A discussion of the more complicated applications of refrigeration to industry and science. Students present a paper on the application 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. *Heating and Ventilation*, Allen and Walker.

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.

Mechanical Engineering Continued

2·672T. 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.

2·681. Engineering Laboratory (B). The use and calibration of instruments used in mechanical engineering practice is followed by experimental studies of heat engineering problems and problems in fluid mechanics. The equipment used consists of steam engines, steam turbine driven pumps, steam pumps, steam specialties, stationary internal combustion engines, an air fan, a single stage air compressor, an impulse type water wheel and pipe lines for study of fluid flow.

2·682. Engineering Laboratory (B). A continuation of 2·681 with equipment such as the following: an air washer for humidity control, a two-stage air compressor, the M. I. T. power and heating plant, heat exchangers, heat measurements, a hydraulic turbine.

2·683T. Engineering Laboratory. Similar to the first part of 2·681.

2·684T. Engineering Laboratory. Parts of 2·681 and 2·682.

2·685T. Engineering Laboratory. A combination of 2·683T and 2·684T.

2·686T. Engineering Laboratory. Similar to 2·681. The exercises assigned to the several Courses differ somewhat according to the several fields of interest.

2·687T. Hydraulic Laboratory. Supplements classroom theory and includes exercises upon orifices, nozzles, weirs, pipes, hydraulic turbines, centrifugal pumps, and other hydraulic equipment.

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 methylchloride refrigerants. A constant temperature room is used in testing the units.

2·691T. 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.

2·701T. 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. The design and construction of such representative automatic production machines as automatic screw machines, wire working machines, automatic machine-tools, are also studied. (For U. S. Army Officers only.)

2·72. Mechanism. Discussion 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.)

2·731. 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).

2·74. 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. Illustrative problems are assigned for solution in the drawing room.

2·751. 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, balancing, lubrication and combined stresses are treated at considerable length. *Library research.*

2·752. Machine Design, Advanced (A). An extension of 2·751 with special reference to dynamic stresses, brakes, problems in vibration, balancing and advanced gear design. *Library references.*

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,

Mechanical Engineering Continued

such as wire working machines, automatic lathes, automatic screw machines, etc.

2·781T, 2·782. Automatic Machinery. Discussion of automatic machines used in production work, such as wire working machines, automatic screw machines, machine tools, etc. (For U. S. Naval Officers only.)

2·791. Automotive Engines (B). A study of the fundamental principles of the internal combustion engine, together with an introduction to design, including the principles of similitude, vibration and balance, materials of construction, working stresses, etc. Lectures and assigned reading are supplemented by laboratory work arranged to emphasize the principles discussed in the classroom.

2·792. Automotive Engines (B). A continuation of 2·791. Essential processes such as carburetion, distribution, ignition, lubrication, are studied as applications of fundamental physics and chemistry to the particular problems of the internal combusion engine. Among the design problems covered are superchargers, induction systems and auxiliary equipment.

2·793. Automotive Engine Design (B). Based on subject 2·791, but may be taken simultaneously. Each student makes engineering computations for, and assembly drawings of, one particular type.

2·794. Automotive Engine Design (B). Continuation of 2·793. The student may go farther with the design started in the previous term or he may select a new type for computations and layout.

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 Vehicle Design (B). The design of some vehicle or component part to supplement 2·795.

2·798. Automotive Vehicle Design (B). The design of some vehicle or component part to supplement 2·796 and a continuation of 2·797.

2·801T, 2·802T. 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.

2·803, 2·804. Automotive Engineering (A). Fundamentals of automotive engineering are the bases of this subject. Study is made of important parts; and procedure of design is outlined. The student is given free choice of the type of machine for his individual study.

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 multicrank 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.

2·83T. 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.

2·871T. 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.

2·872T. 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;

Mechanical Engineering Continued

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, and Notes prepared for class Library Research.*

2·901T, 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 details of the handling of fiber in general and the operations incident to its proper manufacture. The fundamental principles are discussed in detail. The work covers cotton, woolen, worsted, bast fibred materials, rayons, and silk.

2·904. Principles of Textile Manufacturing (B). A continuation of 2·903. Deals with the details of the operations and the fundamental principles involved.

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.

2·951T 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.

2·951T. Manufacturing Practice. First term's work at General Electric Company.

2·952T. 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. (Not offered 1936–37.)

MINING AND METALLURGY

SUBJECTS 3·00 TO 3·99

3·00. INTRODUCTION TO MINING AND METALLURGY. A brief orientation subject designed to inform the student regarding the fields of activity of the mining engineer, the petroleum engineer, the metallurgist and the ceramist. The relation of the fundamental sciences to practice in each of these divisions is discussed and a brief introduction given to the chief professional subjects.

3·01. MINING METHODS. Prospecting and exploring including applications of boring; petroleum development and production; explosives, mining development, rock excavation and tunneling; mineral land titles; coal mine development; subsidence; metal and coal mine ventilation and coal mining; engineering thermodynamics; mine equipment embracing air compressing, machine drilling and coal cutting. Peele, *Mining Engineers Handbook.*

3·02. MINING METHODS. A continuation of 3·01. Support of ground and timbering; shaft sinking; mine production with description of underground mining systems and selection of the proper method; construction and use of mine models and other special topics; mine equipment embracing mechanical loading, underground transport, aerial cableway, hoisting, drainage, ventilating, safety apparatus, lighting and surface plant; power shovel, dredge and hydraulic mining; sampling, selling and purchasing ores, fuels and other mineral products; inquiry into the principles of smelting contracts.

3·03. ECONOMICS OF MINING (B). Mineral resources, metals, fuels and other minerals: the economic effects on the business of mining of the following factors; geographic situation, transportation facilities, overproduction and stocks, secondary metals, by-products, strategic minerals, substitutes, new discoveries, import and export tariffs, government regulations, taxes, monopoly, capital requirements and costs of production and marketing.

3·04. MINING, PRINCIPLES OF (B). The principles and practice of mine sampling and examination; the interpretation of data and the writing of reports; inquiry into the risk factor in mining investments and its effect on valuation; the principles controlling methods and extent of development; the character of mechanical equipment; standardization, administration, depreciation and depletion. Hoover, *Principles of Mining.*

3·05. MINING, ELEMENTS OF. For students in metallurgy, geology, chemical engineering and others who are interested in ores or minerals, which may be the raw materials of their industries. Mining methods, including exploring, sampling, development and production; mining equipment, as air compressors, hoists, machine drills, underground and surface transportation; and laws relating to mining. Young, *Elements of Mining.*

3·061, 3·062. MINING ENGINEERING, ADVANCED (A). For graduate students who have had some experience in mining practice and mining engineering, and who desire to do advanced work in some topic of the subject not specifically covered elsewhere. The student is expected to make his own choice of the topic and of the allotment of time. The latter may be devoted variously to lectures, conferences, assigned readings, library studies, drawings, computations and written reports.

3·07. MINING ENGINEERING (B). Conducted as a seminar in which the student is allowed the election of approved topics in metal, non-metal or coal mining, fire assaying, ore dressing or metallurgy, and pursues his study under instructors in the particular field selected.

3·08. MINING PRACTICE. Given at the Summer Mining Camp at Dover, N. J. Six days in the summer will be spent in familiarizing the students with processes and operations in mining, crushing and concentrating with visits to a number of nearby metal and coal mines in New Jersey and Pennsylvania.

3·101, 3·102. MINE VALUATION (A). Interpretation of mine sampling, estimates of ore reserves, design and estimates of cost of plant equipment, determination of operating costs and valuation of the ore deposit. Given by the case system and the time is devoted to lectures, conferences, assigned readings, computations, and written reports. Designed for graduate students who have a background of experience in mining practice.

3·12. MINING ECONOMICS, ADVANCED (A). The study and analysis of the reports of mining and petroleum companies with inquiry into the principles and practice of cost accounting, the methods of treating depletion, depreciation, and obsolescence, and the incidence of federal income taxes, duties, and tariffs.

3·13. APPLICATIONS OF SCIENCE TO PROSPECTING (B). Lectures covering the elements of prospecting by the various scientific means: including practical magnetic, electric, seismic and gravimetric methods; description and application of apparatus for surveying deep bore-holes. Field exercises provide opportunity for use of electrical and magnetic apparatus following typical field practice. Laboratory work offers a chance for further study of apparatus.

3·21. ORE DRESSING (B). The mechanical concentration of the mine ore to separate the valuable minerals from the waste. The greater part of the time is devoted to wet gravity concentration and flotation, including crushing machinery, screens, classifiers, jigs, vanners, tables and flotation machines. Amalgamation, pneumatic, electrostatic and other minor processes are also discussed, as well as accessory apparatus, mill principles, milling economics and typical mill flow sheets. It is aimed to correlate the lectures with 3·22. Richards and Locke, *Textbook of Ore Dressing.*

3·22. ORE-DRESSING LABORATORY (B). Principles and actual operation of ore-dressing apparatus. Briquetting, polishing and quantitative microscopic studies of mill products. The class usually makes two mill runs, one on gold ore, using stamps, amalgamated plate, vanner, classifier and canvas table, and the other on a lead ore using trommel, classifier, jigs and tables. A flotation mill run may be given, also. Individual tests are made on crushing machines, sizing screens, hydraulic classifiers, magnets and

Mining and Metallurgy Continued

flotation machines. One very important part of this work is the cleaning up, weighing, sampling and analyzing of all the products, the computation of results and the preparation of written reports which are discussed at the weekly seminars.

3·23. Ore Dressing. The lectures embody the principles of wet gravity concentration, flotation, amalgamation and magnetic separation. The most important crushing and concentrating machines of interest to the metallurgists are treated briefly. The laboratory work covers three seven-hour periods for three weeks, and three seminars of one hour; it is practically identical with that of 3·22 with the exception that lack of time prevents the student from performing individual tests. Richards and Locke, *Textbook of Ore Dressing.*

3·241, 3·242. Ore Dressing, Advanced (A). Somewhat variable in scope and time allotment. Devoted to lectures, conferences and assigned readings in continuation of 3·21 or 3·23.

3·251, 3·252. Theory and Practice of Flotation (A). Library readings, conferences and laboratory work, going more deeply into the subject than is possible in undergraduate work, and dealing with special phases in flotation such as fundamental theory, study of reagents, differential flotation, application to oxidized ores and the economics of flotation.

3·26. Ore Dressing, Economics (A). Conferences and problems involving the various factors of equipment costs, operating cost, efficiency of operation and profit.

3·271, 3·272. Ore Dressing, Design (A). Design of flow-sheets and layout of mills; usually includes a special problem of mill design to cover a set of stated conditions.

3·31. 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.*

3·331, 3·332. 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.

3·41. 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 3·415 is closely coördinated with this course. Hayward, *An Outline of Metallurgical Practice;* Hofman and Hayward, *Metallurgy of Copper;* Hofman, *Metallurgy of Lead.*

3·411. Metallurgy: Copper and Lead (B). The lectures are given simultaneously with 3·41. The laboratory work is omitted but it is suggested that 3·415 be taken simultaneously. *Textbook same as for 3·41.*

3·412. Metallurgy: Copper, Lead, Zinc, etc. (B). The lectures on copper and lead are given simultaneously with 3·41 and 3·411. In addition, there are fifteen lectures covering briefly zinc, aluminum and other metals. It is suggested that 3·415 be taken simultaneously. Hayward, *An Outline of Metallurgical Practice.*

3·413. Production Metallurgy I. Deals with the smelting, refining and alloying of the non-ferrous metals. A brief introduction to the world's resources of the metals with special reference to their production in the United States compared with other countries. Special emphasis is placed on the impurities found in the ores, their effects on the finished product and their elimination by various processes. The fundamental principles involved in smelting, refining and alloying are described, together with the comparative merits of various types of furnaces and fuels used in these operations. (For U. S. Army Officers only.)

3·414. Production Metallurgy II. Lectures covering the raw materials of the iron and steel industry, namely, iron ores, fuels, fluxes, refractory materials, ferro-alloys, etc. followed by lectures dealing with blast furnace practice and the production of pig iron, malleable cast iron production, wrought iron, tool steel, Bessemer steel production, open hearth steel practice, electric furnace steel making. The properties and uses of the various products are discussed. Alloy steels and alloy cast irons are dealt with and heat treatment is also taken up. The plant visits cover 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.)

3·415. Metallurgical and Electrochemical 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.

3·42. Metallurgy: Gold and Silver (B). The principles of the subject are covered in thirty lectures. The laboratory work is designed to illustrate some of the standard processes and to give the student experience in testing. Samples of known metallic contents are used and students are held individually responsible for the accuracy of their results.

3·422. Metallurgy: Gold and Silver (B). The same lectures as 3·42 but no laboratory.

3·43. Metallurgy: Iron and Steel (B). The physical and chemical properties of iron, steel and alloy steels, and the production and treatment of pig iron, cast iron, wrought iron, steel, etc. Stress is laid mainly on principles; the processes being given in outline and studied in detail in assigned references to books and journals. The lectures are supplemented by plant visits which are covered by subsequent reports and seminars. Stoughton, *Metallurgy of Iron and Steel;* Camp and Francis, *Making, Shaping and Treating of Steel.*

3·431. Metallurgy: Iron and Steel (B). The lectures are simultaneous with 3·43, but less time is devoted

Mining and Metallurgy Continued

to library work and plant visits. Recommended for Army and Navy officers requiring a knowledge of iron and steel for ordnance or structural purposes. Stoughton, *Metallurgy of Iron and Steel;* Camp and Francis, *Making, Shaping and Treating of Steel.*

3·432. METALLURGY: IRON AND STEEL. The class work is simultaneous with 3·43. Library work and plant visits are omitted. Stoughton, *Metallurgy of Iron and Steel.*

3·44. METALLURGY: GENERAL, ZINC AND MINOR METALS (B). Covers in a general manner the properties of metals and alloys, treats in detail fuels and refractories, discusses the principles which govern pyro, hydro and electrometallurgical processes and considers typical metallurgical apparatus. In zinc and minor metals the work supplements that given in 3·412. Hofman, *General Metallurgy;* Hayward, *An Outline of Metallurgical Practice.*

3·45. METALLURGY, HEAT TREATMENT OF STEEL (B). Heat treatment of steel including some discussion of furnaces and equipment. The lectures are supplemented by plant visits and library work covered by seminars and reports.

3·46. 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. Elective in third or fourth year. Hayward, *An Outline of Metallurgical Practice.*

3·501, 3·502. 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 courses.

3·511, 3·512. 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.

3·52. 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.

3·53. 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. Those desiring to study the properties of metals and alloys should register for 3·651, 3·652.

3·54. GOLD AND SILVER METALLURGY, ADVANCED (A). For graduate students who desire to do advanced work in the metallurgy of the precious metals. May be extended to cover the metallurgy of the metals of the platinum group. Conferences, assigned reading, reports and special problems.

3·55. 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.

3·56. METALLURGICAL PLANTS (B). Drafting room, library and conference work. Details of apparatus, plant arrangement and operations are studied and presented at occasional seminars.

3·60. METALLURGICAL PLANT VISITS (B). Consists of one week spent in visiting metallurgical plants in New Jersey and Eastern Pennsylvania. The production of iron and steel, zinc, copper and lead is studied. Students will meet an instructor at a designated place about one week before the opening of the fall term. Required of men expecting to register for Metallurgy 3·41, 3·411, 3·43 or 3·431.

3·61. 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. Practice in photomicrography is an essential part of the subject. Williams and Homerberg, *Principles of Metallography.*

3·621. 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. Laboratory practice is included.

3·622. METALLOGRAPHY. A continuation of 3·621 in which iron, steel, and the alloy steels are studied. Laboratory practice is included.

3·643. LIGHT ALLOYS (B). A detailed study of the structure, properties, heat treatment and uses of alloys of aluminum, magnesium and beryllium.

3·65. 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.)

3·651, 3·652. PHYSICAL METALLURGY, ADVANCED (A). A series of conferences dealing with recent developments in physical metallurgy, accompanied by laboratory exercises in which brief research problems will be undertaken.

3·653. ADVANCED PHYSICAL METALLURGY. A study of the fundamental properties of metals including the theories 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.)

Mining and Metallurgy Continued

3·656. X-Ray Metallography. Conferences and laboratory work dealing with the use of X-rays in the study of metals. Includes radiographic examination of metal parts, as well as the X-ray defraction study of the atomic and granular structures of metals, and their relations.

3·66. Applications of Metallography (B). Laboratory conferences, arranged to familiarize the student with the applications of metallography to industrial problems.

3·67. Physics of Metals (B). A discussion of the modern theories of the metallic state resulting from a study of the physical properties of metals.

3·673. 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.

3·69. 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.

3·691. Metallography and Corrosion. Designed primarily for students in Petroleum Production. Includes the metallography of 3·61 and the corrosion section of 3·69.

3·71. Heat Treatment. The effect of heat treatment on the physical properties of iron, steel and other metals. Considerable time is devoted to the determination of the proper heat treatment to bring out any particular property desired.

3·713. 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 United States Navy taking Torpedo Engineering.)

3·714. Heat Treatment. A continuation of 3·71, devoted to the study of the effect of heat treatment on the metals used in the automotive industry.

3·72. 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.

3·731, 3·732. Advanced Physical Metallurgy. 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.)

3·74. Theory of Metal Hardening (A). A critical discussion of the modern theories of the hardening of metals.

3·75. Elements of Electrochemistry. Fundamental principles of electrochemistry and their industrial applications for students who desire a general survey of this subject but who have had no previous preparation in physical chemistry. Thompson, *Theoretical and Applied Electrochemistry*.

3·76. Applied Electrochemistry (B). Consideration of the industrial applications of electrochemistry. Includes the theory and construction of different types of electric furnaces, electrometallurgical processes, accumulators and primary cells, and the electrolytic production of chemical compounds. The work also includes the design of one or more electrochemical plants for specific processes. Thompson, *Theoretical and Applied Electrochemistry*.

3·791. Electrochemical Laboratory (B). Carried on in conjunction with 8·82. Electrical conductance, single potentials, decomposition voltages, overvoltages, polarization, and electrolysis including practice in electroplating, also efficiency tests on technical processes involving electrolysis in aqueous solutions, e.g. the production of hypochlorite, chlorate, etc.

3·792. 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*.

3·80. Electrochemistry, Advanced (A). The application of thermodynamics to electrochemical problems, including electromotive force of reversible cells, electrolytic oxydation and reduction phenomena and high temperature equilibria in electric furnaces. Lewis and Randall's *Thermodynamics; Journal articles*.

3·81, 3·82. Elements of Petroleum Engineering. Methods and legal forms for the acquisition of petroleum lands; the planning of surface improvements and of subsurface development; methods of drilling oil and gas wells, drilling contracts and coöperation in drilling; methods of extracting oil and gas from natural reservoirs; methods of protecting wells from caving and from underground waters, and methods of transportation and storage. Safety, sanitation and housing of employees. Statistics and economics of the industry. Methods of preparing and using field, property, production and structural maps. Use of well logs and structural contour models.

3·84. Outline of Petroleum Production. For students outside of the option in Petroleum Production who are interested in the methods of developing, producing and storing the crude products of the petroleum industry. Includes oil and gas land titles, methods of development and production, transportation and storage of petroleum.

3·85, 3·86. Petroleum Production (B). Special methods for increasing the flow of oil and gas to wells: the production and distribution of natural gas; the extraction of natural gasoline from natural gas; the utilization of petroleum products as affecting the oil and gas producer; elements of the valuation of oil and gas lands. Laboratory studies of problems in production, transportation and storage of crude petroleum and natural gas. Examination of cores and samples from producing formations for grain size, porosity and saturation. Testing of cements and muds used in oil wells. Treating of emulsions for the removal of water and sediments.

3·89. Oil Field Visits. A five-day trip to the oil and gas fields of Western Pennsylvania.

3·901, 3·902. Oil and Gas Land Valuation (A). Considers the factors entering into the valuation of oil and gas properties, given by the case system. Lectures, conferences, assigned readings, drawings, computations and

Mining and Metallurgy Continued

written reports. For graduate students who have had some experience in petroleum production.

3·911, 3·912. Advanced Petroleum Engineering (A). For graduate students who have had some experience in petroleum production, and who desire to take advanced work in some branch of the subject not specifically covered by other subjects scheduled. The student is expected to make his own choice of the special division and the allotment of time. The latter will be devoted to lectures, recitations, conferences, assigned readings, library studies, drawings, computations and written reports.

3·921, 3·922. Oil and Gas Law (A). Laws and legal forms relating to the acquisition of petroleum rights to production, storage and transportation of petroleum, natural gas and their products.

3·93. Ceramics (B). An introduction to the more advanced ceramics subjects. The selection of ceramic materials, molding, drying and burning are taken up, as well as the physical properties of finished products. Commercial processes will be carried out in the laboratory on a small scale.

3·94. 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.

3·951. 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 will also be discussed. The principles of kiln and furnace design are discussed and practical examples will be analyzed.

3·952. 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.

3·961, 3·962. 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 is expected to make his own choice of the topic and the allotment of time. The latter may be devoted to lectures, conferences, assigned readings, or laboratory work.

3·99. Glass Blowing. Students are taught how to manipulate glass and make such simple apparatus, electrodes, etc., as are likely to be needed in electrochemical research. (Offered only to fourth-year and special students in Course XIV.)

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. Six weeks 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.

4·031, 4·032. Freehand Drawing. A continuation of 4·022. Drawing from the nude in line and graphite crayon.

4·041, 4·042. Freehand Drawing. A continuation of 4·032. The student is encouraged to experiment in figure drawing in various media. Students showing sufficient mastery of the figure are permitted to work out simple figure compositions.

4·051, 4·052. Freehand Drawing (B). A continuation of 4·042. Students work in different media and make both large and small drawings to give a better sense of scale and proportion. Forms other than the human figure are studied for use in composition work. Simple problems in figure composition are given, with special reference to an architectural application.

4·053, 4·054. Freehand Drawing (A). A continuation of 4·052, the work and problems in figure composition being of a more advanced nature. Open only to graduate students who have passed 4·052, or 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, both scientific and aesthetic, 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.

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.

4·13. Perspective. Fundamental phenomena of appearance, the general theory of conical projection and its

Architecture Continued

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, the cubic system, method of perspective plan, and shadows. *Principles of Architectural Perspective*, Lawrence.

4·22. 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.

4·25. Estimating and Management of Construction Operation. Designed to give some knowledge of the methods used in making estimates of cost as applied to building, and of the Architect's control required during the construction period. (Not offered to students below the fourth year.) *Mimeograph notes and blueprint drawings.*

4·312. Abstract Design. Exercises in the general principles of composition as applied to abstract lines and forms. Problems in composition of architectural subjects decorative in character.

4·321, 4·322. Theory of Architecture. Lectures and drawing exercises supplementing the corresponding subject of Architectural Design and closely related to it.

4·331, 4·332. Theory of Architecture. Lectures and drawing exercises supplementing the corresponding subject of Architectural Design and closely related to it.

4·341, 4·342. Theory of Architecture. Lectures and drawing exercises supplementing the corresponding subject of Architectural Design and closely related to it.

4·421, 4·422, 4·423, 4·424. 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.

4·461, 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 and 4·471.

4·481, 4·482. European Civilization and Art: the Eighteenth Century and Modern Culture (B). A continuation of 4·472 and 4·481.

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.

4·53. 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 accomplishment. *Handbook of the Professional Practice, American Institute of Architects.*

4·62. Site Planning and Construction Details. A subject primarily for students in City Planning, in which problems in landscape construction are studied with emphasis on their relation to site planning. It is arranged in two divisions; *Grading Problems:* Estimating cut and fill; problems relating to contour maps; methods of making grading plans; cross-sections; surface and sub-surface drainage; road curves and gradients. *Construction Details:* Location and construction of steps, ramps, retaining walls, embankments, culverts, catch basins, etc.

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. History and 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 and Practice of City Planning (B). Lectures and class exercises supplementing the corresponding subject of design and closely related to it. *Design of Residential Areas*, Thomas Adams.

4·651, 4·652. Theory and Practice of City Planning (B). A continuation of 4·642. 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 housing groups and neighborhood units. Individual instruction is given in the drafting room, and the system of preliminary sketches, developed problems, and sketch problems is continued.

Architecture Continued

4·681, 4·682. City Planning Design (B). A continuation of 4·672. 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. Includes the preparation of the thesis required for the Bachelor's degree.

4·691, 4·692. City Planning Design, Advanced (A). A continuation of the undergraduate subject 4·682.

4·711, 4·712. Architectural Design I. 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 studio 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. A continuation of 4·712. Problems in architectural composition as applied to buildings of simple requirements and varied character. Carried on by means of eight hour preliminary sketch exercises in the form of sketch problems. Some of these are further developed to a final result in a period of from four to five weeks.

4·731, 4·732. Architectural Design III. A continuation of 4·722. The sketch problem exercises in this course 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. Includes the preparation of the thesis required for the degree of Bachelor in Architecture.

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. The student is given some practice in making sketch plans and is required to make a written report upon the plan of some existing building.

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.*

4·911. Structural Analysis. The major part of the course consists of a consideration of the fundamental problems in structural design with emphasis on the analysis of such problems and the adaptation to their solution of principles already acquired in the study of mathematics and applied mechanics. Elementary forms in wood, cast iron and steel and concrete and steel are studied. Running parallel with this are lectures and discussions planned to give the student a general understanding of the different types of building construction, the typical forms of elementary structures, and some idea of arrangements and proportions imposed by the use of different materials, with visits to buildings in process of construction. *Mimeograph Notes.*

4·912. Structural Design. A continuation of 4·911 with emphasis placed equally on analysis and design.

4·921. Structural Design. Problems in architectural construction, including general steel framing, the design of plate and box girders, with a careful analysis of a shallow girder. *Mimeograph Notes.*

4·922. Structural Design. A continuation of 4·921 including a heavy riveted truss and some consideration of wind resistance.

The following subjects are offered as General Studies.

G17. Design in Manufactured Products.

G50. Fine Arts.

G57. Expressions of Graphic Art.

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; Smith's College Chemistry, 3d Revised Edition*, Smith.

5·04. CHEMISTRY. Lectures, demonstrated by experiments, covering a review of inorganic chemistry with special attention to principles and the fundamentals in inorganic chemistry. Introduction of physical chemical principles including laws of gases, liquid substances, ideal solutions, thermochemistry, and chemical equilibrium. *Mimeographed notes;* Smith-Kendall, "*College Chemistry*"; Millard, "*Physical Chemistry for Colleges.*" (For 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. Time is devoted to recent investigations in inorganic chemistry.

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 commoner elements, and reactions in non-aqueous solvents. In the second term a series of lectures on selected subjects is given by a number of members of the instructing staff.

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. A. A. Noyes, *Qualitative Analysis.*

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. Hall, *Textbook of Quantitative Analysis;* Hamilton and Simpson, *Calculations of Analytical Chemistry.*

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.

5·131. QUANTITATIVE ANALYSIS. Abridgment of 5·13.

5·141. ANALYTICAL CHEMISTRY. Chemical applications of the microscope, including microchemical qualitative analysis and the identification of crystalline material by the polarizing microscope. Typical illustrations of the use of the polariscope, saccharimeter and refractometer. Tests with the viscosimeter, nitrometer, turbidimeter and precision centrifuge.

5·142. 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.

5·16. ANALYTICAL CHEMISTRY. Special methods designed for laboratory conditions of the practice school in Chemical Engineering.

5·18. QUALITATIVE ANALYSIS, ADVANCED (A). A study of the reactions of the rarer elements and their detection. Noyes and Bray, *Qualitative Analysis for the Rare Elements.*

5·20. CHEMISTRY OF WATER AND SEWAGE. Chemical examination of potable waters and sewage with lectures on the sanitary significance of the results.

5·23. SANITARY CHEMISTRY. Chemical problems in the selection and examination of water; the purification of water, and the softening of municipal supplies. Laboratory technique of water analysis and treatment.

5·25. CHEMISTRY OF FOODS. Analytical methods, fundamental basis of nutrition; extent, character and legal status of food adulteration. Woodman, *Food Analysis.*

5·251. CHEMISTRY OF FOODS (B). Abridgment of 5·25.

5·26. FOOD ANALYSIS (B). Problems in state and municipal food control, systems of food inspection and methods of food analysis.

5·35. APPLIED CHEMISTRY. The theoretical principles underlying the causes of corrosion and preventive measures by means of protective coatings. Properties, testing and application of paints, oils, varnishes, lubricants, wood preservatives, alloys.

ORGANIC CHEMISTRY

UNDERGRADUATE SUBJECTS

5·41. ORGANIC CHEMISTRY I. The fundamental principles of the chemistry of the carbon compounds, based on a

Chemistry Continued

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 Army Officers only.)

5·414, 5·424, 5·416, 5·426. Organic Chemistry Laboratory. Includes organic preparations, typical reactions associated with each class of organic compounds, identification of organic compounds, and special experimental problems. The class is divided into sections whose laboratory assignments are selected from the above types of work, but varied to meet the special needs of the several participating courses.

5·417. Quantitative Organic Analysis. Determinations of carbon-hydrogen, nitrogen, halogens and sulfur by macro and semi-micro methods of analysis; conferences and discussions.

5·418. Organic Chemistry Laboratory. Abridgment of 5·416.

5·42. Organic Chemistry I. Amplification and extension of 5·41.

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

5·51, 5·52. Organic Chemistry II (A). The important principles of the science are emphasized from a more mature point of view.

5·53, 5·54. Organic Chemistry III (A). Designed to produce a familiarity with the phenomena exhibited by organic compounds. The laws and principles of organic chemistry are inferred from the known behavior of the substances.

5·55. Identification of Organic Compounds (A). The study of systematic methods of organic qualitative analysis including treatment both of individual compounds and mixtures.

5·56. Chemistry of Heterocyclic Compounds (A). (Alternate years. Not offered in 1936–37.)

5·562. The Carbohydrates (A). Lectures on the determination of configuration and structure in the sugar group, and discussion of the synthesis, derivatives and reactions of such substances, with brief reference to the biological applications of such knowledge.

5·57. Chemistry of Dyes (A). Systematic lectures, illustrated by experiments, on the synthetic organic dyestuffs, and their intermediates. (Alternate years. Offered 1936–37.)

5·574. Free Radicals and Organo-Metallic Compounds (A). The history and current developments in these fields will be discussed. (Alternate years. Offered 1936–37.)

5·58. Organic Substances in Metabolic Processes (A). Lectures dealing with the principles of auto-oxidation reactions, and the chemistry of the animal pigments, flavines, carotinoids and related products, sterols and bile acids, vitamins and hormones. (Alternate years. Offered 1936–37.)

5·581, 5·582. Advanced Organic Laboratory (A).

5·584. Molecular Structure of Carbon Compounds (A). Deals with the classical and the newer methods for determining the molecular structure of organic compounds and problems of stereochemistry. (Alternate years. Not offered in 1936–37.)

5·591, 5·592. Recent Advances in Organic Chemistry.

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.

5·63T. 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, univarient systems; ideal and real solutions; voltaic cells; free energy calculations. Noyes and Sherrill, *An Advanced Course in Instruction in Chemical Principles.*

5·64T. Introduction to Radiation Chemistry (B). Electric and magnetic units; deflection of charged particles; gaseous ions; black body radiation; Planck's theory; photoelectric effect; Bohr atom; quantum numbers; periodic table; hydrogen-like spectra; X-ray spectra; optical spectra; elementary quantum mechanics. White, *Introduction to Atomic Spectra.*

5·66. Surface and Colloid Chemistry (B). Structure of surfaces; surfaces 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 and Public Health. Gillespie, *Physical Chemistry.*

Chemistry Continued

GRADUATE SUBJECTS

5·71, 5·72T. 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.*

5·741T. Advanced Radiation Chemistry (A). Introduction to atomic and molecular spectra and their application to thermodynamic calculations and to molecular structure.

5·742T. Kinetic Theory and Statistical Mechanics (A). Statistical Mechanics and the theory of intermolecular forces with applications to the equation of state problem.

5·75. Thermodynamics (A). The principal general equations of thermodynamics from the entropy point of view.

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. (Alternate years. Offered 1936–37.)

SPECIAL TOPICS IN CHEMISTRY

5·81. Chemical Literature I. A study of foreign language scientific literature.

5·82. Chemical Literature II. Methods of using the journals, books and indexes.

5·83. History of Chemistry (B).

5·842. Optical Methods (B). Laboratory practice in the use of the polarizing microscope for the identification of crystalline material. Equipment is available for both microchemical tests and such optical tests as refractive index, interference figures and optical character.

5·844. Engineering Chemistry. A survey of Qualitative and Quantitative Analysis with particular reference to cement, concrete, alloys, paints, pigments, varnishes and other buildings materials. For students specializing in Building Construction.

5·851. Methods of Electrochemical Analysis (A).

5·852. Organic Physical Chemistry (A). (Alternate years. Not offered in 1936–37.)

5·855. Theories and Applications of Catalysis (A). (Alternate years. Not offered in 1936–37.)

5·90. Logic of Science (A). Discussion of the methods used in making an inquiry into the phenomena of nature; uses of reasoning and of the relations between logic and experiment. (Alternate years.)

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 Inorganic and Organic Chemistry.

5·943, 5·944. Research Conferences in Physical 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, organic or physical chemistry.

ELECTRICAL ENGINEERING

SUBJECTS 6·00 TO 6·99

6·00. PRINCIPLES OF ELECTRICAL ENGINEERING. An extension of the principles of electricity and magnetism to linear-circuit analysis; a treatment of circuits consisting of single- and multi-element combinations with constant and sinusoidal applied voltages or currents; a brief consideration of electric systems in general and the way in which they may be broken down into networks for study. As far as possible, at this time, engineering ideas are associated with the text and class treatment. *Special Notes by the Department of Electrical Engineering.*

6·01T. PRINCIPLES OF ELECTRICAL ENGINEERING. General principles of linear-circuit analysis including graphical methods; properties of non-linear circuit elements and the problems arising out of their association with simple forms of linear circuits with attention to their engineering applications; representation of periodic functions arising in non-linear problems by Fourier series; active and reactive powers in alternating-current circuits; magnetic circuit, eddy-current and hysteresis losses. *Special Notes by the Department of Electrical Engineering.*

6·02T. PRINCIPLES OF ELECTRICAL ENGINEERING. Polyphase currents and harmonics, power measurements in polyphase circuits, electronic principles and their application to vacuum tubes and vacuum-tube circuit problems; thermionic and gaseous rectifiers, amplifiers and their circuits; theoretical consideration of energy conversion devices and methods of analytic treatment. *Special Notes by the Department of Electrical Engineering.*

6·03T. PRINCIPLES OF ELECTRICAL ENGINEERING. Transformers for power and communication circuits, rotating magnetic fields, synchronous and induction machines. *Special Notes by Department of Electrical Engineering.*

6·04T. 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 Department of Electrical Engineering* and Woodruff, *Principles of Electric Power Transmission and Distribution.*

6·10. PRINCIPLES OF ELECTRICAL ENGINEERING (ELECTRIC, DIELECTRIC AND MAGNETIC CIRCUITS). Fundamental concepts of electrical engineering and the laws of the electric, dielectric and magnetic circuits. Timbie and Bush, *Principles of Electrical Engineering.*

6·11, 6·12. PRINCIPLES OF ELECTRICAL ENGINEERING (ALTERNATING CURRENTS, ALTERNATING-CURRENT MACHINERY AND ENGINEERING ELECTRONICS). Single-phase alternating-currents and their vector and symbolic representation, power in alternating-current circuits, alternating-current networks, harmonics; polyphase alternating currents; harmonics in polyphase circuits; single- and polyphase transformers; alternating-current rotating machinery for the generation and transformation of electric power; the more important aspects of thermionic and gaseous conduction, circuit elements, associated circuits, apparatus and related topics with a consideration of the fundamental processes involved. Dawes, *Electrical Engineering, Vol. 2, Third Edition.*

6·20. POWER TRANSMISSION EQUIPMENT (B). Construction and characteristics of the equipment employed in the transmission of electric power and application to transmission-line design.

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. CENTRAL STATIONS (B). The thermal principles and economic considerations influencing the generation of electric power. The generating station studied with regard to those factors which influence the fuel consumption and the cost of generation per unit of electrical energy output; the layout and calculation of heat balance and flow diagrams; the economic considerations affecting the selection of site and machinery and arrangement of plant; the physical layout of the electrical bay, turbine plant and boiler plant.

6·222. CENTRAL STATIONS (B). The theoretical electrical principles and economic considerations influencing the generation of electric power. The generating station studied with regard to the influence of bus layout and reactor location on synchronizing power, limitation of short-circuit currents, maintenance of bus voltage and transfer of power under normal and abnormal operating conditions; the operation of synchronous machinery under short-circuit conditions; principles of relay selection and applications for generating stations; the layout and design of the cell structure of the electrical equipment; factors influencing selection of electrical equipment.

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,

Electrical Engineering Continued

division of loads between substations, determination of subsation 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, 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 and Its Behavior (B). Lectures and laboratory work covering the theory and behavior of insulating materials and their use in high-tension equipment. The treatment includes an introduction to classical electrostatics, after which the latest experimental results on conduction, dielectric loss, and breakdown are considered, as well as the theories which have been developed to explain these results. The subject concludes with practical applications to cables, condensers, etc. The laboratory work includes breakdown tests on insulating materials at voltages up to 100,000 volts as well as the measurement of dielectric loss, dielectric constant, and resistivity.

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 of the Fock, 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). Elementary theory underlying radio communication. High-frequency power sources. Thermionic oscillators and regenerative systems, modulation, demodulation, high- and low-frequency amplification. Applications of the thermionic tube. Transmitting and receiving systems. Transfer of radio frequency energy from apparatus to antenna. Elementary theory of electro-magnetic wave radiation, antenna design and propagation phenomena.

6·29. Storage Batteries. Theory, construction, care and application of storage batteries.

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 photo-electric cells.

6·32. Principles of Electrical Communications (B). 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.

6·330T. Electrical Communications Laboratory. Embraces in general the subject matter of 6·331 and 6·332, but is not so extensive.

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.

6·39. Engineering Electronics. Recitation and laboratory work given for the benefit of transfer students and students of courses other than Course VI who have not had 6·02T, covering the more important engineering aspects of thermionic and gaseous-conduction circuit elements, associated circuits, apparatus and related topics, with a consideration of the fundamental processes involved. The various applications studied in the laboratory include the cathode-ray oscillograph, the thermionic tube, the mercury-arc and tungsten-arc rectifier, the grid-controlled gas-filled tube, and the photo-electric cell.

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.*

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.

Electrical Engineering Continued

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). A series of papers and conferences of the junior instructing staff and of students who are candidates for advanced degrees in electrical engineering, held for the purpose of reviewing the development of the arts and sciences relating to electrical engineering, and studying the trend of their advancement and particularly the effect of scientific research. A collateral object of the subject is to impress upon the members of the seminar the most effective methods of collecting, analyzing and presenting data and conclusions in a comprehensive technical subject.

6·511. Electric Power Circuits (A). Methods of solving power-circuit problems. Calculation of short-circuit currents in networks. The theory of multi-circuit transformers. Treatment of unbalanced circuits by the method of symmetrical components, with applications. General circuit constants. The theory and construction of performance charts for transmission lines. A comprehensive graphical treatment of transmission systems in the steady state. Reference Books: Dahl, *Electric Circuits, Vol. I;* Lyon, *Applications of Symmetrical Components;* Wagner and Evans, *Symmetrical Components as Applied to the Analysis of Unbalanced Electrical Circuits.*

6·512T. 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.*

6·513T. Power System Stability (A). The theory and construction of performance charts for synchronous machines. A general discussion of the problem of power-system stability. A comprehensive exposition of analytical and graphical methods for the determination of static power limits and static stability. A brief introduction to transient stability. Dahl, *Electric Circuits—Theory and Applications, Vols. I and II.*

6·514. Power System Stability (A). Stability of power systems during disturbances. The effect of short circuits and sudden switching. 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 the process or voltage build-up and build-down, etc. Discussion of methods for improvement of stability. Effect of damper windings. Effect of different methods of grounding the neutral points of the system. Dahl, *Electric Circuits—Theory and Applications, Vol. II.*

6·515. Power Systems Laboratory (A). Power-network analysis using the network analyzer (an alternating-current calculation table). 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. Electro-magnetic 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.

Much of the instruction is given during informal conference hours. These are arranged to give each student an opportunity to plan his program so as to concentrate on the study of those problems in which he is particularly interested.

A portion of the time is allotted to work in the machine-transients laboratory upon advanced problems.

6·531, 6·532. Organization and Administration of Public Service Companies (A). Lectures associated with reading, study of financial and operating statistics and forms of organization, and written dissertations by the students. The intention is to give the students a knowledge of the business and engineering characteristics of public service companies and the place held by them in national life.

6·541, 6·542. Power Generating Stations (A). The theoretical principles and economical considerations relating to electric generating stations. Thermal efficiency and commercial economy of the different steam cycles, reheating, regeneration, binary cycles; the effect of load factor and the load curve on station design; feed-water heating for maximum thermal economy, layout and calculation of heat balances; the limitation of short-circuit currents; maintenance of voltage and stability; the calculation of short-circuit currents and the selection of circuit breakers. The control and transfer of power under normal and abnormal operating conditions as influenced by the bus layout of the generating station; principles of relay characteristics and their selection and applications within the station.

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,

Electrical Engineering Continued

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). Characteristics of four-terminal networks; synthesis of two-terminal reactances, their equivalents and inverses; conventional filter theory; impedance correction; series and parallel operation of filters for band separation. Laboratory work is given. Guillemin, *Communication Networks, Vol. II.*

6·562. Advanced Network Theory (A). Latest contributions to analysis and synthesis of networks. Generalization of conventional filter theory; transient behavior of selective systems; synthesis of two-terminal dissipative impedances and of four-terminal reactive networks; two- and four-terminal equivalents; 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. Transient Analysis by the Laplacian Transformation (A). Formulation from physical relationships of the differential equations of circuit and field problems in electrical, mechanical, thermal, and acoustical systems. Development of the direct and inverse Laplacian transformations. The application of transform theory to analysis of the transient behavior of physical systems describable by linear differential equations, ordinary and partial, with general boundary conditions. Bush, *Operational Circuit Analysis.*

6·59. Communications Laboratory (A). A graduate laboratory subject in communications 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.

6·61. Super-High-Voltage Engineering (A). Principles and technique involved in the development and application of voltages higher than those now generally used in engineering. Analysis of high direct-current, alternating current, and impulse voltage sources. High-voltage phenomena and measurements. Material insulation and vacuum insulation for high-voltages. Present trends in the development of high-voltage power for long-distance transmission. Analysis of vacuum electrostatic machinery and its possibilities in generation and conversion for direct-current power systems. Application of very high voltages to engineering testing and to the production of X-rays and other high-energy radiations.

6·62. Principles of Electrical Communications (A). Deals with thermionic gaseous conduction and photo-electric tubes and their associated external networks. Includes an advanced study of linear and non-linear amplifiers, amplitude and frequency modulators, regenerative and super-regenerative circuits and oscillators. The class work is supplemented with laboratory problems.

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.

6·651, 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, direct-current machines and alternating-current machines and predetermination of characteristics. Voltage wave-form 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

Electrical Engineering Continued

and an analysis of tidal power possibilities. Stresses in busbars and busbar supports. Inertia effects in high-speed mechanisms. Some laboratory work is included. Den Hartog, *Mechanical Vibrations.*

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, 6·76T, and 6·77T, 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. Electrical Engineering Laboratory. Methods of measurement of electrical quantities by direct-current methods. Choice of work from a broad selection of topics is left to the student within the limit of his proved ability and interest, and subject to the counsel of his instructor. Laws, *Electrical Measurements;* Ricker and Tucker, *Electrical Engineering Laboratory Experiments, Third Edition; Instructions for Students in Electrical Engineering Laboratory, Seventh Edition, September,* 1932.

6·76T. Electrical Engineering Laboratory. Investigation of the steady state and transient behavior of combinations of both linear and non-linear circuit elements. General electrical measurements. Choice of work from a broad selection of topics is left to the student within the limit of his proved ability and interest and subject to the counsel of his instructor. *Textbook same as for* 6·75.

6·761. Electrical Engineering Laboratory. Similar to 6·76T but abridged. *Textbook same as for* 6·75.

6·77T. Electrical Engineering Laboratory. Divided into two parts: (*a*) Electrical Measurements.—Characteristics of electronic devices and associated circuits. (*b*) Electrical Machinery.—Characteristics and fundamentals of direct-current machinery. Ricker and Tucker, *Electrical Engineering Laboratory Experiments, Third Edition;* Kloeffler, Brenneman, and Kerchner, *Direct-Current Machinery; Instructions for Students in Electrical Engineering Laboratory, Seventh Edition, September,* 1932.

6·771. Electrical Engineering Laboratory. Similar to 6·77T, but slightly abridged. *Textbook same as for* 6·77T.

6·78T. Electrical Engineering Laboratory. Polyphase circuits, symmetrical phase components, transformer, synchronous generator, synchronous motor, three-phase induction motors. Ricker and Tucker, *Electrical Engineering Laboratory Experiments, Third Edition; Instructions for Students in Electrical Engineering Laboratory, Seventh Edition, September,* 1932.

6·781T. Electrical Engineering Laboratory. Similar to 6·78T but slightly abridged. *Textbook same as for* 6·78T.

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. *Textbook same as for* 6·78T.

6·80. Electrical Engineering Laboratory (B). For students who desire to do more than the regularly required amount of undergraduate laboratory work. Arranged to suit the requirements of the individual student.

6·82. Electrical Engineering Laboratory. Methods of measurement of electrical and closely related quantities by direct-current methods. Choice of work from a broad selection of topics is left to the student within the limit of his proved ability and interest, and subject to the counsel of his instructor. Laws, *Electrical Measurements;* Ricker and Tucker, *Electrical Engineering Laboratory Experiments, Third Edition; Instructions for Students in Electrical Engineering Laboratory, Seventh Edition, September* 1932.

6·83T. Electrical Engineering Laboratory. Characteristics and fundamentals of direct-current machinery. *Instructions for Students in Electrical Engineering Laboratory, Seventh Edition, September* 1932; Kloeffler, Brenneman, and Kerchner, *Direct-Current Machinery;* Ricker and Tucker, *Electrical Engineering Laboratory Experiments, Third Edition.*

6·84. Electrical Engineering Laboratory. Divided into two parts: (*a*) Electrical Measurements: Characteristics of electronic devices and associated circuits; (*b*) Electrical Machinery: Characteristics and fundamentals of alternating-current machinery. *Instructions for Students in Electrical Engineering Laboratory, Seventh Edition, September* 1932; Ricker and Tucker, *Electrical Engineering Laboratory Experiments, Third Edition.*

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, Third Edition; Instructions for Students in Electrical Engineering Laboratory, Seventh Edition,* 1932.

6·89. Electrical Engineering Laboratory. Eight laboratory exercises similar in subject matter to those of 6·85. *Textbook 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 Erie. 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

Machine Shop Training Room, Assembling and Inspecting. Armature Winding.

Drafting and Design, including work on Motors, Transformers and Turbines.

Standardizing Laboratory and Meter Testing.

Direct-Current Motor Test.

Alternating-Current Motor Test.

Electrical Engineering Continued

Illumination Department.
Transformer Test.
Turbine Test.
Factory Production.
Air Compressors.
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 Edison Electric Illuminating Company of Boston and the Boston Elevated Railway Company. The various departments to which the students are assigned are listed below in the approximate order in which the work is given at:

EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON

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 COMPANY

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 Edison Electric Illuminating Company of Boston.

6·912. PUBLIC UTILITY PRACTICE (EDISON). Second term's work at the plants of the Edison Electric Illuminating Company of Boston.

6·913. PUBLIC UTILITY PRACTICE (EDISON). Third term's work at the plants of the Edison Electric Illuminating Company of Boston.

6·914. PUBLIC UTILITY PRACTICE (EDISON). Fourth term's work at the plants of the Edison Electric Illuminating Company of Boston.

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 co-operative students at the various plants and laboratories of the Bell Telephone System. The first assignment is usually spent in the plant of the Western Electric Company at Kearny, N. J., and with the installation department in or near New York City, the second with the New York Telephone Company, 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.

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 morphogenesis. Special reading assigned. 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, particularly from the economic aspect. 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 zoology 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.

7·10T. INVERTEBRATE ZOOLOGY. A systematic study of the invertebrate animals, considering their form, structure, distribution, and economic value. Hegner, *Invertebrate Zoölogy.*

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 and the essential histology of the organs. The structures will be partly dissected out by students and partly demonstrated by the instructor.

7·15. ESSENTIALS OF ANATOMY. A brief course in mammalian anatomy designed to give students of food technology an insight into the gross and microscopic structures of the animal body. Given as a series of lectures accompanied by demonstrations of the structures.

7·17. BIOLOGY OF FOOD SUPPLIES. A consideration of the animals that contribute to, injure or infest food supplies with special reference to invertebrates. Also, work on the biology of crop plants which will not overlap 7·06 Botany.

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). An examination into the causes of functional metabolism in terms of physical chemistry; colloidal phenomena, diffusion, osmosis, electrical potentials, energetics, chemistry, hormone action, effects of light, physico-chemical nature of protoplasm, reflexes and tropisms. Mitchell, *General Physiology.*

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 (B). Practical work in applied nutrition with problem work, individual case studies, and a special consideration of the practical difficulties in securing a proper and healthful diet for children of various types and social conditions. The greater part of this work (through the coöperation of the Dispensary Staff) is carried out at the Food Clinic of the Boston Dispensary.

7·28. LIMNOLOGY. A specialized study of the microorganisms important in the examination of water for drinking purposes. The organisms are especially considered in relation to each other and to their environment. Whipple, *Microscopy of Drinking Water, Fourth Edition.*

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;*

Biology and Public Health Continued

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 agglutination tests, bacterial dissociation, filterability 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 and the relation of these to suitability for use as a water supply. Includes sampling and 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 the waters are made in the laboratory, and stress is laid on the interpretation of these analyses. Whipple, *Microscopy of Drinking Water;* American Public Health Association, *Standard Methods of Water Analysis.*

7·35. Planktonology (A). Takes up a consideration of those animals and plants which drift about in the water, unattached. They are the greatest singie source of fish food, either directly or indirectly. 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, as are also enzymes and their technical applications.

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.

7·371, 7·372. Industrial Microbiology (A). Seminar work and laboratory studies involving comprehensive reports and investigations of selected problems in the applications of microbiology to the fermentation and food conservation industries. Among the problems which may be considered are the development or improvement of culture and biochemical methods employed in the manufacture of industrial alcohol, acetone, glycerin, butyl alcohol and organic acids, and the study of special relations of microörganisms in the food, textile, fiber, timber, and leather industries.

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 various prejudicial effects of factory life upon health, including occupational accidents, industrial poisoning and the effects of defective ventilation and of dusty and otherwise dangerous trades upon the health of the worker. Special attention is given to industrial fatigue, factory sanitation, and to the problems of health administration in industry. Consideration is given to recent research dealing with those factors related to employee effectiveness.

7·53. Air Examination. A study of the relation of the composition and physics of air to welfare, efficiency, and comfort. The greater part of the course will be devoted to laboratory examination, use of special instruments for air testing, and the determination of dangerous gases, mineral and organic dusts and microbic organisms in air, and the relation of these to industrial hygiene.

7·531. Air Examination (B). Similar to 7·53 but with additional outside reading and reports.

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. A systematic study of the procedures of official public health agencies.

7·551. Public Health Laboratory Methods (B). Practical methods in use in state and municipal bacteriological laboratories are considered. Detailed training is given in pathogenic bacteriology, including cultural diagnosis of diphtheria, examination of specimens for tuberculosis, Widal reaction in typhoid fever, microscopical diagnosis of malaria, etc. Hematology is included.

7·552. Serological Methods (B). Practical methods used in serological laboratories, production of the materials used therein and of biologicals are studied in detail. The Wassermann, Kahn, Hinton, Kline, and other tests for syphilis are included.

7·57. Municipal Sanitation (B). Lectures and problems dealing with the general principles of sanitation as applied to the community, and including water supply, sewage and sewage disposal, sanitation of swimming pools, collection and disposal of refuse, street cleaning, housing, school sanitation, sanitation of food-stores and restaurants, control of insects and rodents, ventilation, etc. Horwood, *Sanitation of Water Supplies.*

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 health surveys; street cleaning; drainage in relation to mosquito control and control of other insects; rodent control and rat-proofing in buildings; inspection and control of

Biology and Public Health Continued

shellfish areas; the sanitary aspects of food manufacturing, including plant sanitation, inspection of operatives, etc.; garbage 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.*

7·601, 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 as to both organization and method. Practical field work is provided to allow the student an opportunity to study and participate in these activities.

7·604. School Health Administration (A). Deals, not with the technique and methods of school health work, but with the organization of the health work expected from teachers, doctors, nurses, physical educators, nutritionists and others, presenting the objectives and measurements of accomplishment for each phase of the work. Special consideration is given to the development of a systematic health education program.

7·63. Public Health Field Work (A). Conferences and actual 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 neighborhood of 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 of Food Supplies. Lectures, discussions and reports on the 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. For 7·701, Buechel, *Commerce of Agriculture;* for 7·702, Clemen, *By-products of the Packing Industry.*

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, *Bacteriology and Mycology of Foods.*

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 of foods.

7·72. 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 course 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.

7·81. 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.

7·94. 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.

G63. Economic Geography.

G74. Principles of Sanitary Science and Public Health.

G75. Biological Reproduction.

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). A study of the laws of electrostatics, followed by a discussion of steady flow in conductors, properties of conductors, electrical energy and power, magnets and magnetic fields, galvanometers and their uses, meters, capacitance and inductance, and gaseous conduction. The calculus is used freely, and many types of problems are discussed.

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, OPTICS, AND MODERN PHYSICS). Continuation of 8·03, with special emphasis on sinusoidal induced e.m.f.s and simple alternating-current circuits and phenomena. Electrical resonance, free and damped oscillations, and electric waves are discussed. Discussion of waves in general leads to optics, the geometrical optics of lenses and optical systems, and the physical optics of interference and diffraction. Spectra are treated, their explanation in terms of the structure of the atom is given, and various branches of modern physics are discussed.

8·05. VIBRATIONS AND SOUND. The first part of the course 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.

8·06. ACOUSTICS, ILLUMINATION AND COLOR. A discussion of matters of especial interest to students of architecture.

8·07. PRECISION OF MEASUREMENTS. A discussion of the principles underlying the treatment of experimental data and the planning of investigations involving measurements. The subject is intended as an introduction to research or thesis work. Goodwin's *Precision of Measurements and Graphical Methods.*

8·09. PHYSICAL MEASUREMENTS. Laboratory work in mechanics, properties of matter, and heat.

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.

OPTICS AND PHOTOGRAPHY

8·15. PHOTOGRAPHY. An elementary course in photography intended primarily as an elective for students not in Course VIII. It is concerned principally with such applications of photography as record photography, artistic photography, stereoscopic photography, color photography and motion pictures.

8·152. ADVANCED PHOTOGRAPHY. A laboratory course in photography open only to students who have credit for 8·15 or who take 8·15 simultaneously. The experiments are concerned chiefly with the actual 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, photo-electricity, 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.

8·171. ADVANCED OPTICS (B). A subject covering the same general subject matter as 8·161 in a more advanced manner.

Physics Continued

8·173. Color Measurements (B). Theory of methods of measuring and specifying 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 course of a semi-professional character intended primarily for students planning to enter the motion picture industry. The subject matter is included in the Journal of Transactions of the Society of Motion Picture Engineers.

8·181. 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.

8·191. 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 engineering. The lectures during the latter half of the course are given by experts in the above-mentioned fields.

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. A course in 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 includes 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 introduction 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. (Offered in alternate years. Not 1936–37.)

8·214. Advanced Electronics (A). Continuation of 8·213. (Offered in alternate years. Not 1936–37.)

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. Polar Molecules (A). Debye's theory of dielectrics and its application to related phenomena. Theory of dispersion and scattering of light, Kerr effect, electrostriction and electrocaloric effects. The dipole moment and the structure of molecules. P. Debye, *Polar Molecules*. (Offered in alternate years. Not 1936–37.)

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.

8·28. X-ray Diffraction (A). The theory of X-ray diffraction and its application to the study of the structure of matter. Elementary theory of X-ray diffraction in crystals, the Lorentz factor, temperature effect, integrated intensity, the Darwin theory of diffraction in mosaic and perfect crystals. Atomic scattering and F curves. The Fourier method of determining the electron distribution in crystals and in the atom. The Scherrer particle-size equation. X-ray scattering in liquids and gases. (Offered in alternate years.)

8·29. Lattice Theory of the Solid State (A). The methods and results of crystallography and the X-ray investigations of crystal structure will be discussed. The following topics will be considered: homopolar and heteropolar crystals; Born-Madelung's theory of heteropolar lattices; elastic constants and breaking stress; surface tension; dielectric constant and magnetic susceptibility; piezoelectricity; double refraction and optical activity; thermal expansion and pyroelectricity; specific heat of crystals; Hund's theory of crystal types. (Offered in alternate years. Not 1936–37.)

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. Modern theories of the structure of atoms, optical and X-ray spectra, atomic models with application to the structure of the periodic table, radioactivity and nuclear structure, and related topics.

8·312. Atomic Structure Laboratory. Experiments on selected topics in modern physics.

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, designed to be taken concurrently with the Spectroscopy Seminar (8·341, 8·342) by students who desire to carry out special investigations which do not come under the head of thesis work.

Physics Continued

8·344. Practical Spectroscopy (B). A course 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 course consisting of the use of spectroscopic equipment in problems connected with the fields covered by subject 8·344 and designed to be taken concurrently with 8·344.

8·346. Quantitative Spectroscopic Analysis (B). A short course on this subject consisting of the last two weeks of Course 8·344 and designed particularly for those interested in the application of quantitative spectroscopic analysis to industrial problems.

8·35. Excitation of Spectra (A). Lectures and laboratory on fundamental processes of excitation, including excitation by absorption, by electron impact and by radiationless transfer of energy; arc, spark and furnace spectra; complex excitation; mixed gas discharges; optical and electrical methods of critical potential measurements; line intensities under different conditions of excitation.

8·36a. Radiation Measurements and

8·36b. Radiation Measurements Laboratory. Aims to familiarize the student with modern instruments and methods employed in the measurement and analysis of ultraviolet, visible and infra-red radiation, as photoelectric cells and thermopiles. The laboratory instruction includes comparison and calibration of detectors, analysis of radiation by various methods, and practice with radiometric instruments. Special emphasis is placed on line intensity measurements. (Not offered 1936–37.)

8·411. Nuclear Physics (B). Natural radioactivity, nuclear force fields and interaction cross sections, mass and energy, nuclear mechanical and magnetic moments, cosmic rays, and transmutation by natural alpha rays.

8·412. Nuclear Physics (B). Disintegration and detection apparatus, disintegration processes, the neutron, gamma ray, and positron, artificially induced radioactivity, nuclear energy states, and contemporary theories of nuclear stability and constitution.

8·42. Seminar in Nuclear Physics (A). Discussion and reports on special topics in nuclear structure and related subjects, mainly from the experimental point of view.

8·441, 8·442. Special Problems in Nuclear Research (A). Supervised experimental work on radioactivity, nuclear bombardment, and general nuclear research, designed to be taken by 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. (Offered in alternate years. Not 1936–37.)

8·471. Historical Development of Physics (B). A survey of physics up to 1900, intended to correlate the various branches, present them in their historical order, and provide a means of filling in any gaps in the student's training.

8·481. Advanced Mechanics I (A). The mechanics of particles and rigid bodies treated by the generalized methods of Lagrange and Hamilton. (Offered in alternate years. Not 1936–37.)

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. (Offered in alternate years. Not 1936–37.)

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. (Offered in alternate years. Not 1936–37.)

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.

8·512. Statistical Mechanics (A). The basic principles of statistical mechanics with applications to physical problems. (Offered in alternate years.)

8·521. Quantum Mechanics (A). An advanced course 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. (Offered in alternate years.)

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 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. Quasi-stationary state theory and the transition from the Maxwell equations to circuit equations.

8·56. Electromagnetic Wave Theory (A). Radiation problems, mechanics of the electron, and introduction to restricted relativity. (Offered in alternate years.)

Physics Continued

8·58. Theory of Relativity (A). Restricted and general relativity, cosmological considerations, attempts at a unification of electricity and gravitation, quantum theory and relativity. (Offered in alternate years. Not 1936–37.)

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.

ELECTROCHEMISTRY

8·82. Electrochemistry (B). Electrical conduction in liquids, solids and gases, theories of the voltaic cell, polarization and electrolysis, the principles involved in the corrosion, electrodeposition, and refining of metals, and the energy relations underlying the mutual transformations of chemical and electrical energy. Butler's *The Fundamentals of Chemical Thermodynamics; Standard texts on Electrochemistry*, and *Scientific Journals.*

The following subject is offered as a General Study. For description see Division of General Studies.

G66. 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.

10·16. Applied Chemistry. The purpose of this subject is to develop the technique of applying the principles of general and physical chemistry to practical problems. The topics include combustion reactions, the chemical synthesis and transformation of fuels, corrosion, lubricants, the mechanical characteristics of amorphous materials, including plastics, the mechanism of interaction of liquids and solids with gases and the effects of high pressure on the properties of materials.

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.

10·191. Chemical Engineering Literature. Readings in technical literature in both French and German, including researches in reference books and journals.

10·192. Chemical Engineering Literature. Continuation of 10·191.

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 Stoichiometry (A). Offered for graduates of other institutions where the instruction received in physical and organic chemistry has been similar to that given at the Institute but where the instruction received in industrial chemistry has been descriptive in character. The work involves a thorough study of typical processes of chemical industry by the solution of numerous quantitative problems.

10·251. Industrial Chemistry (A). Designed to meet the needs of mature students. Emphasis is laid upon analysis and discussion of the processes and inter-relationships of the more important chemical industries.

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.

10·28. 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.

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.

Chemical Engineering Continued

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 these operations involve fundamental problems in flow of heat and flow of fluids, these topics are first discussed in detail. There follows an analysis of the operations 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 and McAdams, *Principles of Chemical Engineering.*

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.

10·35, 10·36. Industrial Chemical Engineering. These consecutive subjects cover the several basic unit operations of the chemical industry, from the viewpoint of engineering economics. The operations include the dynamics of fluids and flow of heat, evaporation, humidification, drying, distillation, filtration, and the mechanical treatment and handling of solids. Particular attention is given to the suitability and choice of equipment for the plant from the economic standpoint.

10·37. Flow of Fluids (A). A brief review of the principles of fluid flow is followed by a detailed study of the laws of flow of plastic materials, suspensions of fine particles in liquids, movement of fluids through porous structures, influence of velocity and pressure gradient on the permeability of such structures and the movement of multiple phase mixtures of fluids through them.

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 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 Army and Naval Officers only.)

10·41–10·50. Special Topics in Chemical Engineering. The purpose is to study thoroughly and in detail one special phase of chemical engineering. Each subject starts with a brief review of the underlying principles as taken up in 10·31 and 10·32. The more advanced phases are then discussed in detail. To illustrate the general applicability of these principles to the design and operation of industrial plants, numerous problems are solved quantitatively.

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.

10·42. Drying (A). A detailed study of the basic principles of drying of solids and gases. Particular attention is given the fundamental mechanism of the drying of solids, with quantitative problems illustrating the application of the theoretical equations for the diffusion of liquids through solids. The work includes a study of those phases of Mechanical Separation, such as pressing, centrifuging, etc., which are frequently involved in industrial drying operations. (Not offered in 1936–37.)

10·44. Distillation and Absorption (A). A quantitative study of the basic principles of interaction of liquids and gases, as applied to complex hydrocarbon mixtures. The problems studied are mainly those arising in the handling of petroleum, weathering losses, stabilization, recovery of vapor constituents from gases and the like.

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. (Not offered in 1936–37.)

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 adsorption phenomena followed by problems in decolorization of oils, sugar syrups and the like; solvent recovery by adsorption and the leaching of various solids.

10·50. Heat Transmission (A). A course 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.

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

Chemical Engineering Continued

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 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, primarily for students in X-A who have completed field station work.

10·61. Thermodynamics of Hydrocarbons (A). Properties of hydrocarbons as function of structure, P-V-T relations and vapor-liquid equilibria. Emphasis is laid upon behavior under high pressures in complex mixtures in single and multiple phase systems.

10·62. Applied Chemical Thermodynamics (A). Presents and illustrates those elements of thermochemistry and thermodynamics of most importance in the field of chemical engineering.

10·63. Applied Colloid Chemistry (A). A study of the application of colloid chemistry to various chemical industries, including a brief survey of the general principles of colloidal chemistry, with special reference to their industrial application, a discussion of various colloid problems involved in the industries, and a consideration of the important research problems in applied colloid chemistry now pressing for solution.

10·64. Applied Colloid Chemistry (A). A brief survey of the general principles of colloid chemistry, with special reference to their applications in aqueous and hydrocarbon systems. Emphasis will be laid upon the properties of interphase surfaces and their influence upon the system. Attention will be given to emulsification, gelation and to suspensions of mineral matters in both water and oil.

10·65. 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.

10·671. Colloid Seminar (A). Detailed consideration of a limited number of specific colloidal phenomena, such as thixotropy, antithixotropic phenomena, wetting, dispersing, and emulsifying agents and special optical methods in colloid research. Problems are chosen because of their vital importance in the application of colloid chemistry to industry.

10·672. Colloid Seminar (A). A seminar subject paying particular attention to industries using typical colloids as raw materials.

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. The strength of materials and other factors are discussed in relation to the choice of the most economic design.

10·70. Principles of Combustion (A). Open to graduate students who have majored in a non-chemical branch of engineering or science and 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 fuel 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.

10·72. Fuel Engineering Practice (A). At the Lackawanna Plant of the Bethlehem Steel Co. (near) Buffalo, N. Y., an opportunity is provided for a study of fuel engineering under unusually favorable conditions. Coal is processed in modern coke ovens to produce metallurgical coke for blast furnaces. By-product fuels from these processes include coke breeze, coke oven gas, tar, benzol and blast furnace gas. The fuel engineer has the problem of the effective utilization of these fuels in meeting the requirements of blast furnace stoves, soaking pits, reheating furnaces, open hearth furnaces, lime kilns, coke ovens, boiler furnaces and internal combustion engines. Within the Buffalo area, gas plants, petroleum refineries, central power stations and industrial plants furnish a wide diversification of fuel problems. Inspection trips and plant tests round out the student's training in phases of fuel engineering not encountered in the steel plant.

10·73. Fuel Engineering Design (A). Open only to men who have completed the work in 10·72 or who have had an equivalent industrial experience. Involves the design, selection and layout of equipment needed in the solution of a major problem in fuel engineering.

10·74. Furnace Design (A). A study of principles and calculations of furnace design and construction dealing

Chemical Engineering Continued

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.

10·78. Fuel Engineering Laboratory (B). Open only to men who have had 10·70, Principles of Combustion, or its equivalent. Instruction will be given in those phases of analytical chemistry and physical measurements which are of special interest to the fuel engineer, *viz.*, analysis of gaseous, liquid and solid fuels, and products resulting from their processing and utilization; analysis of boiler feed water and its treatment with special reference to its foaming, scaling and corroding properties; determination of heats of combustion; determination of total carbon content of fuels for carbon balances in plant testing; special measurements such as the fusion temperature of ash, true temperature of gases and flames, etc.

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.

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 plants 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, inclusive.

10·82. School of Chemical Engineering Practice —Boston Station (A). Primary emphasis is placed on the study of filtration, handling of corrosive materials, materials of construction and plant layout, flow of heat and absorption. Stress is also placed on the chemistry and chemical engineering involved in the manufacture of heavy chemicals, such as sulphuric acid, nitric acid, hydrochloric acid, glauber salts, etc. This work is carried out at the Everett plant of the Merrimac Chemical Company which manufactures heavy chemicals, and at the Revere Sugar Refinery, Charlestown. Offered from July t! rough December and from February through May, inclusive.

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, inclusive.

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 Chemcial Engineering Practice —Boston 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.

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 students preparing for the oral examination for the Doctor of Science degree. The first term is devoted to a consideration of special topics in applied chemistry and the second term to unit operations in chemical engineering.

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. The lectures cover elementary geometrical and physical crystallography and descriptive mineralogy. Warren, *Determinative Mineralogy;* Dana, *Manual of Mineralogy.*

12·02. MINERALOGY (B). Crystallography and mineralogy of a somewhat more advanced character than that of 12·01. The laboratory work consists of intensive determinative work on certain important minerals as well as some less common ones. The lectures include an introduction to our present knowledge of the structure of crystals, the application of this knowledge to mineralogy, and the genesis of certain minerals. Dana-Ford, *Textbook of Mineralogy, Fourth Edition.*

12·05. MINERALOGICAL SEMINAR (A). Seminar hours devoted to the presentation and discussion of literature bearing on certain phases of theoretical mineralogy.

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 of all types and laboratory work using the polarizing microscope in the study of thin sections of rocks. Supplemented by field excursions to instructive nearby localities. Harker, *Petrology for Students;* Tyrrell, *Principles of Petrology.*

***12·16.** PETROLOGICAL SEMINAR (A). Seminar hours devoted to the presentation and discussion of literature of petrogenesis.

***12·17.** PETROGRAPHIC RESEARCH (A). Research on a petrographic problem. This preferably takes the form of intensive study of a suite of rocks collected by the student. It is intended that each investigation will result in a publication.

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).

* 12·16 and 12·17 are both not given in the same year; ordinarily these subjects will be given in alternate years, but at the request of the graduate students concerned, and at the discretion of the instructor, the order of alternation may be changed.

12·25. CRYSTALLOGRAPHY (B). This subject is intended as an introduction to the study of crystalline material, with special reference to the needs of students of metallography. The subject matter includes: elementary geometrical crystallography, with laboratory study of crystal models; simple crystal measurement and projection; crystal structure theory; point groups, space lattices, space groups; common structural types; the properties of crystals, especially habit, plastic deformation, recrystallization and hardness, and the relation of these properties to crystal structures.

12·30. GEOLOGY. General dynamical geology. Scott, *Introduction to Geology, Third Edition, Part I.*

12·301. GEOLOGY. Fundamental physical geology. Lectures, class discussions with demonstrations; laboratory course in lithology, and during favorable weather, field work in the vicinity. The subject offers a training in sight recognition of rocks, and in methods of field work. Grabau, *Textbook of Geology, Part I.*

12·31. GEOLOGY. Continuation of 12·30. Historical geology, and laboratory work in lithology and on the study of geologic structures and maps. Also several geologic field trips are taken. Scott, *Introduction to Geology, Third Edition, Part II;* Pirsson and Knopf, *Rocks and Rock Minerals, Second Edition.*

12·311. GEOLOGY. Historical geology. Illustrated by sections, maps and specimens. Grabau, *Textbook of Geology, Part II.*

12·32. GEOLOGY. Geology adapted to the needs of engineers. Ries and Watson, *Elements of Engineering Geology.*

12·33. FIELD GEOLOGY. Designed to teach practical methods of geologic mapping in the field.

12·351, 12·352. GEOLOGICAL SURVEYING, ADVANCED (A). Field investigation and mapping of assigned areas with research in connected problems. Also excursions to areas of special interest.

12·38. GEOMORPHOLOGY. 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.

12·39. FIELD GEOLOGY METHODS. Standard methods of fieldwork and the making of field records; reconnaissance methods; cross sections; route geology and methods of plotting; sampling and recording of samples; use and records of photographs and sketches; and a real and detailed

Geology Continued

geologic mapping. Given partly in the laboratory and partly in nearby field localities.

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.

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.

12·44. Economic Geology of Fuels (B). The origin and the geological occurrence and utilization of deposits of natural gas, petroleum and coal.

12·46. Economic Geology of Non-Metallic Deposits (B). Designed to give students in mining and geology a fairly complete orientation in the occurrence of clays, cements, abrasives, fertilizers, barite and other non-metallic deposits. Includes a certain amount of laboratory work.

12·49. Geology of Materials. For students of architectural engineering and building construction who have had no previous work in geology. Describes the character and mode of occurrence of materials of construction, and their application to problems of excavation and building.

12·50. Stratigraphic Geology (B). Seminar and laboratory work on the geological periods of the various continents from the viewpoint of events in earth history.

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.*

12·521, 12·522. 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 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, especially Foraminifera.

12·551, 12·552. Organic Evolution, Advanced (A). Study of various phases in the evolution of plants and animals.

12·581, 12·582. Sedimentation (A). Consists of lectures, assigned reading and laboratory work on sediments and sedimentary rocks.

12·61. Diastrophism and Vulcanology (B). The subject matter is divided into two parts. In the first, the problems of mountain building and major earth movements are considered; the cause of the movements; criteria for their interpretation; and a description of important examples. In the second part, the problem of vulcanology is treated; the genesis and history of volcanoes; the nature of the process of eruption; and the reasons for their distribution. Then the major active volcanic regions of the world are described.

12·631. Geological Climates Seminar (A). (Alternate years. Not offered 1936–37.)

12·632. 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. (Given in alternate years.)

12·70. Structural Geology. 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.

12·75. Metamorphic Geology (A). Study of rock alterations, including weathering, hydrothermal and dynamic alteration from the standpoint of physical, chemical and mineralogical changes.

12·80. Geology of Coal and Petroleum (B). Presents in detail 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.

Geology Continued

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 results is indicated through copious field examples.

The following subjects are offered as General Studies. For description see Division of General Studies.

G60. Geology.

G64. Organic Evolution.

G651, G652. General Science.

NAVAL ARCHITECTURE AND MARINE ENGINEERING

Subjects 13·00 to 13·99

13·01. 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.

13·02. Naval Architecture (B). Continuation of 13·01. 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; estimation of weights and application to design.

13·021. Naval Architecture. The resistance and powering of ships, influence of forms and coefficients on resistance, models and model tanks; powering and propulsion, propeller design, influence of hull on action of propeller; steering and maneuvering; rolling and pitching; flooding of compartments.

13·03. Naval Architecture (B). Rolling, pitching and heaving motions, methods of controlling same. Resistance and propulsion of ships by paddle wheels, screw propellers, and sails. Methods of making power and speed trials, torsion meters, model experiments of hulls and propellers, effect of shallow water on speed and power. Subdivision for safety at sea. Estimation of weights and application to design.

13·11. Theory of Warship Design.*

13·12. Theory of Warship Design.*

13·13. Theory of Warship Design.*

13·14. Theory of Warship Design.*

13·15. Warship Design.*

13·16. Warship Design.*

13·21. Warship Design.*

13·22. Warship Design.*

13·23. Warship Design.*

13·24. Warship Design.*

13·25. Warship Design.*

13·26. Warship Design.*

13·34T. Ship Construction. Lectures and drawing-room exercises. The class-room work is a continuation of 13·32 dealing with carpenter and joiner work, fire-proof and fire-resisting construction of passenger ships, plumbing, ventilation, and lighting. In the drawing-room the student works out numerous details of hull construction.

* Open only to Naval Students in Course XIII-A.

13·40. Ship Design. A lecture subject combined with drafting room work. In the lecture course instruction is given on the historical and technical development of wooden boats; illustrated by lantern slides and moving pictures. In the drafting room the student executes the design of a modern wooden yacht by fairing of lines, making of calculations and preparing plans showing method of construction and type of rig. The student is also given the opportunity to make a model of his design. During this course visits are made to nearby boat building yards.

13·43T, 13·45. Ship Design (13·45,B). In these subjects each student determines the dimensions and coefficients of a merchant ship for definite trade requirements and works up the preliminary design including lines, displacement, freeboard, power, weights, stability, curves of form, etc. Inboard profile, deck and shell plating plans are worked up and a midship section drawn to the rules of one of the registration societies. Calculations are made for curves of floodable lengths, launching, longitudinal and local hull strength; diagrammatic layouts are drawn for hull piping. The student also makes a half model of his boat and indicates the shell plating on this model.

13·47. Ship Design. Drawing-room exercises for students in ship operation. 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. Includes the construction of a half model from the student's design. Such assistance will be given as will enable the student to complete 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). Includes the determination of stresses and the methods of proportioning the parts of reciprocating machinery. The vibration of ships, balancing of engines, inertia forces, dimensional analysis, and other interesting problems of the marine engine designer are treated. Chapman, *The Marine Power Plant. Notes on Marine Engineering; Marine Engineering*, Peabody.

Naval Architecture and Marine Engineering Continued

13·55T. MARINE ENGINEERING. A detail study of Diesel engines and motorship auxiliaries; fuel injection, valve gears, types of engines, Diesel fuels; Diesel-electric drive. 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 devoted mostly to 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. A study of the marine power plant as applied to naval vessels. Discussion and comparison of fuels, boilers, types of modern propelling machinery, auxiliaries, high pressure steam and other improvements in marine engineering.

13·61. MARINE ENGINE DESIGN (B). Computations and drawings are made for certain parts of a marine engine and a boiler. The design of riveted and welded joints, simple machine parts, choice and advantage of different engineering materials and other design problems are also discussed. *Marine Engineer's Handbook*, Sterling.

13·62. MARINE ENGINE DESIGN (B). A continuation of 13·61. Includes the calculation of sizes and layout of main propelling units and auxiliaries of a steamship, together with diagrammatic arrangement of the principal piping systems. Propeller design and similar marine engineering problems are also treated.

13·64. MARINE ENGINEERING DESIGN.*

13·73. MECHANICAL VIBRATION (A). The development of those parts of general vibration theory required for the engineering applications treated in the second term. Complex variable and vector representation, Fourier Series, harmonic analysis by tabular and mechanical methods, systems of several degrees of freedom, formal solutions, solution based on small oscillations, solution based on assumed frequency, continuous mass and elasticity, irregular distribution of mass and elasticity, Rayleigh's and Dunkerley's methods, separation of normal modes and determination of natural frequency by successive approximations, non-linear systems, self-sustained oscillations.

13·74. MECHANICAL VIBRATION (A). Engineering applications of vibration theory and methods of analysis. Stability of rotating bodies, balancing machines, balancing under operating conditions, turbine vibration, whirling disc and blades, torsional oscillation of geared turbines. Reciprocating engines, balance of multi-cylinder engines, torsional vibration of internal combustion engines, generating forces, harmonic analysis of turning effort, calculation of natural frequency, amplitude, phase and vector diagram for energy input, damping. Methods for control of vibration in machinery installations. Methods of avoiding resonance, vector cancellation methods, dampers. Vibration isolation, vibration measuring instruments.

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. TERMINAL 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 terminal facilities.

* Open only to Naval Students in Course XIII-A.

BUSINESS AND ENGINEERING ADMINISTRATION

SUBJECTS 15·00 TO 15·99

15·11, 15·12. INTRODUCTION TO BUSINESS MANAGEMENT (B). Designed to introduce the student to the functions and methods of business. The principal fields touched are corporate organization, finance, accounting, production, marketing, and the legal principles applicable thereto. Emphasis is placed on the inter-relations between these various functions. Consideration of business problems in the order they would be encountered were a new business to be launched; namely, analyzing the field for a new venture; promoting the concern; organization; operation; control; and problems of expansion or liquidation. (Not open to Course XV.)

15·25. INDUSTRIAL TRAFFIC MANAGEMENT (A). A detailed study of the organization and operation of a traffic management department of an industrial plant. The course deals with industry's conception, interpretation and use of such matters as freight classifications, rate structures, routes, carrier-shipper relations, common carrier liabilities, general and special services, national and state common carrier regulations and protective insurance. Due consideration is given to 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.

15·42. CORPORATION FINANCE AND INVESTMENTS. Deals with the fundamental principles of financial organization and management. The various types of corporate securities are examined, the financial problems of the promoter, the incorporators and the later financial management are studied and illustrations are drawn from concrete cases. The latter part of this subject considers more specifically the different kinds of investment securities with exercises in investment analysis, and a discussion of brokerage, speculation and the methods of the exchanges. Lecturers from investment houses assist in this branch of the subject.

15·45. FINANCIAL ADMINISTRATION OF INDUSTRY (A). Covers the fundamental principles of financial organization and management but emphasis is placed on the ordinary problems of business finance which arise in the day to day work of average manufacturing and trading enterprises. Among the topics developed are the promotion and organization of corporations, holding companies and their uses, problems of capitalization, the marketing of securities, the administration of income, expansion and reorganization. Attention is given to the relations of corporations with such financial institutions as banks, commercial paper houses, and credit agencies. Other topics considered are working capital requirements, analysis of securities, financial statements and their interpretation, corporation income tax reports, credits and collections, insurance, price policies and budgetary control.

15·46. FINANCIAL ADMINISTRATION OF INDUSTRY (A). Deals chiefly with the practical problems of internal financial management as those problems emerge in concrete situations. Based upon the principles developed in 15·45, the course proceeds with an analysis of the specific problems confronting business managers in the manufacturing, mercantile and public utility fields. The case method is used throughout and the cases represent actual business situations. Oral and written reports constitute an important part of the work.

15·50. ACCOUNTING. Familiarity with the uses and interpretation of financial reports is an essential business tool. Since analysis depends upon a knowledge of constituent elements and is vastly facilitated by acquaintance with the common combinations of those 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 common financial statements. Form and content of balance sheets and of profit and loss statements, nature of and problems raised by surplus, and depreciation and other valuation problems are studied. The subject concludes with an introduction to methods of statement analysis. So far as possible, reports and accounting policies of actual companies form the basis for discussion. Throughout the course emphasis is placed more upon interpretation of results than upon technique. (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. Material used is based on a wide variety of business situations.

15·52. ACCOUNTING. This shorter subject has as its objective the introduction of the student to the problems of accounting. The preparation and structure of and the relationships between the usual financial reports to stockholders and creditors are examined in order that the student may understand their uses and significance.

15·55. PROBLEMS IN ACCOUNTING POLICY (A). A consideration of case problems involving discussions of accounting policy. All problems will be approached from the administrative viewpoint, and the application of analytical methods to financial data will be stressed. Problems will cover the nature and determination of income, asset valuation, presentation of net worth, consolidated statements.

15·56. ANALYSIS OF BUSINESS STATEMENTS (A). Aims to develop analytical ability in the interpretation of business statements and reports. Will include a study of type of statement, information needed for complete investigation and the analysis of actual statements. Particular emphasis will be placed on the effect of economic conditions on the industrial enterprise and the relation of these factors to the analytical procedure. The subject will be conducted through the medium of case discussions and written reports.

15·58. CONTROL THROUGH BUSINESS RECORDS (A). Control of any but the smallest business depends upon an adequate system for the gathering of information needed by

Business and Engineering Administration Continued

executives. Examines the fundamental principles behind records systems and the extent to which various actual systems meet the requirements for which they were set up. Periodic reports, budgets, costs, cash control, internal check, inter-company and branch office control, voucher procedure, inventory records, pay roll procedure, expense control, sales records, machine accounting and special problems of control in various industries will be considered. A general study of some complete record system or a detailed study of some special problem of control will be required of each student.

15·61T. 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.

15·62T. 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.

15·63. Business Law and Organization (B). A graduate study of business organization from both a legal and a management standpoint. The subject of contracts and the personal relations of individuals within the organization are emphasized. The advantages and disadvantages of various types of organization are discussed. (For graduate students in Course VI-A only.)

15·64. The Law of Business Organizations. 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 associations are considered in detail.

15·70T. Production. A basic treatment of the manufacturing process. Among the more important topics covered are: factory organization, 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 motion picture process studies.

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 the management of clerical activities. Classroom work is supplemented by plant visits.

15·73. Management Laboratory. Work Simplification and Time Study. (a) 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. Moving picture films of industrial operations are used as case material. (b) Instruction in the use of the stop watch for rate setting. Includes such topics as selected times, leveling factors, fatigue study, allowances, etc.

15·75. Manufacturing Analysis (A). Deals with the analyses of management methods in a manufacturing establishment. Schedules are prepared for the critical investigation of such functions as organization, arrangement and maintenance of buildings and equipment, product research and design, purchasing, traffic control, storage of materials and product, intrafactory transportation, quality control, salvage, time study and production control. Library research, field interviews and inspections, and a brief thesis are requirements of the subject, which is conducted as a seminar.

15·81T. Marketing. An elementary subject which deals with marketing functions, methods, and agencies. Major emphasis is laid on the marketing of manufactured consumer goods, although some attention is given to the marketing of industrial goods and of agricultural products. The methods of instruction comprise weekly lectures, reading of a basic marketing text, and group discussions of actual case problems.

15·82T. Sales Management (B). An introductory subject designed to familiarize the student with the problems faced in operating sales departments in industrial concerns. Among the topics covered are: product planning, market research, pricing, credit problems, sales promotion and advertising, organization of the sales department, 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 case problems. Frequent brief written reports are required.

15·83. Marketing Research (B). Deals with the basic principles and techniques used in research in the marketing field. Through experience with actual problems the student is trained in breaking a problem down into its components, in devising methods to secure the facts necessary to solve the problem, in executing these methods, and in interpreting the data resulting from his investigation. Each student is expected to conduct an original investigation and submit a complete report.

15·85. Industrial Marketing (A). An advanced subject in the methods and problems of marketing goods to manufacturers and other industrial users. Deals with the basic problems presented by this type of marketing, and compares them with the problems involved in marketing manufactured goods for consumption. Special emphasis is given to the coördination of selling methods and to the fundamentals underlying sales policies. Specific problems of individual concerns engaged in this type of marketing form the basis for class discussion.

15·86. Marketing of Consumer Goods (A). An advanced subject in the problems faced by manufacturers in marketing goods sold to consumers. Deals with such problems as studying consumer demand, designing and packaging products, setting prices, relations with distributors, use of various methods of sales promotion and advertising. Contemporary marketing literature is largely used as source material for discussions.

Business and Engineering Administration Continued

15·88. Advertising (A). Deals with the underlying principles and technique of advertising, with particular emphasis on the viewpoint of the business man using advertising as a tool. The subject deals with the advertising of both industrial and consumer goods.

15·92. Industrial Problems (B). This study will coördinate the previous subjects which the student has taken. The work will consist of a series of readings and problems illustrating the application of underlying principles to specific business situations. The emphasis will be upon the formulation of a well rounded administrative policy as distinguished from the previous functional approach. In this way, the interdependence and interrelations of Marketing, Finance, Accounting, Production, and Statistics will be indicated.

15·97. Standards of Measurement in Industrial Management (A). Measurement in management is as essential to the successful conduct of any industrial enterprise as measurement in the strictly engineering field is to the successful design, construction and functioning or operation of some structure or machine. It is the application to management of the principle that a quantitative unit of measure is essential to the scientific regulation of any activity. Classroom discussions will be based upon specifically prepared notes, typical problems, and original inquiries by the student into the fundamentals upon which management is based. Measures to be studied will apply to men, methods, money, machines and materials in manufacture and other places of business activity, typical of which are economic lot sizes, economic life of equipment, economic control of quality, efficiency of human effort, the economic characteristics of industry, and financial ratios.

15·98. The Business Audit (A). For the successful administration of business the executive must have a highly developed sense of values and a keen appreciation of what constitutes the "total situation" which confronts him at any instant in this era of rapid economic change. Judgment must be supported by a careful evaluation of all factors if the decisions of the executive are to be sound and this entails a thorough comprehension of the true standards for business. Based on original investigations, classroom discussions will be devoted to a study of the nature, relationship and behavior of the fundamentals governing all business activity with the objective of evolving a basic philosophy, with accompanying criteria by means of which adequate business policies may be determined. To establish the necessary criteria and technique for a business audit consideration will be given to economic forces, human behavior, laws and functions of management, organization, business ethics, inter- and intra-industrial relationships and the overall efficiency of management as it relates to the combined effectiveness of purchasing, manufacture, marketing, finance, accounting, research and office management.

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 fashion. The thesis extends through both terms of the senior year. The first term will be devoted to the selection of a thesis topic, the completion of suitable arrangements for the investigation, a thorough survey to determine the precise nature of the problem and the preparation of a preliminary report based thereon to outline an appropriate method for conducting the study. The preliminary report will constitute the prerequisite for continuation of the thesis and must be submitted for acceptance before the close of the first term. The second term will be devoted entirely to the actual conduct of the investigation and the writing of the report. All theses must be submitted for grading two weeks in advance of the day of the last exercise.

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, Karman streets 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. 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;* 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. 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.*

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.*

16·25. 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.

16·52. 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.*

16·55T. AERONAUTICAL AND METEOROLOGICAL INSTRUMENTS (A). A general analysis is made of the behavior of any mechanical instrument which responds to a forcing function starting from fundamental principles of dynamics. Vector analysis, gyroscope theory, kinetic theory of gases and dimensional analysis are used where needed. Application is made to predict the theoretical performance characteristics of a number of the more important instruments in aeronautics and meteorology, such as gyroscopic horizons, magnetic compasses, rate of turn and directional gyroscopes, altimeters, temperature indicators, etc. The theoretical performance is then

Aeronautical Engineering Continued

compared with the experimental performance found from laboratory or flight tests. Practical problems associated with vibration, magnetic fields, natural periods, etc. are treated.

16·56T. Aeronautical Instruments (A). A continuation of 16·55. Considers viscous flow in capillaries, the rate of climb meter, motion in fluid media, airspeed instruments, theory of sound and psychological acoustics, the sonic altimeter, electromagnetic wave theory and radio receivers and transmitters, radio compasses, directional beam systems, and blind landing systems. The subject is concluded with a study of special test instruments and equipment for automatic control of aircraft.

16·57T. Aeronautical and Meteorological Instrument Laboratory (A). The principles developed in 16·55 are applied to various types of instruments. Laboratory exercises devoted to transients in mechanical systems, mechanical vibrations, magnetic compasses, gyroscopic instruments, barometric altimeters, rate of climb meters, recording thermometers and humidity instruments. To be taken simultaneously with 16·55.

16·58. Meteorological Instruments (B). Intended to enable the student to obtain accurate data with the instruments used in meteorological work and to carry out aerological evaluations. Lectures on fundamental theory and laboratory and field exercises to familiarize the student with different kinds of meteorological observations.

16·59. Special Problems in Aeronautical and Meteorological Instruments (A). Problems of interest to individual students are studied in consultation with the instructor.

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.

16·901. Introductory Meteorology (B). Intended to give a simplified almost non-mathematical treatment of the fundamental physical laws which hold in the atmosphere and their practical working out in the usually observed meteorological phenomena. A brief study of weather maps and polar front analysis is included together with a short discussion of the principles underlying weather forecasting. Humphreys, *Physics of the Air*.

16·911, 16·912. Synoptic Meteorology (A). A non-mathematical study of the phenomena of the weather map, starting with the modern conception of the structure of extra tropical cyclones, the polar front theory and the general circulation of the atmosphere. A detailed discussion of the forecasting of local weather phenomena, especially fog, showers and thunder storms.

16·921, 16·922. Meteorological Laboratory (A). Decoding and plotting of the daily weather reports broadcast from the Arlington radio station, analysis of weather maps and practice forecasting for selected areas.

16·931, 16·932. Dynamic Meteorology (A). The application of hydrodynamical and thermodynamical methods to the study of the atmosphere in rest and in motion.

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.

16·961, 16·962. Physical Oceanography (A). A qualitative discussion of the general circulation of the North Atlantic and a theoretical analysis of the most important types of ocean currents.

BUILDING ENGINEERING AND CONSTRUCTION

SUBJECTS 17·00 TO 17·99

17·20. BUILDING FORMS AND DETAILS. A series of lectures and discussions of the development of architectural and structural forms which man has evolved as a builder. The geographical, geological, political, social and religious influences on man's life are studied. The subject presents a short history of architectural and structural types and stresses the forms and details of each, in order to familiarize the student with the vocabulary and technique of the architect and craftsman.

17·21. BUILDING CONSTRUCTION. A study of the sequence of the construction of a dwelling of the first class. Commencing with the excavation, the materials ordinarily used in dwelling house work and their assembly are studied in the same order and sequence as the work is done in the field. Instruction is given by lectures illustrated with data sheets and from demonstration from models and samples, after which the student makes scale drawings of key details and writes a complete text describing each step of the operation.

17·22. BUILDING CONSTRUCTION. A study of the dwelling. A continuation of 17·21.

17·31. BUILDING CONSTRUCTION. A study of the sequence and construction of an industrial building of brick and timber. Standard mill and semi-mill construction. Excavation with power tools; sheet piling, timber joints and splices; heavy timbering and bracing; brick and brick work and the structural details characteristic of buildings of this kind.

17·32. BUILDING CONSTRUCTION. A study of the sequence and construction of an industrial building in reinforced concrete. Typical plant layout; forms of wood and metal; reinforcing materials and appurtenances. Heavy duty floors and the structural details common to buildings of this type.

17·41. BUILDING CONSTRUCTION. A study of the sequence construction and management of steel framed structures below and above grade; structural steel erection; fireproof floor systems; enclosure walls of brick and stone; architectural terra cotta; partitions; marble and tile work; floor finishes. Sequence of the trades; job management with special emphasis upon safety in building.

17·42. BUILDING CONSTRUCTION. A continuation of 17·41.

17·46. BUILDING CONSTRUCTION. General subject in sequence of erection for buildings of wood, steel and concrete, with special emphasis on details of construction and properties of materials. Arranged for students who desire a general idea of building construction.

17·50. JOB MANAGEMENT. A series of lectures on the management and control of an operation in the field. Includes a study of job organization; the time schedule; the progressive and orderly sequence in which the materials should flow to the job; the coördination of the several crafts, their regulation and management; the elimination of the hazard of fire and accident. Under this heading will also be included lectures on Professional Relations; Organized Labor; Business Experience, etc.

17·51. STRUCTURAL ANALYSIS. A lecture and supervised drafting-room subject in the graphical analysis of structures as applied to building construction and engineering. Intended to establish a connection by graphical and analytical methods between the study of applied mechanics and structural theory. Wolfe, *Graphical Analysis.*

17·52. STRUCTURAL ANALYSIS. A study of the structural design of timber, including analyses of compound beams, trussed girders, floor frames, mill construction, roof trusses and details, timber and concrete-filled columns, and special details such as stair frames and the like. *Wood Construction*, Voss and Varney.

17·53. STRUCTURAL ANALYSIS. A study of the structural design of reinforced concrete, including the development of the theory of concrete design, a study of the specifications for stress, the design of fireproof slabs of several standard types, both solid and ribbed, the design of beam and girder construction, flat-slab construction, columns reinforced with vertical steel and spirals. *Design of Reinforced Concrete Structures*, Peabody; *Reinforced Concrete Design*, Sutherland and Clifford.

17·54. STRUCTURAL ANALYSIS. A study of the structural design of the steel framed commercial building, including shoring, needling and underpinning, derrick loads, standard code requirements, typical floor arch systems, beams and girders of rolled and built-up sections, study of riveted joints, review of plate-girders and trusses, columns and column loads, grillage footings, and caissons. *Steel Construction*, Voss and Varney.

17·73. MATERIALS—WOOD. A study of wood designed to meet the special needs of building engineers and architects. The following subjects are discussed: growth, formation and structure; species and their characteristics; mechanical properties; decay; preservatives and fireproofing; shrinkage and drying; wood-working and finishes; wood products. Koehler, *Properties and Uses of Wood.*

17·74. MATERIALS—MASONRY AND METALS. Intended to give the student a fundamental scientific and technical knowledge of the properties of the usual masonry materials and of ferrous and non-ferrous metals and alloys. Includes a study of cement, lime, plasters, brick and mortars, hollow tile and block, natural and cast stone, architectural terra-cotta, concrete mixes, wall and floor tile, cast irons, steels, and the usual non-ferrous metals used in construction. Leighou, *Chemistry of Engineering Materials and Departmental notes.*

DRAWING

SUBJECTS D1 TO D99

D11. ENGINEERING DRAWING. Instruction in the correct use of drafting instruments and materials. Objects studied in plan, elevation, and section. Practice in lettering and dimensioning. Drawing in pencil, in orthographic, isometric, and oblique projection. The making of dimensioned freehand sketches of machine parts, and of accurate detail and assembly drawings from the sketches. Tracing in ink on cloth or paper, of the finished drawings. French, *Engineering Drawing.*

D12. DESCRIPTIVE GEOMETRY. A study of the fundamental conceptions of descriptive geometry, including reference systems, orthographic projection, representation of the point, line, and plane: fundamental problems of position, of perpendicularity, and of measurement. Followed by a study of various surfaces and solids, their sections, developments, and intersections. Finally, the application of descriptive geometry to certain problems arising in engineering practice. Neatness and accuracy are required in the solutions. Especial emphasis is placed on the ability to visualize the problems, and the processes involved in their solution. Hood, *Geometry of Engineering Drawing.*

ECONOMICS AND SOCIAL SCIENCE

SUBJECTS Ec1 TO Ec99

Ec11, Ec12. POLITICAL ECONOMY. Elementary but comprehensive. Consists of an analysis and description of the existing economic structure of society, a brief study of economic theory and the application of that theory to some of the more important economic questions.

Ec14. CURRENT ECONOMIC PROBLEMS (B). Applies economic principles and statistical tests to the groups of economic problems that seem each year to be most timely. Among these have been the following: the problem of technological unemployment; high wage theory; the problem of full working days; gold standard; banking gold reserves; price fixing; international balances; control of speculation; tariff problem; financing by bonds vs. taxation.

Ec15. ECONOMIC PRINCIPLES (B). A study of the fundamentals of production, business organization, supply and demand, 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). This includes a brief historical review showing the interdependence between the development of the Economic Organism and the development of Economic Theory. There follows a study of the interdependence of prices and the equilibria of total values under normal conditions of competition and monopoly. This includes the theory of distribution and the determination of the chief prices such as wages, rents and interest. The assumed conditions will be compared with what seem to be the actual economic situations.

Ec18. MATHEMATICAL APPROACH TO ECONOMICS (A). The application of mathematical methods to the following problems: (1) the determination of prices in monopolistic and competitive industry; (2) the theory of the distribution of national income; (3) international trade; (4) special topics. (Not offered 1936–37.)

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.

Ec31. STATISTICS. Instruction in the presentation, methods of analysis and interpretation of statistics. Includes frequency distributions, averages, measures of dispersion, elements of sampling, precision of measurements and computations, index numbers, analysis of time series, and graphical presentation.

Ec37. ADVANCED ECONOMIC STATISTICS (A). The construction and analysis of index numbers. The construction and analysis of economic time series. The theory and applications of correlation and association. *Elements of Statistics*, by A. L. Bowley; *An Introduction to the Theory of Statistics* by G. U. Yule; *The Making of Index Numbers* by I. Fisher.

Ec38. STATISTICAL METHODS FOR QUALITY CONTROL (A). A fundamental subject in the application of statistical methods to the control of the quality of manufactured products. *Elements of Statistics*, Part II, by A. L. Bowley; *Economic Control of Quality of Manufactured Product* by W. A. Shewhart; *The Application of Statistical Methods to Industrial Standardization and Quality Control* by E. Pearson.

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). The topics discussed include forms of business organization, formal aspects of corporate securities, promotion and financing of

Economics and Social Science Continued

new enterprises, financial aspects of business combination, accounting for income, administration of corporate income and of working capital, problems of business failure and of reorganization. The course is designed (1) to enable prospective investors to appraise the financial policies of business managements; and (2) to enable prospective business managers to understand the financial policies necessary to protect and to attract investment funds.

Ec48. Investment Analysis (A). Deals with the investment characteristics of enterprises of various kinds and with methods of analyzing the corporations whose securities are offered to investors. 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. Special attention is devoted to appraising enterprises whose securities may be under consideration for investment.

Ec53. Corporations. Deals with four related groups of topics: (1) the corporation as a form of business organization, comparison with other forms, rights and obligations of stockholders, directors, officers and creditors, concentration of control, holding companies; (2) corporate securities, financial structure, sale of securities; (3) public utility corporations, regulation, valuation, rate of return; (4) industrial combinations and government control, development of trusts, pools, combinations and trade associations in the United States, governmental regulative policy before and since the passage of the National Industrial Recovery Act.

Ec56. Economics of Transportation (B). The operation of economic principles and political factors in the transport industry, including the social significance of the industry, its rate problems, financial aspects and relation to the government. An attempt will be made to estimate the rôle which each separate agency plays in the transport system as a whole and to indicate the economic consequences of current developments.

Ec57. Public Utilities: Organization and Finance (A). Includes a brief study of corporations in general, followed by the application of the principles of management and finance to public utility enterprises. Among the topics considered are: the economic and legal characteristics of public service industries, organization and structure of systems, holding companies and intercorporate control, the economic elements in the production and delivery of public utility service and the financial problems of management. Brief attention will be given to accounting practices and the interpretation of financial statements. Practice in the analysis of actual cases constitutes an important part of the work.

Ec58. Public Utilities: Rates and Regulation (A). Deals with the relation of governments to public service industries. Among the topics considered are: the development and limits of the public utility concept, commission regulation and judicial review, valuation, rate of return to investors, depreciation policy, taxation, holding company regulation, public relations and public ownerships. Attention will be given to the Tennessee Valley Authority and similar governmental projects. Practice in the analysis of actual cases constitutes an important part of the work. Students are expected to attend and report on certain hearings before the Massachusetts Public Utilities Commission.

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.

Ec60. Labor Relations (B). Studies the relations of employers and employees under present conditions of industry, how these are influenced by objective economic and legislative factors, and how they may be affected by company policies. Special attention is devoted to issues of collective bargaining.

Ec67. Labor Economics (A). Deals primarily with the problems of wages, hours of labor and unemployment. It begins with a brief historical survey of labor's status and of the development of protective legislation. Special emphasis will be put upon the current aspects of these problems.

Ec68. Labor Organization and Industry (A). Falls into two parts. The first, historical in nature, to trace the development of the labor movement. The second to study, with the help of cases, the actual functioning of trade unions and of employee representation plans.

Ec72. American Government. The governmental process in the United States viewed historically and comparatively. 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 gild 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.

Ec82. Principles of Sociology (B). After an introductory study of the social origins from the anthropological point of view, the effect of environment on human life and society will be dealt with. The social process will be discussed with reference to social institutions, folkways, mores, and laws. Some attention will be given to the con-

Economics and Social Science Continued

cept of social progress, especially the social implications of the Industrial Revolution.

Ec83, Ec84. Social and Economic Factors in City Planning (B). Growth and location of cities; rural urban migrations and their relation to shifting industries; effect of social changes within city to land values; repercussions of urban life upon the family and personality; relationship of specific urban areas to such problems as crime, poverty and disease; function of planning in solution of these problems.

Ec85. 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.

Ec86. Methods of Social Investigation (B). Designed especially for students in City Planning who have to deal with data of social significance. Points out the available sources of social data. Discusses the guiding principles of field investigation, especially the cautions to be observed in the use of the schedule and questionnaire. Administration of the field work and methods of tabulation are considered, as well as the analysis and interpretation of the raw data through such devices as measures of central tendency.

The following subjects are offered as General Studies. For description of subjects see Division of General Studies.

G5. Principles of Psychology.

G6. Social Psychology.

G13. Social Institutions.

G14. Contemporary Social Problems.

G15. Comparative Political Institutions.

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 done in small section meetings, at which each student presents 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 1850. 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 1850 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 the equivalent of two one-act plays during the term.

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.

E41. Problem Analysis. The object is to train students in architecture to present in definite and clear form the reasons that have actuated them in preparing plans for any given project. Emphasis is placed especially on care-

English and History Continued

ful preparation in written form and in oral delivery before final presentation.

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, G2. History of Science.

G4. History of Engineering.

G11. Social and Industrial History of Modern Europe.

G12. Social and Industrial History of the United States.

G41. Contemporary English Literature.

G42. Contemporary European Literature.

G43. American Literature.

G44. The Philosophic Dramas of Literature. (Not offered in 1936–37.)

G45. The Bible as Literature. (Not offered in 1936–37.)

G48. Introduction to Music.

G49. Literature and the Fine Arts.

G51. Biography in Science.

G52, G53. Advanced Composition.

G58. Shakespeare. (Not offered in 1936–37.)

G59. Problems of Modern Philosophy.

GENERAL STUDIES

THIS division 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
G59 Problems of Modern Philosophy
G60 Geology
G651 General Science

Second Term

G2 History of Science
G51 Biography in Science
G64 Organic Evolution
G66 Descriptive Astronomy
G74 Principles of Sanitary Science and Public Health
G76 History of Philosophy
G652 General Science

HISTORY OF CIVILIZATION

First Term

G4 History of Engineering
G11 Social and Industrial History of Modern Europe

Second Term

G10 Development of Transportation
G12 Social and Industrial History of the United States
G63 Economic Geography

LITERATURE AND FINE ARTS

First Term

G17 Design in Manufactured Products
G41 Contemporary English Literature
G44 Philosophic Dramas of Literature
G49 Literature and the Fine Arts
G52 Advanced Composition
G57 Expressions of Graphic Art
G831 French Literature
G931 German Literature
G951 Dante in English

Second Term

G42 Contemporary European Literature
G43 American Literature
G45 The Bible as Literature
G48 Introduction to Music
G50 Fine Arts
G53 Advanced Composition
G58 Shakespeare
G832 French Literature
G932 German Literature
G952 Dante in English

SOCIAL SCIENCE

First Term

G5 Principles of Psychology
G13 Social Institutions
G15 Comparative Political Institutions
G31 Humanics. A Study of Human Relations

Second Term

G6 Social Psychology
G14 Contemporary Social Problems
G32 Humanics. A Study of Human Relations
G75 Biological Reproduction

General Studies Continued

SUBJECTS G1 TO G99

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.)

G4. 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 by lantern slides.

G5. PRINCIPLES OF PSYCHOLOGY. This subject treats of the fundamental concepts and principles of psychology, and indicates their bearings upon the arts, the other sciences, business and industry, and the affairs of everyday life.

G6. SOCIAL PSYCHOLOGY. Personality, normal and abnormal; social factors in the development of personality; principles of psychology applied to such phenomena as public opinion, propaganda, the crowd, politics and religion, and to such problems as those of advertising and selling, vocational guidance, and supervision.

G10. 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 various means of transportation upon the industrial, economic and social development of the world forms the fundamental thesis of this subject. The interrelation of the arts, general sciences and transportation is emphasized.

G11. 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.

G12. 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.

G13. SOCIAL INSTITUTIONS. The evolution of human society from primitive to modern man, including specific discussion of comparative cultures observable from materials available in local museums; man's relations to his physical environment; typical social processes, and how they relate to such human institutions as the family, education and the state; the engineer's obligations and opportunities toward society.

G14. CONTEMPORARY SOCIAL PROBLEMS. Discussion of social situations demanding collective action: population problems, specific social industrial problems, crime, health and mental hygiene as a social problem, family disorganization.

G15. 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.

G17. 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.

G31. HUMANICS. A Study of 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, multi-lateral, penetrating, unbiased analysis which characterizes good method. Because both maturity and experience are essential to getting the most out of the work, except by special permission of the instructor, only juniors and seniors may elect the subject.

G32. HUMANICS. A Study of Human Relations. A continuation of G31 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. Because both maturity and experience are essential to getting the most out of the work, except by special permission of the instructor, only juniors and seniors may elect the subject.

G41. CONTEMPORARY ENGLISH LITERATURE. Treats of a number of the most important English men of letters since 1890.

General Studies Continued

G42. Contemporary European Literature. An introductory study of some of the chief figures in European Literature of the past century and today.

G43. American Literature. American writers, particularly those of the nineteenth and twentieth centuries, discussed with emphasis on their relation to contemporary life.

G44. The Philosophic Dramas of Literature. The study of a selected number of the most important poems and dramas of literature. The choice will be made from among the following: The Book of Job, Prometheus Bound, The Divine Comedy, Hamlet, Paradise Lost, Faust, The Ring by Richard Wagner, The Dynasts. (Not offered in 1936–37.)

G45. 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 in 1936–37.)

G48. 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.*

G49. Literature and the Fine Arts. The problems, purposes, and products of the contemporary artist, especially in literature, seen against the past, the object being to give the student a breadth of outlook on the artistic activity of our day.

G50. 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.

G51. 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.

G52. 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. Reading of examples of good prose.

G53. Advanced Composition. Continuation of G52.

G57. 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 in different media.

G58. Shakespeare. An analysis of representative plays with emphasis on the development of Shakespeare as a dramatist. (Not given in 1936–37.)

G59. Problems of Modern Philosophy. The self and the will. Lectures and discussions, outside readings and reports.

G60. 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.*

G63. 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.

G64. 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.*

G651, G652. General Science. Non-technical and designed to impart a cultural appreciation of the natural sciences. The treatment emphasizes the aspects of each science that bears upon the architect's interests.

G66. Descriptive Astronomy. A general survey of the facts and theories relative to the solar system and the sidereal universe. Illustrated by slides. Baker, *Astronomy.*

G74. 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.

G75. Biological Reproduction. For students without previous training in biology. Lectures, lantern slides, moving pictures, and clay modeling, in illustration of the basic phenomena of reproduction in plants and animals from protozoa to man. The physiological effects of the reproductive function are taken up and the basic principles of embryological development are illustrated. A matter of fact consideration of the subject from the biological standpoint.

G76. History of Philosophy. A general survey of modern philosophy from the time of Descartes. (Not offered in 1936–37.)

G831, G832. French Literature. Outline of the history of French literature. Reading of illustrative specimens and some masterpieces complete: Chanson de gestes, medieval theatre, Villon, Montaigne, Rabelais, Corneille, Racine, Molière, Voltaire, Rousseau, the Romantic School and subsequent movements. Braunschvig, *Notre Littérature Étudiée Dans Les Textes. Vols. 1 and 2.*

General Studies Continued

G931, G932. GERMAN LITERATURE. A brief survey of some period or school of German literature with the reading of some masterpieces. A brief outline of the history of German literature is given, but the attention is chiefly centered on such topics as Goethe and Schiller, the novel, the modern theatre. Each term may be taken independently.

G951, G952. DANTE IN ENGLISH. A study of the Divine Comedy in English translation (bi-lingual text) with lectures on the life and times of Dante.

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. Woods and Bailey, *Elementary Calculus, Revised Edition.*

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 curvature; series. Woods and Bailey, *Elementary Calculus, Revised Edition.*

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, M24. ALGEBRA AND GEOMETRY. Determinants, matrices, theory of equations, quadratic forms, conics and quadrics, curvilinear coördinates, elements of analytic and differential geometry.

M31. DIFFERENTIAL EQUATIONS. Deals mainly with the equations which the student of electricity meets in his work. These equations will be discussed from the general point of view, but specific applications will be made to electrical problems. Franklin, *Differential Equations for Electrical Engineers.*

M331, M332. MATHEMATICAL THEORY OF STATISTICS (B). Pearson's system of frequency curves and systems of moments, with the consideration of appropriate tables and charts. The basis and derivation of several distributions both continuous and non-continuous. Calculus of finite differences. General theory of sampling and precision of statistical measures. Simple, partial and multiple correlation, association, contingency and statistical estimation.

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.*

M381, M382. ADVANCED CALCULUS (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, definite integrals, functions of a complex variable, asymptotic expansions, Fourier series, differential equations, integral equations, and various transcendental functions of importance in the applications of mathematics. Whittaker and Watson, *Modern Analysis.*

M41. DIFFERENTIAL EQUATIONS. Especially adapted to the needs of students in Chemical Engineering. Hitchcock and Robinson, *Differential Equations in Applied Chemistry.*

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.*

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.*

M451, M452. FOURIER SERIES AND INTEGRALS (A). The subject is devoted to the modern theory of Fourier series and integrals, following lines laid down in Zygmund's "*Trigonometrical Series*," in Wiener's "*Fourier Integral and Its Applications*," and in Paley and Wiener's "*Harmonic Analysis in the Complex Domain.*" Among other topics, a considerable amount of space is devoted to almost periodic functions, to Tuaberian theorems, and to harmonic analysis as applied to the study of integral functions.

M461, M462. THEORY OF NUMBERS (A). Elementary theory, divisibility, properties of numbers, congruences,

Mathematics Continued

quadratic residues, linear forms, binary quadratic forms, higher theory of numbers, algebraic domains, ideals. (Not offered in 1936–37.)

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 primarily devoted to a formulation of the fundamental concepts of infinitesimal analysis more precise than the intuitive treatment in the elementary calculus course. Among the topics treated are real numbers, functions, continuity, derivative, integral, sequences of functions, equi-continuity, uniform convergence, existence theorems, Taylor's series, Fourier series. (Not offered in 1936–37.)

M561, M562. FUNCTIONS OF A COMPLEX VARIABLE (A). A study of the elementary functions for complex values of the variable. Development and application of the fundamental theorems of the analytic function theory. Elements of the theory of the Gamma function, the elliptic functions, and other special functions.

M563. FUNCTIONS OF A COMPLEX VARIABLE (A). An introductory subject covering the essential topics of the theory of functions.

M571, M572. DIFFERENTIAL EQUATIONS (A). Presupposing the formal solution of differential equations as given in undergraduate Courses, this subject deals with the following topics: existence theorems of the various types, Cauchy polygons, Picard successive approximations, power series and majorant functions; the properties of functions defined by differential equations, especially linear differential equations; and partial differential equations. An idea of the direction of the subject can be had by consulting Goursat-Hedrick, "*A Course in Mathematical Analysis*," *Volume II, part 2*, and Bieberbach, "*Differentialgleichungen.*"

M581, M582. CONTINUOUS GROUPS (A). A study of the basic concepts of group-theory, such as group, subgroup, 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.

M62. MODERN ALGEBRA (B). Polynomials, determinants, linear equations, linear transformation, matrices, bilinear, quadratic, and Hermitian forms, introduction to fields and algebras.

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. (Not offered in 1936–37.)

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.

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. POTENTIAL THEORY (A). In the first term, the elementary theory. Logarithmic, Newtonian, potential. Potentials of simple and double distribution. Laplace's and Poisson's equations. Harmonic functions. Connection with function theory in the case of two dimensions. Harnack's theorems. Boundary value problems for the circle and the sphere. Poisson's integral. Spherical harmonics. Applications to physics. In the second term, general treatment of the boundary value problems of potential theory. Integral equations. The method of Perron-Remak. Green's function. Applications to conformal mapping.

M681, 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 in 1936–37.)

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 in 1936–37.)

M73. REVIEW OF MATHEMATICS. Review of algebra, plane and solid geometry, trigonometry, elementary calculus, differential equations.

M731, M732. MECHANICS (B). The fundamental principles of mechanics with applications mainly to the statics and dynamics of rigid bodies.

M75. MATHEMATICS. Practical instruction in numerical, graphical and mechanical calculation and analysis necessary for the solution of problems in interior and exterior ballistics, especially arranged for Army Ordnance officers.

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.

Mathematics Continued

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.*

M831, M832. Analysis (B). The real and complex number system, elementary properties of point sets, limits, continuity, convergence of series, derivative, integral, infinite products, and other notions necessary for a rigorous treatment of calculus. Hardy, *Pure Mathematics.*

M841. Analysis (B). Presupposing the preliminary work of M831, M832, this subject presents the modern theory of functions of a complex variable, including single valued analytic functions, residues, analytic continuation, conformal representation, and integral functions.

M842. Analysis (B). Topics in theory of functions of a real variable, including the theory of measure, Lebesgue integration, Fourier series, and an elementary discussion of the Fourier integral.

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 course 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 subject is offered as a General Study. For description see Division of General Studies.

G76. 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 markmanship, 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 seven weeks of map and aerial photograph reading, six 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. Engineer organization and training; military sketching; military explosives and demolitions; scouting and patrolling.

MS223. Military Science. Signal Corps. Tactical principles; principles of signal communication; Signal Corps equipment; codes and ciphers.

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. Position-finding, fire control, and gunnery for seacoast artillery; determination of firing data; conduct of fire; observation of fire; and adjustment of fire.

MS312. Military Science. Engineer Corps, Advanced. Combat principles of small units; organization and duties of engineers.

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. Storage and handling of ammunition; methods of surveillance and destruction.

MS316. Military Science. Chemical Warfare, Advanced. Combat principles of infantry and the chemical 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. Position finding, gunnery, and fire control for antiaircraft artillery.

MS322. Military Science, Engineer Corps, Advanced. Military Engineering:—fortifications, bridging, roads.

Military Science and Tactics Continued

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. Cannon construction; theory of recoil and design of recoil mechanisms; organization and duties of the Ordnance Department in the Zone of the Interior.

MS326. MILITARY SCIENCE. CHEMICAL WARFARE, ADVANCED. Tactics and technique of Chemical Warfare Service.

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.

MS411. MILITARY SCIENCE. COAST ARTILLERY, ADVANCED. Coast artillery matériel, organization, and employment.

MS412. MILITARY SCIENCE. ENGINEER CORPS, ADVANCED. Military engineering and tactical problems.

MS413. MILITARY SCIENCE. SIGNAL CORPS, ADVANCED. Instruction in methods of training men; emergency procurement and funds; Reserve Corps regulations.

MS414. MILITARY SCIENCE. ORDNANCE DEPARTMENT, ADVANCED. Industrial mobilization; ordnance property accounting.

MS416. MILITARY SCIENCE. CHEMICAL WARFARE, ADVANCED. Tactical employment of the chemical platoon.

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.

MS421. MILITARY SCIENCE. COAST ARTILLERY, ADVANCED. Tactical employment of fixed, mobile, and anti-aircraft artillery.

MS422. MILITARY SCIENCE. ENGINEER CORPS, ADVANCED. Military engineering and tactical problems.

MS424. MILITARY SCIENCE. ORDNANCE DEPARTMENT, ADVANCED. Organization and duties of the Ordnance Department in the Theater of Operations; Officers' Reserve Corps regulations.

MS98. MILITARY HISTORY AND POLICY OF THE UNITED STATES. Military history and policy of the United States from the early colonial times to the present day given in such a manner as to avoid a too technical discussion of the strategic principles involved or of the political or other factors leading up to the events referred to except where a clear understanding of the situation requires it. Required of students registered in any Advanced R. O. T. C. Unit. Ordinarily taken during the first term Junior year.

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 point of view of the country studied. Occasional illustrated lectures are given to supplement the class exercises and stimulate interest. The advanced subjects for students in Architecture are planned to give a more ready command of the language, an acquaintance with great examples of literary art, and a familiarity with architectural literature. The General Study subjects offer the student an opportunity to carry his study beyond the Intermediate grade, increasing his practical command of the language, reading ability, and acquaintance with the greatest writers.

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.

SUBJECTS L1 TO L99

L11, L12. GERMAN, ELEMENTARY. The necessary foundation for the study of the German language and literature, or for scientific studies. 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 and reading of easy matter, some of which deals with science. Vos, *Essentials of German;* Wright, *German Science Reader;* Strauss, *Schmuggler in Masuren;* Schnack, *Klick aus dem Spielzeugladen.*

L21, L22. GERMAN, INTERMEDIATE. Includes a systematic review of grammar. The reading, scientific as well as literary, gradually becomes more difficult, while the syntax, idioms and synonyms of the language are carefully

Modern Languages Continued

studied. By the end of the subject 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. Herzog, *Die Burgkinder;* Wesselhoeft, *German Composition;* Curts, *Readings in Scientific and Technical German.*

L31, L32. GERMAN, ADVANCED. Exercises in scientific German. Selections are made from current scientific journals and from the latest scientific literature. Exercises are conducted in German as far as practicable. *Selected texts from the Goeschen Scientific Series.* (Offered if a sufficient number apply.)

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. The last term will include the reading of some technical French. (Subject to modification): Fraser and Squair, *Standard French Grammar;* Bovée, *Aventures par la Lecture; Les Chemins de Fer* or *Le Cinéma* (both in *L'Encyclopédie par l'image*).

L61, L62. FRENCH, INTERMEDIATE. Designed to enable students to meet the entrance requirements in intermediate French. Recitations partly conducted in French. A continuation of the study of grammar, pronunciation, and useful conversational forms; drill in composition and in translation into French of connected passages; reading of matter dealing with French geography, history and industrial activity; some standard modern authors; reading of scientific French. Barton and Sirich, *New French Review Grammar;* Williams, *Technical and Scientific French;* Pargment, *Trente-trois Contes;* a selected play; Kullmer and Gérard, *Sketch Maps of France.*

L63, L64. FRENCH, ADVANCED. Planned to meet the needs of Course IV. Emphasis is laid upon good pronunciation, and the ability to express in French matters dealing with travel and architecture. Most of the reading matter will deal with architecture and allied subjects. Such books as Bovée and Carnahan, *New French Review Grammar;* Coindreau and Lowe, *French Composition; L'Art Egyptien, L'Art Grec et l'Art Romain, L'Art Roman, L'Art Gothique* (*Grammaire des Styles*); Molière, *L'Avare;* George Riat, *Paris* (*Les Villes d'Art Célèbres*); Foville, *Pise et Lucques; Histoire de France* (*Encyclopédie par l'image*).

L65, L66. FRENCH, ADVANCED. For Course IV, second year. Reading of French prose of a varied nature, part of which deals with an outline of French civilization and with the description of French cities, cathedrals, châteaus, etc. Practice in writing French, in pronunciation and conversational phrases useful for travel. Coindreau and Lowe, *French Composition* (continued); such reading matter as Guerlin, *Ségovie, Avila et Salamanque;* Besnard, *Le Mont-Saint-Michel; La Renaissance Italienne, La Renaissance Française, Le Style Louis XIII, Le Style Louis XIV, Le Style Louis XV* (all five in the series of *Grammaire des Styles*); Hugo, *Notre Dame de Paris;* Demaison, *La Cathédrale de Reims.*

L81, L82. SPANISH, ELEMENTARY. Pronunciation, elementary grammar, easy reading matter, practice in conversational phrases useful for travel. Such books as Hills and Ford, *First Spanish Course;* Wilkins, *Beginner's Spanish Reader;* Romera-Navarro, *Historia de España;* Carrión and Aza, *Zaragüeta,* the New York newspaper *La Prensa.*

L91, L92. ITALIAN, ELEMENTARY. Pronunciation, elementary grammar, easy reading matter, practice in conversational phrases useful for travel. Russo, *Elementary Italian Grammar;* Tutt, *Italian Reader;* Capocelli, *L'Italia nel Passato e nel Presente.*

The following subjects are offered as General Studies. For description see Division of General Studies.

G831, G832. FRENCH LITERATURE.

G931, G932. GERMAN LITERATURE.

G951, G952. DANTE IN ENGLISH.

DEPARTMENT OF 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 Athletic Field 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—one at Walker Memorial by the Physical Director, from which anthropometric charts are plotted, and the other a health examination at the Medical Department by a physician. 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	Surv. & Top. Drawing	D12	2	2	I	0	4	0	Howard
1·02	Surveying	D12	3	S	III_3, VI	1	2	1	Howard
			2	S	VI-A				
			2	2	IX-B				
			3	1	IV-A				
			4	1	IV-B				
1·041	Surveying	D12	3	S	VII_3, XI, XV_1a	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	1·13, 1·05	4(B)	S	(Elective)	0	10	0	Howard
1·10	Surveying	M4, D12	3	S	$III_{1,2}$	5	18	1	Foster
1·12	Astron. & Spherical Trig.	M4, 1·00	2	2	I	3	—	4	Howard
1·13	Geodesy	M22, 1·12	3	1	I	2	—	2	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)		★		
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
1·15	Navigation	—	3	2	(Elective)	2	—	2	Howard
1·16	Aerial Surveying	1·05	4(B)	2	(Elective)	2	—	2	Howard
1·18	Map Read. & Top. Draw.	D12	2	2	VII_3, XI	0	2	0	Howard
1·20	Rail. & High. Fieldwk.	*1·05* or *1·041*	3	S	I, XV_1a	1	4	0	Babcock
1·21	Rail. & High. Curves	M21; 1·20 or 1·041	3	1	I, XI, XV_1a	2	—	2	Babcock
1·22	Quantity Surveying	1·20 or 1·041	3	2	I, VII_3, XI, XV_1a	1	1	2	Babcock
			G	S	I (A.E.)				
1·25T	Eng. Construction	1·22, 2·04	4(B)	1 ('37–'38)	I, VII_3, XI, XV_1a	3	—	2	Breed
			G	S	I (A.E.)				
1·26	Railway Signaling	—	4(B)	2	(Elective)	2	—	3	Babcock
1·271	Transportation Eng.	1·21, 1·25, *1·35*	4(B)	1	I_2	4	2	5	Breed, Babcock
			G	1	I (A.E.)				
1·272	Transportation Eng.	1·271	4(B)	2	I_2	3	2	4	Bone
			G	2	I (A.E.)				
1·28	Railway Design	1·271, *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	3	—	4	Bone
1·35	Roads & Pavements	1·21 or *1·21*	3	1	I	2	—	1	Breed
			4	1	I				
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	1·271, *1·272*	4(B)	2	(Elective)	0	5	0	Bone
1·39	Graphic Statics	8·02	2	1	I	1	2	1	Mitsch
1·40T	Structures	2·04	3	2	I, XI, XV_1a, XVII	3	4	4	Fife
1·401	Structures	2.04	3	2	IV-A, VII_3, IX-B	3	—	5	Fife

★ Time specially arranged.

Civil and Sanitary Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
1·402	Structures	——	G	S	I (A.E.)	4	—	8	Fife
1·41	Structures	1·40	4(B)	1	I, IV-A, VII_3, XI, XV_1a, XVII	3	—	6	Spofford
1·411	Structures	1·402	G(B)	1	I (A.E.)	3	—	6	Fife
1·42	Structures	1·41	4(B)	2	I, IV-A, XI, XVII	2	—	4	Spofford
1·421	Structures	1·41	4(B)	2	VII_3, XV_1a	2	—	4	Mitsch
1·44	Stat. Structures	2·04	4	2	$III_{1,2}$	2	—	2	Wilbur
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
1·48	Foundations	2·04	4(B)	1	I, IV-A, XI, XV_1a	3	—	4	Gilboy
1·491	Soil Mechanics	2·04	G(A)	1	I (A.E.)	3	—	6	Gilboy
1·492	Soil Mechanics	1·491	G(A)	2	I (A.E.)	3	—	6	Gilboy
1·501	Bridge Design	*1·41*	4(B)	1	I	0	8	0	Mirabelli
1·502	Structural Design	1·501	4(B)	2	I	0	6	0	Mirabelli
1.51	Structural Theory Adv.	1·411	G(A)	2	I (A.E.)	3	—	6	Fife
1·52	Structural Design	1·41	4(B)	2	XI	0	3	0	Mirabelli
1·531	Reinf. Concrete Design	2·06	4(B)	1	IV-A	4	6	0	Peabody
1·532	Reinf. Concrete Design	1·531	4(B)	2	IV-A	2	6	0	Peabody
1·541	Reinf. Conc. Des. Adv.	1·42	G(A)	1	I (A.E.)	2	4	2	Mitsch
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	Spofford
1·552	Structural Design Adv.	1·551	G(A)	2	(Elective)	2	4	0	Spofford
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	1·42 or 1·421	G(A)	1	(Elective)	3	—	6	Spofford
1·572	Stat. Indet. Structures	1·571	G(A)	2	(Elective)	3	—	6	Spofford
1·58	Des. Reinf. Conc. Struct.	1·41	4(B)	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_3, XI, XV_1a	1	4	0	Putnam
1·62	Hydraulics	2·01	3	2	I, VII_3, IX-B, XI, XV_1a	4	—	6	Russell
1·63	Hydraulics	2·01	4	1	XV_1b	2	—	3	Russell
			4	2	III_3, XV_1a				
			3	1	XV_1b				
			3	2	IV-A				
1·64	Hydraulics	2·01	4	1	VI	3	—	6	Russell
			4	2	$VI-A_{1,2}$				
1·66	Hydraulics, Adv.	1·62	G(A)	1	(Elective)	2	—	6	Russell
1·68	Theory of Models	1·62	G(A)	1	(Elective)	2	—	4	Reynolds
			G	S	I (A.E.)				
1·691	River Hydraulic Lab.	1·62, *1·68*	G(A)	1	(Elective)	0	9	0	Reynolds
			G	S	I (A.E.)				
1·692	River Engineering	1·62	G(A)	2	(Elective)	2	—	4	Reynolds
1·70	Water Power Eng.	1·62	4(B)	1	I_3	3	4	4	Barrows
			G	1	I (A.E.)				
1·71	Water Power Eng.	1·70, 1·41	4(B)	2	I_3	2	4	3	Barrows
			G	2	I (A.E.)				
1·731	Water Power Eng. Adv.	1·42, 1·71, *1·851*	G(A)	1	(Elective)	3	—	6	Barrows
1·732	Water Power Eng. Adv.	1·731, *1·852*	G(A)	2	(Elective)	3	—	6	Barrows
1·75	Hydraulic & San. Eng.	1·62	4(B)	1	I_1, VII_3, XI	4	—	6	Camp
1·76	Sanitary Engineering	1·75	4(B)	2	I_1	2	—	3	Camp
1·78	Sanitary Engineering	1·75	4(B)	2	VII_3, XI	3	—	4	Camp
1·79	Sanitary Design	1·75	4(B)	2	I_1	0	2	0	Camp
1·801	Hydraulic & San. Des.	1·75	4(B)	1	I_1, VII_3, XI	0	3	0	Camp
1·802	Sanitary Design	*1·76* or *1·78*	4(B)	2	VII_3, 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
1·851	Water Power Des. Adv.	*1·731*	G(A)	1	(Elective)	0	8	0	Barrows
1·852	Water Power Des. Adv.	1·851, *1·732*	G(A)	2	(Elective)	0	8	0	Barrows
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
1·90	Prof. Prac. in Civ. Eng.	1·41	G(A)	2	(Elective)	1	—	2	Spofford

★ Time specially arranged.

MECHANICAL ENGINEERING—2·00–2·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·00T	Applied Mechanics	*D12*, M21, 8·02	2	1	I, II, II-A, IV-A, VI, VI-B, VI-A, IX-B, XIII, XIII-C, XV_1, XVI, XVII	3	—	5	Fuller
			2	2	$III_{1, 2, 3}$				
2·01	Applied Mechanics	2·00T	2	2	I, II, II-A, IV-A, VI, VI-A, IX-B, XIII, XIII-C, XV_1, XVI, XVII	3	—	5	Fuller
			3	1	$III_{1, 2, 3}$				
			4	1	VI-B				
2·011	Applied Mechanics	*M21, 8·02*	2	2	III_4, VII_3, X, XI	3	—	5	Fuller
2·02T	Applied Mechanics	2·01	3	S	II	2	6	0	Fuller
2·031T	Struct. Mechanics, El.	M111	1	2	IV, IV-B	3	—	6	Holmes
2·032	Structural Mechanics	2·031T	2	1	IV, IV-B	2	—	4	Holmes
2·033	Structural Mechanics	2·032	2	2	IV, IV-B	2	—	4	Holmes
2·04	Applied Mechanics	2·01 or 2·011	3	1	I, II, III_4, VI, VI-C $VI\text{-}A(B)_{1, 2}$, VII_3, IX-B, X, XI, XIII, XIII-C, XIII-A, XV_1a, b, XVI, XVII	3	—	5	Fuller
			3	S	II-A, IV-A, VI-A(A)				
			4	S	$VI\text{-}A(B)_3$				
			3	2	$III_{1, 2, 3}$				
			4	2	VI-B				
2·05	Applied Mechanics	——	G	S	II (A.O.)	4	—	6	Holmes
2·06T	Applied Mechanics	2·04	3	2	II, XIII, XIII-A	3	—	5	L. S. Smith
			3	1	II-A, IV-A				
2·07	Applied Mechanics	2·04	3	2	VI, $VI\text{-}A(A)_{1, 2}$	3	—	5	Fuller
			4	S	$VI\text{-}A(B)_{1, 2}$				
2·081	Applied Mechanics	2·04	4(B)	1	$II_{1, 2, 4, 5}$, II-A	3	—	5	Riley
2·082	Applied Mechanics	2·06T	4(B)	2	$II_{1, 2, 4, 5}$, II-A	3	—	5	Fuller
2·10T	Ordnance Engineering	2·04	4(B)	1	(Elective)	3	—	3	Holmes
2·11	Industrial Plant Eng.	*2·082*	4(B)	2	(Elective)	3	—	3	Peabody
2·121	App. Photoelasticity	2·06T	4(B)	1 or 2	(Elective)	1	2	2	Vose
2·122	App. Photoelasticity	——	G	2	II(T.E.)	1	2	1	Vose
2·125	Res. in Photoelas.	2·121	G(A)	1 or 2	(Elective)		★		Vose
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
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
			G	1	II (T.E.)				
2·202	Adv. Mech. & Th. Elast.	2·201	G(A)	2	(Elective)	3	—	9	Fuller
			G	2	II (T.E.)				
2·203	Theory of Elasticity	2·05	G	2	II (A.O.)	3	—	5	Fuller
2·221	Plasticity	2·082	G(A)	1 or 2	(Elective)	3	—	6	MacGregor
2·222	Adv. Plasticity Prob.	*2·221*	G(A)	1 or 2	(Elective)		★		MacGregor
2·251T	Fluid Mechanics	M22, 2·01	3	1	II, XIII	3	2	3	Hunsaker
			4	1	XIII-A				
2·252	Fluid Mechanics	2·251T, 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	Peters
2·271T	Hydromechanics	1·62 or 1·64	G(A)	1	(Elective)	3	—	6	Peters
2·272	App. Hydromechanics	2·271T	G(A)	2	(Elective)	3	—	6	Peters
2·273	Adv. Hydromech. Prob.	2·271T	G(A)	1 or 2	(Elective)		★		Peters
2·31	Foundry Practice	——	2	1	II, II-A	1	2	1	Kyle
2·311	Foundry Practice	——	2	1	III_4	1	2	0	Kyle
			2	2	III_3				

★ Time specially arranged.

Mechanical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·312	Foundry Practice, Adv.	2·31 or 2·311	4	2	(Elective)	1	3	2	Kyle
2·32T	Mechanical Processes	*2·35T*	3	1	II	3	2	1	Kyle
2·321	Forging	——	2	1	III_4	0	2	0	Sheppard
2·33	Weld. Eng. & Practice	——	4	2	(Elective)	1	2	1	Bullock
2·34T	Welding Eng., Adv.	2·32T or 2·33	4(B)	2	(Elective)	1	3	2	Bullock
2·35T	Materials of Eng.	*2·04*	3	1	II, II-A, XVI	3	—	3	Lessells, R. S. Williams
2·351	Materials of Eng.	*2·04*	3	1	IV-A, XIII-A, XV_1b	2	—	2	Lessells
			4	2	XIII				
2·352	Materials of Eng.	——	G	1	II (T.E.)	1	—	2	Lessells
2·37	Test. Materials Lab.	2·04, 2·35T	4(B)	1	$II_{1, 2, 4, 5}$	1	3	2	Cowdrey
			3	2	XVI				
			4	S	II-A				
2·371T	Test. Materials Lab.	2·04	3	2	I, III_4, X, XI, XIII-A	0	2	1	Cowdrey
			3	S	VI-A(A)				
			4	1	$III_{3, 4}$, IV-A, XV_1a, XVII				
			4	2	VI-A(B), XIII				
2·38T	Test. Mat. Lab. (Concrete)	2·351	4	1	IV-A	0	3	2	Cowdrey
			G	S	I (A.E.)				
2·391	Dyn. Str. of Metals	2·082, 2·35T, 2·37	G(A)	1	(Elective)	1	4	3	deForest
2·392	Dyn. Str. of Metals	2·391	G(A)	2	(Elective)	1	4	3	deForest
2·40	Heat Engineering	*M21*, 8·02	3	1	II, II-A, III_3, VI, IX-B, XIII, XIII-C, XVI	4	—	5	Berry
			4	S	$VI-A(A)_{1, 2}$				
			4	1	$VI-A(B)_{1, 2}$				
2·41T	Heat Engineering	*M21*, 8·02	3	1	XV_1b	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	Berry
			4	1	$VI-A(A)_{1, 2}$				
			4	2	$VI-A(B)_{1, 2}$				
2·421	Heat Engineering	2·41T or 2·411	4	2	I, XI	2	—	4	Taft
			3	2	XV_1b				
2·43	Heat Engineering	2·40	4(B)	1	$II_{1, 3}$	3	—	5	Berry
			4	S	II-A				
2·44T	Thermodyn. of Mixtures	2·42 or 2·421	4(B)	1	(Elective)	2	—	4	Moore
2·45	Eng. Thermodyn., Adv.	2·43	G(A)	2	(Elective)	3	—	6	Keenan
2·461	Refrigeration, Adv.	2·43	G(A)	1	(Elective)	3	—	9	Berry
2·462	Heat Transmission, Adv.	2·43	G(A)	2	(Elective)	3	—	9	Berry
2·50	Heat Measurements	8·04	3	1	III_3	1	2	1	Wilkes
			4	1	III_4, XIV				
2·501T	Heat Measurements	8·04	3	1	IX-A	0	2	1	Wilkes
2·51T	Heat Measurements	8·04	4(B)	1	II_3	1	2	3	Wilkes
			4	2	II-A				
2·52T	Heat Measurements	8·04	4(B)	2	(Elective)	1	4	2	Wilkes
2·53T	Heat Measurements	2·50, 2·501T, 2·52T	G(A)	1	(Elective)		★		Wilkes
2·55T	Power Plant Eng.	2·42 or 2·421	4(B)	1	$II_{1, 3, 4}$	3	—	3	Taft
2·551	Power Plant Eng.	2·42	4	2	II-A	3	—	5	Taft
2·56T	Power Plant Eng.	2·55T	4(B)	2	$II_{1, 3, 4}$	3	—	3	Taft
2·57	Power Plants, Adv.	2·56T	G(A)	1	(Elective)	3	—	6	Holt
2·58T	Heat Eng. in Ind. Plants	2·42	4(B)	2	(Elective)	3	—	5	Taft
2·59T	Torpedos	——	G	1	II (T.E.)	2	—	4	Taft
2·60	Food Engineering I	8·02	4	1	VII_2	2	—	2	W. H. Jones
2·601T	Food Engineering II	2·60	4	2	VII_2	3	—	3	W. H. Jones
2·621	Refrigeration Eng.	*2·43*	4(B)	1	II_3	3	—	3	W. H. Jones
2·622T	Refrigeration Eng.	2·621	4(B)	2	II_3	3	—	5	Svenson
2·63T	St. & Trans. of Foodstuffs	2·621	G(A)	1	(Elective)	3	—	6	W. H. Jones
2·64T	Refrigeration Eng.	2·43	G(A)	2	(Elective)	3	—	6	Svenson
2·65	Mech. Eq. Bldgs. H & V.	8·02	4	2	IV-A, VII_3	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 2·41T	4(B)	1	$II_{3, 5}$	3	—	5	Holt

★ Time specially arranged.

Mechanical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·671	Air Conditioning, Adv.	2·66	G(A)	1	(Elective)	3	—	6	Holt
2·672T	Heat. & Vent. Design	2·671	G(A)	2	(Elective)	4	—	4	Holt
2·681	Engineering Lab.	2·40	4(B).	1	$II_{1, 3, 4, 5}$	0	3	3	Eames
			4 . .	2	II_2, II-A				
2·682	Engineering Lab.	2·681	4(B).	2	II_1	0	3	3	Eames
2·683T	Engineering Lab.	2·40	3 . .	2	XIII	0	2	2	Eames
2·684T	Engineering Lab.	2·683T	4 . .	2	XIII	0	2	2	Eames
2·685T	Engineering Lab.	2·40	3 . .	2	XIII-C	0	4	4	Eames
			4 . .	2	XIII-C				
2·686T	Engineering Lab.	2·40 or 2·41T or 10·29	4 . .	1	VI, IX-B, XV_1b	0	3	3	Eames
			4 . .	2	X, XV_2				
			3 . .	2	XVI				
2·687T	Hydraulic Lab.	1·62	4 . .	2	I, XI	0	2	2	Eames
2·69	Refrig. & Air Con. Lab.	2·43, 2·66	4(B).	2	II_3	0	6	6	Jones, Holt
2·691T	Refrigeration Lab.	2·43 or 2·681	4(B).	2	(Elective)	0	2	2	Jones
2·692	Refrig. & Air Con. Lab.	2·69	G(A)	2	(Elective)	0	4	6	Jones, Holt
2·70	Machine Drawing	D12	2 . .	2	II, II-A	0	4	0	James
2·701T	Machine Drawing	D12	3 . .	2	III_4	0	6	0	James
			2 . .	1	IX-B				
			3 . .	S	III_3				
			3 . .	1	XVI				
2·71	Th. & App. of Mechanisms	M75	G . .	1	II (A.O.)	6	—	8	Swett
2·72	Mechanism	——	G . .	1	XIII-A	2	—	3	Townsend
2·731	Machine Design	2·04, 2·35T	3 . .	2	II	2	2	1	Townsend
		2·04, *2·35T*	3 . .	1	II-A				
2·732	Machine Design	2·731	4(B).	1	$II_{1, 4, 5}$	2	2	2	Swett
2·733	Machine Design	2·731	4 . .	2	II-A	2	2	2	Swett
2·74	Machine Design	2·04	4 . .	1	XV_1b	2	2	0	Townsend
			3 . .	2	XV_1b				
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.)	2	4	2	Swett
2·77	Design of Prod. Mach.	2·732	4 . .	2	II_4	2	2	2	Swett
2·781T	Automatic Mach.	——	G . .	1	II (T.E.)	3	—	3	Swett
2·782	Automatic Mach.	2·781T	G . .	2	II (T.E.)	1	3	4	Swett
2·791	Automotive Engines	2·42	4(B).	1	II_2	4	—	4	C. F. Taylor
2·792	Automotive Engines	2·791	4(B).	2	II_2	4	—	4	C. F. Taylor
2·793	Automotive Eng. Des.	*2·791*	4(B).	1	II_2	0	6	0	C. F. Taylor
2·794	Automotive Eng. Des.	2·793	4(B).	2	II_2	0	3	0	C. F. Taylor
2·795	Automotive Vehicles	——	4(B).	1	II_2	3	—	3	Fales, King
2·796	Automotive Vehicles	2·795	4(B).	2	II_2	3	—	3	Fales, King
2·797	Auto. Vehicle Design	2·04, 2·35T, *2·795*	4(B).	1	II_2	0	6	0	Fales, King
2·798	Auto. Vehicle Design	2·797, *2·796*	4(B).	2	II_2	0	3	0	Fales, King
2·801T	Auto. Eng. Prob., Adv.	——	G(A)	1	(Elective)		★		C. F. Taylor
2·802T	Auto. Eng. Prob., Adv.	——	G(A)	2	(Elective)		★		C. F. Taylor
2·803	Automotive Eng.	2·791, 2·795	G(A)	1	(Elective)		★		King
2·804	Automotive Eng.	2·803	G(A)	2	(Elective)		★		King
2·82	Diesel Engine Design	2·081, 2·42	4(B).	2	II-A(a)	0	6	0	Riley
2·83T	Steam Turbine Eng.	2·42	4(B).	2	II-A(b)	4	—	2	Keenan
2·851	Machine Tool Lab.	——	2 . .	1	II, II-A, XIII	1	3	0	English
2·852	Machine Tool Practice	2·851	2 . .	2	II, II-A, XIII	1	3	0	English
2·853	Machine Tool Lab.	——	2 . .	1	VI, VI-A	1	3	0	English
2·854	Machine Tool Lab.	——	2 . .	1	XIII-C, XIV	1	2	0	English
			2 . .	2	III_4, IX-B				
			3 . .	2	XV_1b				
			4 . .	2	XIII-C				
2·871T	Manufacturing Eng.	2·852	4(B).	1	II_4	3	—	6	Buckingham
2·872T	Prep. for Manufacturing	2·732 or 2·74 or 6·03	4(B).	2	II_4	3	—	3	Buckingham

★ Time specially arranged.

Mechanical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·88T	Metrology & Dimens. Stand.	Eng. 2·852	G(A)	1	(Elective)	3	—	6	Buckingham
2·901T	Prin. of Fabric Struct.	8·02	4(B)	1	II_5	3	—	5	Schwarz
2·902	Prin. of Fabric Struct.	2·901T	4(B)	2	II_5	3	—	6	Schwarz
2·903	El. of Textile Manufact.	2·01	4(B)	1	II_5	3	—	5	Schwarz
2·904	Pr. of Textile Manufact.	2·903	4(B)	2	II_5	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.	2·904	G(A)	1	(Elective)	0	6	0	Schwarz
2·912	Textile Research Lab.	2·911	G(A)	2	(Elective)	0	6	0	Schwarz
2·951T	Manufacturing Practice	——	3	S	II-A		40 h. p. w.		Townsend
2·952T	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

MINING AND METALLURGY—3·00–3·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
3·00	Int. to Min. & Met.	——	2	1	III	1	—	0	Hutchinson
3·01	Mining Methods	8·04, 12·01	3	1	III_1	7	—	7	Foster
3·02	Mining Methods	3·01	3	2	III_1	7	—	7	Foster
3·03	Econ. of Mining	3·02 or 3·08 or 3·82; 3·21 or 3·23	4(B)	1	$III_{1,2}$	2	—	4	Hutchinson
3·04	Mining, Prin. of	3·03	4(B)	2	$III_{1,2}$	2	—	4	Hutchinson
3·05	Mining, Elem. of	——	3	1	III_3	2	—	2	Bugbee
3·061	Mining Eng., Adv.	3·04	G(A)	1	(Elective)		★		Hutchinson
3·062	Mining Eng., Adv.	3·04	G(A)	2	(Elective)		★		Hutchinson
3·07	Mining Eng.	3·03	4(B)	2	(Elective)	2	—	6	Staff
3·08	Mining Practice	1·10	3	S	$III_{1,2}$	0	3	0	Hutchinson
3·101	Mine Valuation	3·04, 3·08	G(A)	1	(Elective)	3	—	8	Hutchinson
3·102	Mine Valuation	3·101	G(A)	2	(Elective)	3	—	8	Hutchinson
3·12	Econ. of Min., Adv.	3·04	G(A)	2	(Elective)		★		Hutchinson
3·13	Appl. Sci. to Prospec.	M21, 8·04	4(B)	1	$III_{1,2}$	2	2	2	Foster
3·21	Ore Dressing	12·01, *3·22*	3(B)	2	$III_{1,3}$	3	—	2	Locke
3·22	Ore Dressing Lab.	3·31, 5·12, *3·21*	3(B)	2	$III_{1,3}$	1	6	2	Locke
3·23	Ore Dressing	12·01	3	2	III_2	1	2	2	Locke
3·241	Ore Dressing, Adv.	3·21, 3·22; or 3·23	G(A)	1	(Elective)		★		Locke
3·242	Ore Dressing, Adv.	3·21, 3·22; or 3·23	G(A)	2	(Elective)		★		Locke
3·251	Th. & Prac. of Flot.	3·21, 3·22; or 3·23	G(A)	1	(Elective)		★		Locke
3·252	Th. & Prac. of Flot.	3·21, 3·22; or 3·23	G(A)	2	(Elective)		★		Locke
3·26	Ore Dressing Econ.	3·21, 3·22; or 3·23	G(A)	1 or 2	(Elective)		★		Locke
3·271	Ore Dressing Des.	3·21, 3·22; or 3·23	G(A)	1	(Elective)		★		Locke
3·272	Ore Dressing Des.	3·21, 3·22; or 3·23	G(A)	2	(Elective)		★		Locke
3·31	Fire Assaying	5·12, 12·01	3	1	$III_{1,3}$	2	4	2	Bugbee
3·331	Fire Assaying, Adv.	3·31	G(A)	1	(Elective)		★		Bugbee
3·332	Fire Assaying, Adv.	3·31	G(A)	2	(Elective)		★		Bugbee
3·41	Met.: Copper, Lead	3·60, 5·13	4(B)	1	$III_3b, _4b$	4	4	3	Hayward
3·411	Met.: Copper, Lead	3·60, 5·13	4(B)	1	$III_3a, _4a$	4	—	3	Hayward
3·412	Met.: Copper, Lead, Zinc	5·12	4(B)	1	III_1, XIV	3	—	3	Hayward
3·413	Production Metal. I	——	G	S	II (A.O.)	3	—	3	Hayward
3·414	Production Metal. II	3·413	G	1	II (A.O.)	3	—	3	Waterhouse
3·415	Met. & Electrochem. Lab.	——	4	1	$III_{1,3,4}$, XIV	0	4	0	Hayward
3·42	Met.: Gold & Silver	3·31, 3·23	4(B)	2	$III_{1,3}$	2	3	2	Bugbee
3·422	Met.: Gold & Silver	5·02	4(B)	2	III_4	2	—	2	Bugbee
3·43	Met.: Iron & Steel	3·60, 5·02	4(B)	1	$III_3a, _4a$	7	—	3	Waterhouse
3·431	Met.: Iron & Steel	3·60, 5·02	4(B)	1	$III_3b, _4b$	3	—	3	Waterhouse

★ Time specially arranged.

Mining and Metallurgy Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
3·432	Met.: Iron & Steel	5·02	4	1	$III_{1,2}$	2	—	1	Waterhouse
			4	2	XIII-A				
3·44	Met.: Gen. Zinc & Min. Met.	3·411, 3·431	4(B)	2	$III_{3,4}$	4	—	3	Hayward
3·45	Met.: Heat Tr. Steel	3·431, 3·61, 2·54	4(B)	2	III_3	2	—	1	Waterhouse
3·46	Met.: of Com. Met.	5·02	4	2	(Elective)	3	—	3	Hayward
3·501	Met.: Iron & Steel, Adv.	3·43	G(A)	1	(Elective)		★		Waterhouse
3·502	Met.: Iron & Steel, Adv.	3·43	G(A)	2	(Elective)		★		Waterhouse
3·511	Met. Plant Design	3·41, 3·42, 3·43	G(A)	1	(Elective)	13	—	0	Waterhouse
3·522	Met. Plant Design	3·41, 3·42, 3·43	G(A)	2	(Elective)	13	—	0	Waterhouse
3·52	Gen. Metal., Adv.	3·44	G(A)	2	(Elective)		★		Hayward
3·53	Non-Fer. Met., Adv.	3·41, 3·44	G(A)	1	(Elective)		★		Hayward
3·54	Gold & Silver Met., Adv.	3·42 or 3·422	G(A)	1	(Elective)		★		Bugbee
3·55	Metal. Calc., Adv.	3·44	G(A)	2	(Elective)	2	—	6	Hayward
3·56	Metal. Plants	*3·41, 3·42, 3·43*	4(B)	1 or 2	(Elective)	3	—	3	Waterhouse
3·60	Metal. Plant Visits	——	4(B)	S	$III_{3,4}$	0	3	1	Hayward
3·61	Metallography	5·12, 8·04	3	2	III_3, $VIII_2$	2	2	1	R. S. Williams
			G	1	XIII-A				
3·621	Metallography	8·04	3	1	III_4, XII_3	3	6	3	R. S. Williams
3·622	Metallography	3·621	3	2	III_4	3	6	3	R. S. Williams
3·643	Light Alloys	3·61 or 3·622	4(B)	2	(Elective)	2	—	4	R. S. Williams
3·65	Physical Metallurgy	——	G	1	II (A.O.)	4	—	6	R. S. Williams
3·651	Physical Metal., Adv.	3·61 or 3·622	G(A)	1	(Elective)		★		R. S. Williams
3·652	Physical Metal., Adv.	3·61 or 3·622	G(A)	2	(Elective)		★		R. S. Williams
3·653	Physical Metal., Adv.	3·61, 3·656	G	2	II (A.O.)	3	—	5	R. S. Williams
3·656	X-Ray Metallog.	M22, 8·04, 3·61 or 3·621	4	2	XIV	2	1	3	J. T. Norton
			3	2	III_4, XII_3				
3·66	App. of Metallography	3·61 or 3·622	4(B)	2	III_4	0	6	2	Homerberg
			4(B)	1	(Elective)				
3·67	Physics of Metals	3·61 or 3·622, 8·04, M22	4(B)	1	III_4	2	—	4	J. T. Norton
3·673	Physics of Metals, Adv.	3·656, 3·67	G(A)	1 or 2	(Elective)		★		J. T. Norton
3·69	Corrosion & Heat Resisting Alloys	3·61 or 3·622	4(B)	1	(Elective)	2	—	4	R. S. Williams Homerberg
3·691	Metallog. & Corros.	5·12, 8·04	4	1	III_2	3	2	1	R. S. Williams
3·71	Heat Treatment	2·351 or 2·361; 2·371T or *2·371T*	4	2	II_4, III_4	1	3	2	Zavarine
			3	2	III_4				
3·713	Heat Treatment	3·61	G	1	II (T.E.)	1	2	2	Zavarine
3·714	Heat Treatment	3·71	4	2	(Elective)	1	3	2	Zavarine
3·72	Ferromagnetism	——	G(A)	1	(Elective)	2	—	4	Bitter
3·731	Phys. Metallurgy, Adv.	——	G	1	II (T.E.)	4	—	4	R. S. Williams
3·732	Phys. Metallurgy, Adv.	3·731	G	2	II (T.E.)	1	7	2	R. S. Williams
3·74	Th. of Metal Hard.	3·61 or 3·622	G(A)	2	(Elective)	2	—	4	Zavarine
3·75	Electrochemistry, Elem.	8·04, 5·02	4	1	III_3	2	—	2	Thompson
3·76	App. Electrochemistry	8·82	4(B)	2	XIV	3	—	6	Thompson
3·791	Electrochemistry Lab.	*8·82*	4(B)	1	XIV	0	9	3	Thompson
3·792	Electric Furnaces	8·04, 5·02	4(B)	1	(Elective)	1	2	2	Thompson
3·80	Electrochemistry, Adv.	8·82	G(A)	1	(Elective)	3	—	6	Thompson
3·81	Petroleum Eng., El.	8·04, 12·30	3	1	III_2	6	—	6	Mann
3·82	Petroleum Eng., El.	3·81	3	2	III_2	5	—	4	Mann
3·84	Outline Petrol. Prod.	——	4	2	(Elective)	3	—	1	Mann
3·85	Petroleum Product.	3·82	4(B)	1	III_2	4	—	4	Mann
3·86	Petroleum Product.	3·85	4(B)	2	III_2	3	—	4	Mann
3·89	Oil Field Visits	1·10	3	S	III_2	0	3	0	Mann
3·901	Oil & Gas Land Val.	3·86, 3·89	G(A)	1	(Elective)	3	—	8	Mann
3·902	Oil & Gas Land Val.	3·901	G(A)	2	(Elective)	3	—	8	Mann
3·911	Petroleum Eng., Adv.	3·86	G(A)	1	(Elective)		★		Mann
3·912	Petroleum Eng., Adv.	3·86	G(A)	2	(Elective)		★		Mann

★ Time specially arranged.

Mining and Metallurgy Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
3·921	Oil & Gas Law	3·86	G(A)	1	(Elective)	2	—	4	Mann
3·922	Oil & Gas Law	3·86	G(A)	2	(Elective)	2	—	4	Mann
3·93	Ceramics	5·02, 8·04	4(B)	2	(Elective)	2	2	5	F. H. Norton
3·94	Optical Ceramics	8·04	4(B)	1	(Elective)	0	6	2	F. H. Norton
3·951	Fund. Ceramic Proc.	3·93; 5·61T or 5·62; 2·50 or 2·52	G(A)	1	(Elective)	3	4	4	F. H. Norton
3·952	Phy. Prop. Ceramic Prod.	3·951	G(A)	2	(Elective)	2	3	4	F. H. Norton
3·961	Sp. Prob. in Ceramics	3·93, 3·94	G(A)	1	(Elective)		★		F. H. Norton
3·962	Sp. Prob. in Ceramics	3·93, 3·94	G(A)	2	(Elective)		★		F. H. Norton
3·99	Glass Blowing	—	4	1	(Elective)	0	1	0	Thompson

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, VI-B	0	4	0	Reid
4·022	Freehand Drawing	4·021	2	2	IV, IV-B, VI-B	0	4	0	Reid
4·031	Freehand Drawing	4·022	3	1	IV, IV-B	0	4	0	Reid
4·032	Freehand Drawing	4·031	3	2	IV, IV-B	0	4	0	Reid
4·041	Freehand Drawing	4·032	4	1	IV, IV-B	0	4	0	Reid
4·042	Freehand Drawing	4·041	4	2	IV	0	4	0	Reid
4·051	Freehand Drawing	4·042	5(B)	1	IV	0	6	0	Reid
4·052	Freehand Drawing	4·051	5(B)	2	IV	0	6	0	Reid
4·053	Freehand Drawing	4·052	G(A)	1	(Elective)	0	6	0	Reid
4·054	Freehand Drawing	4·053	G(A)	2	(Elective)	0	6	0	Reid
4·06	Graphics	—	1	1	IV, IV-B	2	4	0	Dean
4·071	Modeling	4·722	3	1	IV, IV-B	0	3	0	Selmar-Larsen
4·072	Modeling	4·071	3	2	IV, IV-B	0	3	0	Selmar-Larsen
4·081	Color, Comp. Th. & App.	4·732	4	1	IV, IV-B	1	—	3	Beckwith
			2	1	VI-B				
4·082	Color, Comp. Th. & App.	4·081	4	2	IV, IV-B	1	—	3	Beckwith
			2	2	VI-B				
4·091	Color, Comp. Th. & App.	4·082	5(B)	1	IV	1	—	4	H. W. Gardner
4·092	Color, Comp. Th. & App.	4·091	5(B)	2	IV	1	—	4	H. W. Gardner
4·11	Shades & Shadows	*4·06*	1	1	IV, IV-B	0	2	0	H. W. Gardner
4·12	Perspective	*4·06* or *D12*	1	1	IV, IV-B	1	1	0	Dean
4·13	Perspective	D12	2	1	IV-A, VI-B	2	—	2	W. H. Lawrence
4·22	Arch. Practice	D12	3	S	IV-A	0	6	0	Bridge
4·25	Estimating & Manage. Constr. Operation	4·212 or 4·22 and 4·812 or 4·912	4	2	IV-A	1	—	3	Jenrick
4·312	Abstract Design	4·311	1	2	IV, IV-B	5	—	4	H. W. Gardner
4·321	Theory of Arch.	4·312	2	1	IV, IV-B	1	—	1	Beckwith
4·322	Theory of Arch.	4·321	2	2	IV, IV-B	1	—	1	Beckwith
4·331	Theory of Arch.	4·322	3	1	IV, IV-B	2	—	0	H. W. Gardner
4·332	Theory of Arch.	4·331	3	2	IV, IV-B	2	—	0	H. W. Gardner
4·341	Theory of Arch.	4·332	4	1	IV, IV-B	1	—	1	Cash
4·342	Theory of Arch.	4·341	4	2	IV	1	—	1	Cash
4·421	Architectural History	—	2	1	IV, IV-B	3	1	5	Putnam
			3	1	VI-B				
4·422	Architectural History	—	2	2	IV, IV-B	3	1	5	Putnam
			3	2	VI-B				
4·423	Architectural History	—	2	1	IV-A	3	1	4	Putnam
4·424	Architectural History	—	2	2	IV-A	3	1	4	Putnam
4·461	Europ. Civilization & Art	4·422	3	1	IV, IV-B	3	—	4	Seaver
4·462	Europ. Civilization & Art	4·461	3	2	IV, IV-B	3	—	4	Seaver
4·471	Europ. Civilization & Art	4·462	4	1	IV, IV-B	2	—	3	Seaver
4·472	Europ. Civilization & Art	4·471	4	2	IV, IV-B	2	—	3	Seaver
4·481	Europ. Civilization & Art	4·472	5(B)	1	IV, IV-B	2	—	3	Seaver
4·482	Europ. Civilization & Art	4·481	5(B)	2	IV, IV-B	2	—	3	Seaver
4·491	Europ. Civilization & Art	4·482	G(A)	1	(Elective)	2	—	4	Seaver

★ Time specially arranged.

Architecture Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
4·492	Europ. Civilization & Art	4·491	G(A)	2	(Elective)	2	—	4	Seaver
4·53	Professional Relations	4·241	5(B)	1	IV	1	—	2	Emerson
4·62	Site Planning and Construction Details	——	4	2	IV-B	6	—	0	Cautley
4·63	City Planning Admin.	——	G(A)	2	(Elective)	2	—	4	J. T. Woodruff
4·641	Hist. & Prin. City Plan.	4·61	3	1	IV, IV-B	3	—	1	F. J. Adams
4·642	Th. & Prac. City Plan.	4·641	4(B)	2	IV-B	3	—	3	F. J. Adams
4·651	Th. & Prac. City Plan.	4·642	5(B)	1	IV-B	3	—	3	F. J. Adams
4·652	Th. & Prac. City Plan.	4·651	5(B)	2	IV-B	3	—	3	F. J. Adams
4·661	City Planning Research	4·652	G(A)	1	(Elective)	2	—	4	F. J. Adams
4·662	City Planning Research	4·661	G(A)	2	(Elective)	2	—	4	F. J. Adams
4·672	City Planning Design	4·671	4(B)	2	IV-B	0	18	0	J. T. Woodruff
4·681	City Planning Design	4·672	5(B)	1	IV-B	0	25	0	J. T. Woodruff
4·682	City Planning Design	4·681	5(B)	2	IV-B	0	12	0	J. T. Woodruff
4·691	City Planning Design, Adv.	4·682	G(A)	1	(Elective)	0	36	0	F. J. Adams
4·692	City Planning Design, Adv.	4·691	G(A)	2	(Elective)	0	36	0	F. J. Adams
4·711	Architectural Design I	——	1	1	IV, IV-B	0	10	1	Bridge
4·712	Architectural Design I	——	1	2	IV, IV-B	0	12	0	Bridge
4·721	Architectural Design II	4·712	2	1	IV, IV-B	0	13	0	Beckwith
4·722	Architectural Design II	4·721	2	2	IV, IV-B	0	13	0	Beckwith
4·731	Architectural Design III	4·722	3	1	IV, IV-B	0	12	0	Clapp
4·732	Architectural Design III	4·731	3	2	IV, IV-B	0	17	0	Clapp
4·741	Architectural Design IV	4·732	4	1	IV, IV-B	0	21	0	Gunther
4·742	Architectural Design IV	4·741	4	2	IV	0	29	0	Gunther
4·751	Architectural Design V	4·742	5(B)	1	IV	0	30	0	Cash, Anderson
4·752	Architectural Design V	4·751	5(B)	2	IV	0	14	0	Cash, Anderson
4·761	Architectural Design VI	4·752	G(A)	1	(Elective)	0	36	0	Cash, Anderson
4·762	Architectural Design VI	4·761	G(A)	2	(Elective)	0	36	0	Cash, Anderson
4·78	Planning Principles	4·413, 4·414	3	2	IV-A	1	3	8	Clapp
			4	2	VI-B				
4·811	Construction	2·031	3	1	IV, IV-B	2	5	0	Gelotte
4·812	Construction	4·811	3	2	IV, IV-B	2	5	0	Gelotte
4·911	Structural Analysis	2·04	3	1	IV-A	4	13	2	W. H. Lawrence
4·912	Structural Design	——	3	2	IV-A	3	8	0	W. H. Lawrence
4·921	Structural Design	4·912, 1·40, 4·90	4	1	IV-A	2	8	0	W. H. Lawrence
4·922	Structural Design	4·921	4	2	IV-A	1	5	0	W. H. Lawrence

CHEMISTRY—5·00–5·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	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 and IV-B	4	3	4	Blanchard
5·02	Chemistry, General	5·01	1	2	All Courses except IV and IV-B	4	3	4	Blanchard
5·04	Chemistry	——	G	S	II (A.O.)	4	—	5	Wareham
5·061	Inorganic Chemistry	5·13 or 5·131	4(B)	1	V, XII_3	2	—	3	Schumb
5·062	Inorganic Chemistry	5·061	4(B)	2	V, XII_3	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 or 5·131	G(A)	1 or 2	(Elective)	0	6	0	Young
5·10	Qualitative Analysis	5·02	2	S	V, X, XIV	3	11	4	Hamilton
			2	1	(Elective)				
5·11	Qualitative Analysis	5·02	2	1	III, VII, $VIII_1$, IX-A, XI, $XII_{2,3}$, XV_2	3	4	2	Simpson
			2	S	$VIII_2$				
5·12	Quantitative Analysis	5·10 or 5·11	2	1	V, $VIII_2$, X, XIV	3	4	2	Hamilton
			2	2	III, VII, IX-A, XI, XII_3, XV_2				
5·13	Quantitative Analysis	5·12	3	1	$III_{3,4}$	3	4	2	Hamilton
			2	2	V				
5·131	Quantitative Analysis	——	2	2	X	2	3	2	Marvin
5·141	Anal. Chemistry	5·12	3	1	V	0	3	1	Woodman
5·142	Anal. Chemistry	5·12	2	2	V	2	—	1	Simpson
5·16	Anal. Chemistry	5·131	4	2	X-A	1	3	1	Marvin
5·18	Qualitative Anal., Adv.	5·10	G(A)	1	(Elective)	1	8	1	W. T. Hall
5·20	Chem. of Water & Sewage	5·12	3	1	VII	1	3	1	Woodman
5·23	Sanitary Chemistry	5·12	3	2	XI	1	7	1	Woodman
5·25	Chemistry of Foods	5·12	3	2	$VII_{1,2}$	1	4	1	Woodman
5·251	Chemistry of Foods	5·12	4(B)	1 or 2	(Elective)	1	2	1	Woodman
5·26	Food Analysis	5·12	4(B)	1 or 2	(Elective)	0	5	0	Woodman
5·35	Applied Chemistry	5·02	3,4	2	(Elective)	2	—	2	Marvin
5·41	Organic Chemistry I	5·12, 8·04	3	1	V, VII_3, IX-A, X, XI, XIV, XV_2	4	—	3	Huntress
			3	S	$VII_{1,2}$				
			4	1	$VIII_2$ (Not 1936–37)				
5·412	Org. Chemistry & Lab.	5·04	G	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 Chemistry Lab.	5·12, *5·41*	3	1	V	0	9	0	Ashdown
5·416	Organic Chemistry Lab.	5·12, *5·41*	3	1	X, XV_2	0	7	0	Ashdown
5·417	Quant. Org. Anal.	5·41	4	1	V	0	4	0	Armstrong
5·418	Organic Chemistry Lab.	5·12, *5·41*	3	1	IX-A, XIV	0	6	0	Ashdown
			4	1	$VIII_2$ (Not 1936–37)				
5·42	Organic Chemistry I	5·41	3	2	V, X	4	—	2	Ashdown
5·424	Organic Chemistry Lab.	5·414	3	2	V	0	9	0	Ashdown
			G	2	Chem. War.				
5·426	Organic Chemistry Lab.	5·416	3	2	X	0	5	0	Ashdown
5·428	Organic Chemistry Lab.	*5·41*	3	S	$VII_{1,2}$	0	10	0	Huntress
5·43	Powder, Explosives and War Agents	5·42	4(B)	2	(Elective)	2	—	2	T. L. Davis
			G	2	Chem. War.				
5·51	Organic Chemistry II	5·42	G(A)	1	(Elective)	2	—	2	Norris
5·52	Organic Chemistry II	5·42, 5·51	G(A)	2	(Elective)	2	—	2	Norris
5·53	Organic Chemistry III	5·42	G(A)	1	(Elective)	2	—	4	T. L. Davis
5·54	Organic Chemistry III	5·42	G(A)	2	(Elective)	2	—	4	T. L. Davis
5·55	Ident. Organic Comp.	5·42, 5·414	G(A)	1	(Elective)	2	8	0	Huntress
5·56	Chem. Heterocyclic Comp.	5·42	G(A)	2	(Elective)	2	—	4	Morton
5·562	The Carbohydrates	5·41	G(A)	1	(Elective)	2	—	4	Hockett
5·57	Chemistry of Dyes	5·42	G(A)	2	(Elective)	2	—	2	Huntress
5·574	Free Rad. & Organo-Metallic Comp.	5·42	G(A)	1	(Elective)	2	—	2	Morton
5·58	Org. Substances in Metabolic Procs.	5·42	G(A)	1	(Elective)	2	—	4	Milas

Chemistry Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
5·581	Organic Lab., Adv.	5·42, 5·424	G(A)	1	(Elective)	1	5	1	Morton
5·582	Organic Lab., Adv.	5·42, 5·424	G(A)	2	(Elective)	0	5	1	Morton
5·584	Mol. Str. of Carbon Comp.	5·42	G(A)	1	(Elective)	2	—	4	Ashdown
5·591	Recent Adv. in Org. Chem.	5·42	G	1	(Elective)	1	—	1	Norris
5·592	Recent Adv. in Org. Chem.	5·42	G	2	(Elective)	1	—	1	Norris
5·61	Physical Chem. I	M21, 8·03, 5·12	3	1	III$_4$, V, VIII$_2$, X, XII$_{2,3}$, XIV, XV$_2$	4	—	4	Millard
			4	1	III$_3$				
5·611	Physical Chem. Lab. I.	*5·61*	3	1	V, VIII$_2$a, XIV	0	4	0	Dietrichson
5·612	Physical Chem. Lab. I.	*5·61*	3	1	X	0	2	0	Dietrichson
5·62	Physical Chem. II	5·61	3	2	V, VIII$_2$, X, XII$_{2,3}$, XIV	4	—	4	Millard
5·621	Physical Chem. Lab. II	5·611, *5·62*	3	2	V, VIII$_2$a, XIV	0	4	0	Dietrichson
5·622	Physical Chem. Lab. II	5·612, *5·62*	3	2	X	0	2	0	Dietrichson
5·63T	Int. to Thermodynamics	5·62	4(B)	1	V	3	—	5	Sherrill
5·64T	Int. to Rad. Chemistry	5·62 or 5·71	4(B)	2	V	2	—	3	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, II-A, XVI	2	—	2	Beattie
5·684	Physical Chem., Elem.	M21, 5·12, 8·04	3	1	VII$_{1,2}$	3	—	3	Gillespie
			4	1	XI (Not 1936–37)				
5·71	Physical Chem.	M21, 8·03, 5·13	G(A)	1	(Elective)	4	—	6	Sherrill
5·72T	Physical Chem.	5·71	G(A)	2	(Elective)	2	—	4	Sherrill
5·741T	Radiation Chem., Adv.	5·64 or 5·72T	G(A)	1	(Elective)	3	—	6	Harris
5·742T	Kin. Th. & Stat. Mech.	5·741T	G(A)	2	(Elective)	2	—	4	Keyes
5·75	Thermodynamics	——	G(A)	2	(Elective)	2	—	2	Keyes
			G	2	II (T.E.)				
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
5·81	Chem. Literature I	——	3	1	V	2	—	3	W. T. Hall
5·82	Chem. Literature II	5·81, 5·41, 5·61	3	2	V	1	—	1	Huntress
5·83	History of Chemistry	5·41	4(B)	2	V	2	—	2	T. L. Davis
5·842	Optical Methods	5·12, 8·02	4(B)	1 or 2	(Elective)	0	2	1	Woodman
5·844	Eng. Chemistry	——	2	1	XVII	2	3	1	Marvin
5·851	Meth. of Electrochem. Anal.	5·12	G(A)	2	(Elective)	1	3	2	W. T. Hall
5·852	Organic Physical Chem.	5·42, 5·62	G(A)	1	(Elective)	2	—	2	Morton
5·855	Th. & App. of Catalysis	5·41	G(A)	1	(Elective)	2	—	2	Milas
5·90	Logic of Science	——	G(A)	1	(Elective)	2	—	2	T. L. Davis
5·911	Journal Meeting in Inorg. Chem.	——	G(A)	1	(Elective)	1	—	1	Schumb
5·912	Journal Meeting in Inorg. Chem.	——	G(A)	2	(Elective)	1	—	1	Schumb
5·921	Journal Meeting in Org. Chem.	5·42	G	1	(Elective)	1	—	1	Norris
5·922	Journal Meeting in Org. Chem.	5·42	G	2	(Elective)	1	—	1	Norris
5·931	Journal Meeting in Phys. Chem.	——	G	1	(Elective)	1	—	1	Scatchard
5·932	Journal Meeting in Phys. Chem.	——	G	2	(Elective)	1	—	1	Scatchard
5·941	Research Conf. in Inorg. & Org. Chem.	5·42	G	1	(Elective)	1	—	1	Norris
5·942	Research Conf. in Inorg. & Org. Chem.	5·42	G	2	(Elective)	1	—	1	Norris
5·943	Research Conf. in Phys. Chem.	——	G	1	(Elective)	1	—	1	Scatchard
5·944	Research Conf. in Phys. Chem.	——	G	2	(Elective)	1	—	1	Scatchard
5·98	Research	——	G(A)	1 or 2	(Elective)		★		Norris
	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. Lec.	Lab. Draw.	Prep.	Instructor in Charge
6·00	Elec. Eng. Prin.	*M22*, 8·03	2	2	VI, VI-A, VI-B, VIII	4	—	4	Frazier
			3	2	XII_4				
6·01T	Elec. Eng. Prin.	6·00	3	1	VI, VI-B, VI-C, VIII	5	—	7	R. R. Lawrence
			3	S	VI-A				
6·02T	Elec. Eng. Prin.	6·01T	3	2	VI, VI-B, VI-C	5	—	6	R. R. Lawrence
			3	1	VI-A				Gray
6·03T	Elec. Eng. Prin.	6·02T	4	1	VI, VI-B, VI-C	6	—	8	R. R. Lawrence
			3	2	VI-A				
6·04T	Elec. Eng. Prin.	6·03T	4(B)	2	VI	6	—	9	R. R. Lawrence
			4	1	$VI\text{-}A(A)_{1,2}$				L. F. Woodruff
			4	S	$VI\text{-}A(B)_{1,2}$				
6·10	Elec. Eng. Prin.	*M22*, 8·03	2	2	XIV	4	—	4	Lyon
6·11	Elec. Eng. Prin.	6·00	3	1	XIV	5	—	6	R. R. Lawrence
6·12	Elec. Eng. Prin.	6·11	3	2	XIV	5	—	6	R. R. Lawrence
6·20	Power Trans. Equip.	*6·04T*	4(B)	2	(Elective)	3	—	6	L. F. Woodruff
6·211	App. Elec. in Industry	6·02T	4(B)	1	(Elective)	3	—	6	Dawes
6·212	App. Elec. in Industry	6·03T	4(B)	2	(Elective)	3	—	6	Dawes
6·221	Central Stations	2·42	4(B)	1	(Elective)	3	—	6	Mulligan
6·222	Central Stations	6·03T	4(B)	2	(Elective)	3	—	6	Mulligan
6·241	Electric Railways	6·77T, *6·03T*	4(B)	1	(Elective)	3	—	6	Balsbaugh
6·242	Electric Railways	6·241	4(B)	2	(Elective)	3	—	6	Balsbaugh
6·251	Elec. Mach. Design	*6·03T*	4(B)	1	(Elective)	3	—	6	Dwight
6·252	Elec. Mach. Design	6·03T	4(B)	2	(Elective)	3	—	6	Dwight
6·26	Elec. Insulation and its Behavior	M31	4(B)	1	(Elective)	2	3	4	Moon
6·27	Illum. Eng. Prin.	8·02	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.	6·02T	4(B)	1	(Elective)	3	—	6	C. E. Tucker
6·282	Prin. Radio Com.	6·02T	4(B)	2	(Elective)	3	—	6	Barrow
6·29	Storage Batteries	—	4	1	(Elective)	1	—	1	R. R. Lawrence
6·30	Elec. Com. Prin.	*6·02T*	3	2	VI-C	3	—	6	Guillemin
6·31	Elec. Com. Prin.	6·30, 6·02T	4(B)	S	$VI\text{-}A_3$	3	—	5	Bowles
			4	1	VI-C				
6·32	Elec. Com. Prin.	6·30, 6·02T	4(B)	2	$VI\text{-}A_3$, VI-C	3	—	5	Guillemin
6·330T	Elec. Com. Lab.	6·02T, *6·31*	4	1	$VI\text{-}A(A)_3$	0	6	8	Fay
			4	S	$VI\text{-}A(B)_3$				
6·331	Elec. Com. Lab.	6·02T, *6·31*	4	1	VI-C	0	4	4	Fay
6·332	Elec. Com. Lab.	6·331	4	2	VI-C	0	4	6	Fay
6·39	Eng. Electronics	—	4	1	(Elective)	2	3	4	Gray
6·40	Elec. Eng. Elem.	*8·04*	3	1	I, XI, $XV_{1a,1c}$, XVI	4	—	6	Hudson
			3	2	II, IX-B, $XV_{1b,2}$				
			4	1	III, X, XIII, XIII-C				
			4	S	II-A				
6·42	Elec. Eng. Elem.	—	G	1	II (A.O.)	5	—	5	Hudson
6·47	App. Elec. in Industry	6·40	4	1	$II_{1,2,3,4}$	2	2	4	Tucker, Dawes
6·48	Elec. Eq. of Bldgs.	8·04	4	2	(Elective)	1	—	2	Hudson
6·501	Elec. Eng. Seminar	—	G(A)	1	VI	2	—	10	L. F. Woodruff
			G	S	VI-A(A)				
			G	S or 1	VI-A(B)				
6·502	Elec. Eng. Seminar	—	G(A)	2	VI, VI-A	2	—	2	L. F. Woodruff
6·511	Elec. Power Circuits	6·04	G(A)	1	(Elective)	3	—	7	Wildes
6·512T	Elec. Power Circuits	6·04	G(A)	2	(Elective)	3	—	7	Wildes
6·513T	Power System Stability	6·04	G(A)	1	(Elective)	3	—	7	Dahl
6·514	Power System Stability	6·04, 6·511	G(A)	2	(Elective)	3	—	7	Dahl
6·515	Power Systems Lab.	*6·513* or *6·514*	G(A)	1 or 2	(Elective)		★		Fitzgerald
6·521	Alt. Cur. Machinery	6·04, M31	G(A)	1	(Elective)	3	2	5	Lyon, Kingsley
6·522	Alt. Cur. Machinery	6·04, M31	G(A)	2	(Elective)	3	2	5	Lyon, Kingsley
6·531	Org. & Adm. Pub. Ser. Co.	6·04, Ec12	G(A)	1	(Elective)	3	—	7	Balsbaugh
6·532	Org. & Adm. Pub. Ser. Co.	6·04, Ec12	G(A)	2	(Elective)	3	—	7	Balsbaugh

★ Time specially arranged.

Electrical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
6·541	Power Gen. Stations	6·03, Ec12	G(A)	1	(Elective)	3	—	6	Mulligan
6·542	Power Gen. Stations	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	6·312	G(A)	1	(Elective)	3	2	5	Guillemin
6·562	Adv. Network Theory	6·561	G(A)	2	(Elective)	3	—	5	Guillemin
6·571	Illum. Eng., Prin.	6·27 or 8·161	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. Anal. by Laplacian Transf.	6·04 or 6·312, M31	G(A)	1 or 2	(Elective)	3	—	7	M. F. Gardner
6·59	Communications Lab.	6·332 or 6·330	G(A)	1 or 2	(Elective)		★		Fay
6·60	Math. Anal. by Mech. Methods	M22	G(A)	1	(Elective)	2	—	4	Caldwell
6·61	Super-High-Volt. Eng.	6·04	G(A)	1	(Elective)	2	—	4	Trump
6·62	Elec. Com. Prin.	6·312	G(A)	2	(Elective)	2	3	5	Bowles
6·631	Engineering Electronics	6·03	G(A)	1	(Elective)	3	—	7	Gray
6·632	Engineering Electronics	6·631	G(A)	2	(Elective)	3	—	7	Gray
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	(Elec e)	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	L. F. Woodruff
6·672	Vibrations	6·671	G(A)	2	(Elective)	3	1	6	L. F. Woodruff
6·69	Sound in Elec. Com.	M31, 6·04 or 6·312	G(A)	2	(Elective)	2	3	5	Fay
6·73	Elec. Meas. Lab., Adv.	6·71, 6·04	G(A)	1 or 2	(Elective)		★		Bennett
6·74	Elec. Eng. Lab., Adv.	6·04, 6·72	G(A)	1 or 2	(Elective)		★		C. E. Tucker
6·75	Elec. Eng. Lab.	*6·00* or 6·40	2	2	VI, VI-A, VI-B, VIII	1	1	2	Bennett
			3	2	XII_4				
			4	2	III_4				
6·76T	Elec. Eng. Lab.	6·75, *6·01T*	3	S	VI-A(A)	1	3	4	Bennett
			3	1	VI, VI-A(B)$_3$, VI-B, VI-C				
6·761	Elec. Eng. Lab.	——	3	1	VI-A(B)$_{1,2}$, VIII$_2$b	0	2	3	Bennett
6·77T	Elec. Eng. Lab.	6·76T, *6·02T*	3	1	VI-A(B)	2	4	6	C. E. Tucker
			3	2	VI, VI-C, VI-A(A)				Bennett
6·771	Elec. Eng. Lab.	6·76T, *6·02T*	3	2	VI-B	2	3	6	Tucker, Bennett
6·78T	Elec. Eng. Lab.	6·77T, *6·03T*	4	1	VI, VI-A(A)$_{1,2}$	1	3	5	C. E. Tucker
			4	S	VI-A(B)$_{1,2}$				
6·781T	Elec. Eng. Lab.	6·77T, *6·03T*	4	1	VI-A(A)$_3$	1	1	3	C. E. Tucker
			4	S	VI-A(B)$_3$				
			4	2	VI-C				
6·79	Elec. Eng. Lab.	6·78T, *6·04T*	4	2	VI	1	2	4	C. E. Tucker
6·80	Elec. Eng. Lab.	——	4(B)	1 or 2	(Elective)		★		Tucker, Bennett
6·82	Elec. Eng. Lab.	*6·10*	2	2	XIV	1	1	2	Bennett
6·83T	Elec. Eng. Lab.	6·00	3	1	XIV	2	2	4	C. E. Tucker
6·84	Elec. Eng. Lab.	*6·12*, 6·83T	3	2	XIV	0	5	5	Tucker, Bennett
6·85	Elec. Eng. Lab.	*6·40*, or 6·42	4	2	III$_3$, X	0	2	3	C. E. Tucker
			4	1	III$_{1,2}$, IX-B				
			G	2	II (A.O.)				
6·89	Elec. Eng. Lab.	*6·40*	3	1	I, XI, XV$_1$a,$_1$c	0	2	2	C. E. Tucker
			3	2	XV$_1$b, XVI				
			4	1	XI, XIII, XIII-C, XV$_1$b,$_2$				
			4	S	II-A				
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)$_1$				

★ Time specially arranged.

Electrical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
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 h. p. 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. p. w.			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)$_3$				

BIOLOGY AND PUBLIC HEALTH—7·00–7·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
7·01	General Biology	——	2	1	VII, XI, XII$_1$	2	3	2	Bunker
			3	1	IX-A				
7·03	Theoret. Biology	7·01, 7·06, 7·10T	4(B)	2	VII$_1$	2	—	3	Blake
7·06	Botany	*7·01*	2	2	VII$_{1,2}$, XII$_1$	2	4	3	Jennison
7·08	Parasitology	7·10T	3(B)	2	VII$_1$	2	—	4	Blake
7·09	Parasitology, Adv.	7·08	G(A)	2	(Elective)	0	4	4	Blake
7·10T	Invertebrate Zoology	——	3	1	VII$_1$ (Not 1936–37)	2	6	4	
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$_{1,2}$	2	6	2	Blake
			3	1	VII$_1$				
7·15	Essent. of Anatomy	7·10T	3	1	VII$_2$	4	—	2	Sizer
7·17	Biol. Food Supplies	7·01	3	1	VII$_2$ (Not 1936–37)	4	—	2	Blake, Jennison
7·18	Tech. Aspects of Entom.	7·10T	G(A)	1	(Elective)	2	—	3	Blake
7·20	Physiology	5·501, 7·14 or 7·15	3	2	VII$_{1,2}$	3	3	4	Bunker
7·201	Adv. Physiology	7·20, 7·80, 5·684	G(A)	2	(Elective)	3	6	3	Sizer
7·22	Personal Hyg. & Nut.	7·20	4(B)	1	VII$_{1,2}$	2	—	2	
7·23	Applied Nutrition	——	G(B)	2	(Elective)	1	—	2	Turner
7·28	Limnology	——	3	1	(Elective)	1	2	1	Jennison
7·29	Bacteriology	7·01	3	2	XI	1	4	2	Jennison
7·301	Bacteriology	7·01	3	1	VII	2	4	4	Horwood
7·302	Bacteriology	7·301	3(B)	2	VII	2	4	3	Horwood
			4(B)	2	(Elective)				
7·321	Bacteriology, Adv.	7·301, 7·80	G(A)	1	(Elective)	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$_2$	1	—	2	Prescott
7·34	Limnological Field	7·01, 5·12	3	S	VII$_3$, XI	0	5	0	Jennison
7·35	Planktonology	7·06, 7·10T	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$_2$	1	4	2	Prescott

Biology and Public Health Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
7·362	Indust. Microbiology	7·361	4(B)	2	VII_2	1	3	4	Proctor
7·371	Indust. Microbiology	7·362	G(A)	1	(Elective)	1	4	4	Prescott
7·372	Indust. Microbiology	7·371	G(A)	2	(Elective)	1	3	4	Prescott
7·50	Communicable Diseases	7·301	3(B)	1	$VII_{1,3}$	3	—	3	J. W. Williams
7·52	Industrial Hygiene	7·50	4(B)	2	VII	3	1	4	Turner
7·53	Air Examination	8·04	3	1	VII_3	1	2	0	Jennison
7·531	Air Examination	8·04	G(B)	1	(Elective)	1	2	2	Jennison
7·541	Public Health Admin.	7·302	4(B)	1	$VII_{1,3}$	2	—	3	Turner
7·542	Public Health Admin.	7·302	4(B)	2	$VII_{1,3}$	2	—	3	Turner
7·551	Pub. Health Lab. Meth.	7·301	4(B)	1	VII_1	2	6	3	J. W. Williams
7·552	Serological Meth.	7·301	4(B)	2	VII_1	1	5	1	J. W. Williams
7·57	Municipal Sanitation	7·301	3(B)	2	VII	4	—	3	Horwood
7·58	Vital Statistics	7·301, 7·50	4(B)	1	$VII_{1,3}$	2	—	3	Horwood
7·59	Sanitation	7·302, 7·57	4(B)	1	VII_3	2	2	3	Horwood
7·601	Health Education	7·01	G(A)	1	(Elective)	2	—	4	Turner
7·602	Health Education	7·601	G(A)	2	(Elective)	1	3	6	Turner
7·604	School Health Admin.	7·601	G(A)	2	(Elective)	1	—	2	Turner
7·63	Pub. Health Field Wk.	7·542	G(A)	2	(Elective)	2	—	4	Turner
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. of Food Supplies	*7·301*	3	1	VII_2	3	4	4	Proctor
7·702	Tech. of Food Supplies	*7·302*	3	2	VII_2	2	2	4	Proctor
7·711	Tech. of Food Products	7·702	4(B)	1	VII_2	3	3	4	Proctor
7·712	Tech. of Food Products	7·711	4(B)	2	VII_2	2	3	4	Proctor
7·72	Adv. Food Technology	7·711	G(A)	1	(Elective)	1	2	3	Proctor
7·80	Biochemistry	5·41, 7·20	4(B)	1	$VII_{1,2}$	3	5	5	Bunker
7·81	Zymology	7·80	G(A)	1	(Elective)	2	4	3	Bunker, Gould
7·82	Biochemistry, Adv.	——	G(A)	2	(Elective)	6	—	3	Bunker
7·94	Research Problems	——	G(A)	1 or 2	(Elective)		★		Bunker

PHYSICS—8·00–8·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Lab. Prep.	Instructor in Charge
8·00	Physics Entrance	——	–	S	——	2	—	5	Frank
8·01	Physics (Mechanics)	——	1	1	All courses except IV and IV-B	4	2	5	Boyce, Sears
8·012	Physics (College Transfer)	——	1	1	——	4	—	6	Allis
8·02	Physics (Mech. and Heat)	8·01	1	2	All courses except IV and IV-B	4	2	5	Frank, Sears
8·03	Physics (Electricity)	8·01, M12	2	1	All Courses except IV and IV-B	4	1	5	Page, Wulff
8·034	Physics (College Transfer)	——	2	2	——	4	—	6	Allis
8·04	Physics (Elec. Optics & Modern Phys.)	8·03	2	2	All courses except IV and IV-B	4	2	4	Page, Wulff
8·05	Vibrations and Sound	8·04, M12	4	1	VI-C, $VI-A_3$	3	—	6	Morse
8·06	Accoust., Ill. & Color	——	3	1	IV-A	1	—	2	Morse
8·07	Precision of Measure	M22	4	1	XIV	1	—	1	Goodwin
8·09	Physical Measurements	——	3	1	VIII	0	3	2	Stockbarger
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	3	4	Harrison
8·13	Undergrad. Colloquium	——	4(B)	2	VIII	2	—	2	Allis
8·15	Photography	8·04	–	2	(Elective)	2	—	1	Hardy

★ Time specially arranged.

Physics Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
8·152	Adv. Photography	*8·15*	–	2	(Elective)	0	3	2	Hardy
8·161	Optics	8·04	3	1	VI-B, VIII	3	—	6	Hardy
8·162	Optical Measurements	*8·161*	3	1	VIII	0	3	2	Hardy
8·171	Advanced Optics	8·161	4(B)	1	(Elective)	2	—	3	Hardy
8·173	Color Measurements	8·04	4(B)	2	II_5	0	3	2	Hardy
8·174	Motion Picture Photography	8·161	4(B)	1	(Elective)	1	—	3	Hardy
8·181	Optics, Seminar	8·161	G(A)	2	(Elective)	2	—	2	Hardy
8·191	Microscopy and Photomicrography	——	4	2	(Elective)	2	—	0	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.	8·04, 8·201, *8·212*	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, 8·04, 8·201, 8·512 or 8·21	G(A)	1	(Elective)	3	—	9	Nottingham
8·214	Advanced Electronics	8·213	G(A)	2	(Elective)	3	—	9	Rudberg
8·215	Sp. Prob. in Electronics	8·201	G(A)	1	(Elective)		★		Nottingham
8·26	Polar Molecules	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
8·28	X-Ray Diffraction	8·27	G(A)	2	(Elective)	2	—	4	Warren
8·29	Lattice Th. of the Solid State	8·27, 8·311	G(A)	2	(Elective)	2	—	4	Mueller
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	Rudberg
8·312	Atomic Struct. Lab.	8·04, *8·311*	3	2	VIII	0	3	2	Stockbarger
8·32	Line Spectra	8·311	G(A)	1	(Elective)	3	—	6	Boyce
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)		★		Harrison
8·346	Quant. Spectros. Anal.	8·04	(B)	S	(Elective)	1	—	1	Harrison
8·35	Excitation of Spectra	8·32	G(A)	2	(Elective)	2	3	4	Stockbarger
8·36a	Radiation Meas.	——	–	S	(Elective)	2	—	2	Stockbarger
8·36b	Radiation Meas. Lab.	——	–	S	(Elective)	0	3	2	Stockbarger
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
8·441	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	VIII, XII_4, XVIII	4	—	8	Stratton
8·462	Int. to Th. Physics II	8·461	4(B)	2	VIII, XVIII	4	—	8	Morse
8·463	Int. to Th. Physics III	8·32, 8·461	G(A)	2	(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)	2	(Elective)	3	—	9	Morse
8·50	Heat & Thermodynamics	8·02, M22	3	1	VI-A(B)$_3$, VI-C, $VIII_1$	3	—	4	Slater
			4	1	VI-B, VI-A(A)$_3$				
8·512	Statistical Mechanics	8·50	G(A)	2	(Elective)	3	—	9	Frank
8·521	Quantum Mechanics	8·463	G(A)	1	(Elective)	3	—	9	Morse
8·54	Electromag. Theory	M77	4(B)	2	XII_4	3	—	6	Stratton
8·56	Electromag. Wave Theory	8·491	G(A)	1	(Elective)	3	—	9	Vallarta
8·58	Th. of Relativity	8·462, M631	G(A)	1	(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	(Elective)		★		Slater
8·82	Electrochemistry	8·802	4(B)	1	XIV	3	—	6	Goodwin

★ Time specially arranged.

CHEMICAL ENGINEERING—10·00–10·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	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
10·16	Applied Chemistry	5·683	2	2	II, II-A, XVI	2	—	2	Lewis
10·17	Indust. Chemistry	*5·41, 5·61*	3	1	X	3	—	2	Lewis
10·18	Indust. Chemistry	10·17, *5·42, 5·62*	3	2	X	4	—	6	Lewis
10·191	Chem. Eng. Lit.	L12, L52	2	1	X (Elective)	3	—	5	Gilliland
10·192	Chem. Eng. Lit.	10·191	2	2	X (Elective)	4	—	4	Gilliland
10·201	Industrial Chemistry	5·41, 5·611	3	2	XV_2	4	—	4	Lewis
10·203	Industrial Chemistry	*5·42, 5·62*	3	2	V	3	—	4	Lewis
10·21	Industrial Chemistry	10·201, or 10·203, or 10·18	4(B).	1	V, X, XV_2	2	—	2	Lewis
			G.	1	Chem. War.	2	—	2	Lewis
10·25	Indust. Stoichiometry	5·42, 5·62	G(A)	1	Chem. War.	2	—	4	Gilliland
10·251	Industrial Chemistry	5·42, 5·62	G(A)	1	(Elective)	3	—	3	Lewis
10·26	Industrial Chem. Lab.	*10·21*	4(B).	1	X, XV_2	2	3	1	Weber
10·28	Chemical Eng.	5·61, 10·17	3	2	X, XV_2	4	—	6	Weber
			G.	1	Chem. War.				
10·29	Chemical Eng.	10·28	4(B).	1	X	3	—	6	Monroe
			G.	2	Chem. War.				
10·30	Eng. Equipment	*10·32*	4	2	X-B	4	—	1	Whitman
10·31	Chemical Eng.	10·18, 10·28	4(B).	1	X	5	—	4	C. S. Robinson
			G.	1	Chem. War.				
10·32	Chemical Eng.	10·31	4(B).	2	X, X-B	5	—	4	C. S. Robinson
			G.	2	Chem. War.				
10·33	Anal. Treat. of Chem. Eng. Processes	M41, 5·62	G(A)	1	(Elective)	3	—	6	Sherwood
10·35	Ind. Chemical Eng.	5·61T	4	1	XV_2	3	—	6	C. S. Robinson
10·36	Ind. Chemical Eng.	10·35	4	2	XV_2	3	—	6	C. S. Robinson
10·37*	Flow of Fluids	10·28	G(A)	1	(Elective)	3	—	6	McAdams
10·38	Explosives Plant Eng.	5·412	G.	1	II (A.O.)	6	—	4	C. S. Robinson
10·39	Th. Int. Ballistics	10·38	G.	2	II (A.O.)	3	—	5	C. S. Robinson
10·41	Distillation	10·32	G(A)	2	(Elective)	3	—	5	McAdams
10·42	Drying	10·32	G(A)	1	(Elective)	2	—	4	Sherwood
10·44*	Distil. & Absorption	5·61	G(A)	2	(Elective)	3	—	6	Sherwood
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
10·52	Chemical Eng. II	10·32	G(A)	1	(Elective)	3	—	6	McAdams
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	McAdams
10·55	Economic Balance	10·32	G(A)	2	(Elective)	3	—	6	Sherwood
10·61*	Therm. of Hydrocar.	10·28	G(A)	2	(Elective)	3	—	6	Weber
10·62	App. Chem. Therm.	5·62, 10·29	G(A)	1, 2	(Elective)	3	—	6	Weber
10·63	App. Colloid Chem.	5·62	G(A)	2	(Elective)	3	—	6	Lewis
10·64*	App. Colloid Chem.	5·41, 5·61	G(A)	1	(Elective)	3	—	6	Lewis
10·65	High Pres. Proc.	*10·32*	G(A)	2	(Elective)	2	—	4	Gilliland
10·661	Int. to Colloid Chem.	5·42, 5·62	G(A)	1	(Elective)	2	—	4	Hauser
10·662	Colloid Chemistry	10·661	G(A)	2	(Elective)	2	—	4	Hauser
10·671	Colloid Seminar	5·62, 10·63, or *10·66*	G(A)	1	(Elective)	1	—	3	Hauser
10·672	Colloid Seminar	10·671	G(A)	2	(Elective)	1	—	3	Hauser
10·68	Corrosion	5·62	G(A)	1	(Elective)	2	—	4	Lewis
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
10·72	Fuel Eng. Practice	10·71, 10·78	G(A)	1	(Elective)	0	20	0	Hottel
10·73	Fuel Eng. Design	10·72	G(A)	1	(Elective)	3	—	6	Hottel
10·74	Furnace Design	10·31	G(A)	1, 2	(Elective)	3	—	6	Hottel
10·76	Sem. in Radiant Heat Transmiss.	10·31	G(A)	2	(Elective)	2	—	4	Hottel

*Specially arranged for graduate students in Petroleum Production and not ordinarily to be taken by graduate students in Chemical Engineering.

Chemical Engineering Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
10·78	Fuel Eng. Lab.	10·70	4(B)	2	(Elective)	0	4	2	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 (Boston 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 (Boston 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	Whitman
10·992	Seminar Chem. Eng.	10·32	G(A)	2	(Elective)	2	—	4	Whitman

GEOLOGY—12·00–12·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
12·01	Mineralogy	5·02	2	1	$III_{1, 2, 3}$, XII	2	6	2	Buerger
			3	1	IX-A				
12·02	Mineralogy	12·01	4(B)	2	$XII_{2, 3}$	2	3	1	Buerger
12·05	Mineral. Seminar	12·02, 12·15	G(A)	1	(Elective)	2	—	4	Buerger
12·06	Mineral. Research	——	G(A)	1	(Elective)		★		Buerger
12·15	Petrography	12·11	3	2	$XII_{1, 2, 3}$	1	7	2	Buerger
12·16	Petrolog. Seminar	——	G(A)	2	(Elective)	2	—	4	Buerger
12·17	Petrographic Research	12·15	G(A)	2	(Elective)	0	4	1	Buerger
12·211	Optical Crystallog.	8·02	3	1	$XII_{1, 2, 3}$	1	3	2	Buerger
12·25	Crystallography	8·04	3(B)	1	III_4	1	2	2	Buerger
12·30	Geology	12·01	2	2	$III_{1, 2}$	3	1	1	Morris
			3	2	IX-A				
12·301	Geology	——	2	2	XII	3	6	2	Morris
12·31	Geology	12·30	3	1	$III_{1, 2}$	3	2	3	Shimer
			4	1	IX-A				
12·311	Historical Geology	12·301	3	1	XII	3	—	3	Shimer
12·32	Geology	——	3	2	I	3	3	4	Mead, Morris
12·33	Field Geology	1·03, 12·01, 12·31	4	1	$III_{1, 2}$	0	3	2	Morris, Whitehead
12·351	Geol. Survey., Adv.	12·33	G(A)	1	(Elective)	0	4	4	Morris
12·352	Geol. Survey., Adv.	12·351	G(A)	2	(Elective)	0	4	4	Morris
12·38	Geomorphology	——	4	1	$XII_{1, 2}$	3	—	6	Morris
12·39	Field Geology Meth.	12·31	3	2	(Elective)	0	3	1	Morris
12·40	Geology, Economic	12·01, 12·31	3	2	$III_{1, 2}$, $XII_{2, 3}$	3	—	5	Newhouse
			4	2	XII_4				
12·41	Econ. Geology Lab.	12·40	4(B)	1	$XII_{2, 3}$	0	8	0	Newhouse
12·42	App. Econ. Geology	12·40	4(B)	2	$XII_{2, 4}$	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	—	2	Newhouse
12·434	Econ. Geol. Sem., Adv.	12·40	G(A)	2	(Elective)	2	—	2	Newhouse
12·44	Econ. Geol. of Fuels	G60	4(B)	2	(Elective)	1	—	1	Whitehead
12·46	Econ. Geol. of Non-Metallic Deposits	12·40	4(B)	2	XII_2	2	1	3	Newhouse
12·49	Geol. of Materials	——	3	2	IV-A, XVII	2	—	2	Morris
12·50	Stratigraphic Geol.	12·31	4(B)	1	XII_1	2	2	5	Shimer

★ Time specially arranged

Geology Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
12·511	Paleontology	12·31 or G60	3	1	XII_1	1	2	4	Shimer
12·512	Paleontology	12·511	3	2	XII_1	1	3	5	Shimer
12·521	Paleontology, Adv.	12·512	G(A)	1	(Elective)	1	3	3	Shimer
12·522	Paleontology, Adv.	12·512	G(A)	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
12·551	Org. Evolution, Adv.	G64	G(A)	1	(Elective)	2	1	3	Shimer
12·552	Org. Evolution, Adv.	G64	G(A)	2	(Elective)	2	1	3	Shimer
12·581	Sedimentation	12·301	G(A)	1	(Elective)	2	2	4	Shimer
12·582	Sedimentation	12·581	G(A)	2	(Elective)	2	2	4	Shimer
12·61	Diastro. & Vulcan.	12·15, 12·31	4(B)	1	(Elective)	2	—	3	Morris
12·631	Geology Climates Sem.	12·31	G(A)	1	(Elective)	2	—	5	Shimer
12·632	Physical Geol. Sem.	12·631	G(A)	1	(Elective)	2	—	5	Mead
12·64	Geology of N. America	12·31 or G60	G(A)	1	(Elective)	2	—	4	Shimer
12·70	Structural Geology	12·31	3	2	$XII_{1, 2, 4}$	3	—	6	Mead, Morris
12·71	Structural Geology, Adv.	12·70	G(A)	2	(Elective)	3	—	6	Mead, Morris
12·75	Metamorphic Geology	12·31	G(A)	1	(Elective)	3	—	6	Mead
12·80	Geology Coal & Petrol.	12·31 or G60	4(B)	2	XII_1	4	—	3	Whitehead
			3	2	III_2				
12·81	Geology of Petrol., Adv.	12·80	G(A)	2	(Elective)	3	—	2	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)	1	(Elective)	2	—	2	Slichter
12·87	Intro. Geophysical Prospecting	——	4(B)	2	XII_4	2	—	2	Slichter

NAVAL ARCHITECTURE AND MARINE ENGINEERING—13·00–13·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
13.01	Naval Architecture	M12, 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 Architecture	13·02	4(B)	1	XIII, XIII-A	3	—	3	Chapman
13·11	Th. of Warship Des.	——	3	1	XIII-A	4	—	10	Rossell, Keith
13·12	Th. of Warship Des.	——	3	2	XIII-A	4	—	10	Rossell, Keith
13·13	Th. of Warship Des.	——	4	1	XIII-A	3	—	6	Rossell, Keith
13·14	Th. of Warship Des.	——	4	2	XIII-A	3	—	8	Rossell, Keith
13·15	Th. of Warship Des.	——	G	1	XIII-A	3	—	6	Rossell, Keith
13·16	Th. of Warship Des.	——	G	2	XIII-A	3	—	6	Rossell, Keith
13·21	Warship Design	——	3	1	XIII-A	0	5	0	Rossell, Keith
13·22	Warship Design	——	3	2	XIII-A	0	5	0	Rossell, Keith
13·23	Warship Design	——	4	1	XIII-A	0	5	0	Rossell, Keith
13·24	Warship Design	——	4	2	XIII-A	0	5	0	Rossell, Keith
13·25	Warship Design	——	G	1	XIII-A	0	6	0	Rossell, Keith
13·26	Warship Design	——	G	2	XIII-A	0	6	0	Rossell, Keith
13·34T	Ship Construction	——	3	1	XIII	2	3	2	Owen, Burtner
13·40	Ship Design	——	2	2	XIII	2	4	1	Owen
13·43T	Ship Design	——	3	2	XIII	0	3	0	Owen
13·45	Ship Design	13·43	4(B)	1	XIII	0	8	0	Owen
13·47	Ship Design	13·021, 13·52	4	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	2·06T, 2·40, 13·52	4(B)	1	XIII	2	—	3	Burtner, F. M. Lewis
13·55T	Marine Engineering	2·42, 13·52	4	2	XIII	4	—	5	Burtner, F. M. Lewis
13·56	Marine Engineering	13·52	4	1	XIII-C	3	—	4	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	0	5	0	Burtner
13·62	Marine Eng. Design	13·61	4(B)	2	XIII	1	4	0	Burtner
13·64	Marine Eng. Design	13·58	4	2	XIII-A	0	3	0	Chapman
13·73	Mechanical Vibration	2·06T	G(A)	1	(Elective)	3	—	6	F. M. Lewis
13·74	Mechanical Vibration	13·73	G(A)	2	(Elective)	3	—	6	F. M. Lewis
13·81	Ship Operation	13·021, 13·52, 13·83	4(B)	1	XIII-C	3	—	5	Chapman
13·82	Ship Operation	13·81	4(B)	2	XIII-C	2	—	4	Chapman
13·83	Terminal Facilities	——	3	1	XIII-C	3	—	3	Chapman

BUSINESS AND ENGINEERING ADMINISTRATION—15·00–15·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
15·11	Int. to Bus. Manage.	Ec12	4(B)	1	XIII	3	—	3	Fernstrom
15·12	Int. to Bus. Manage.	15·11	4(B)	2	(Elective)	3	—	3	Fernstrom
15·25	Indust. Traf. Manage.	15·70	G(A)	1	(Elective)	3	—	5	Fernstrom
15·42	Corp. Fin. & Invest.	Ec53	4	2	XV	3	—	5	Armstrong
15·45	Fin. Adm. of Industry	Ec12, 15·50	G(A)	1	(Elective)	3	—	6	Armstrong
15·46	Fin. Adm. of Industry	15·42, 15·45	G(A)	2	(Elective)	3	—	6	Armstrong
15·50	Accounting	——	3	1	XV_2	5	—	4	Porter, Fiske
			3	2	XV_1				
15·51	Indust. Accounting	15·50	4(B)	1	XV	4	—	3	Porter, Fiske
				2	(Elective)				
15·52	Accounting	——	3	2	I, XIII-C	4	—	2	Porter, Fiske
			2	2	XIII-C				
			3	1	(Elective)				
15·55	Prob. in Account. Policy	15·50, *15·51*	G(A)	1	(Elective)	3	—	6	Fiske
15·56	Anal. of Business State.	15·55; 15·42 or 15·45	G(A)	2	(Elective)	3	—	6	Fiske
15·58	Control through Bus. Records	15·51, 15·71, 15·81	G(A)	2	(Elective)	3	—	5	Fiske
15·61T	Law of Contracts	Ec40	G	1	XIII-A	3	—	6	Schaefer
			3(B)	1	XIII-C, XV				
15·62T	Law of the Market	15·61T	4(B)	2	(Elective)	3	—	6	Schaefer
15·63	Business Law & Org.	Ec11	G(B)	2	VI-A(A)	3	—	5	Fernstrom
			4	2	VI-A(B)				
15·64	Law of Business Org.	15·61T	4(B)	2	(Elective)	3	—	6	Schaefer
15·70T	Production	Ec12, *15·81*	3	2	XV	3	—	6	Fernstrom
15·71	Production	15·70	4(B)	1	XV	3	—	3	Schell
15·73	Management Lab.	15·11; 15·70 or 2·731	4	1 or 2	(Elective)	4	—	2	Fernstrom
15·75	Manufact. Analysis	15·70	G(A)	1	(Elective)	3	—	5	Schell
15·81T	Marketing	Ec12, Ec31	3	1	XV_1	3	—	6	Elder
			3	2	XV_2				
15·82T	Sales Management	15·81T	4(B)	2	(Elective)	3	—	6	Elder
15·83	Marketing Research	15·81	4(B)	1	(Elective)	3	—	6	Elder
15·85	Indust. Marketing	15·81	G(A)	1	(Elective)	3	—	5	Elder
15·86	Marketing of Consumer Goods	15·81	G(A)	2	(Elective)	3	—	5	Elder
15·88	Advertising	15·81	G(A)	2	(Elective)	2	—	6	H. Bugbee
15·92	Industrial Problems	15·51, 15·61, 15·71, 15·81T	4(B)	2	XV	2	—	4	Schell
15·97	Stand. Meas. in Indust. Man.	15·51, 15·71, 15·81T	G(A)	1	(Elective)	3	—	5	Raymond
15·98	The Business Audit	15·51, 15.71, 15.81T	G(A)	2	(Elective)	3	—	5	Raymond
	Thesis	——	4	1	XV	0	3	0	Raymond
			4	2	XV	0	6	0	Raymond
	Graduate Thesis	——	G(A)	-	XV				

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	1	XVI	4	2	4	Rauscher
			4(B)	1	(Elective)				
16·02	Intro. to Aero. Mech.	16·01	3	2	XVI	4	2	4	Rauscher
			4(B)	2	(Elective)				
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
16·25	Adv. Aircraft Struct.	16·17, 16·21	G(A)	2	(Elective)	3	—	6	Newell
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
16·52	Aircraft Prop. Design	16·11	G(A)	2	(Elective)	2	2	4	Ober
16·55T	Aero. & Meteor. Insts.	8·04, M22	G(A)	1	(Elective)	3	—	6	Draper
16·56T	Aeronautical Insts.	16·55	G(A)	2	(Elective)	3	—	6	Draper
16·57T	Aero. & Meteor. Inst. Lab.	M22, 8·04, *16·55T*	G(A)	1	(Elective)	0	2	4	Draper
16·58	Meteorological Insts.	16·901	G(B)	2	(Elective)	4	—	4	Draper
16·59	Sp. Prob. in Aero. & Meteorological. Insts.	16·57, 16·56T or 16·58	G(A)	2	(Elective)		★		Draper
16·60	Adv. Aeron. Prob.	16·11 or 16·25 or 16·31 or 16·63	G(A)	1 or 2	(Elective)		★		R. H. Smith
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
16·901	Int. Meteorology	M22	4(B)	1	(Elective)	2	—	2	Willett
16·911	Synoptic Meteorology	8·04, L12, *16·901*, *16·921*	G(A)	1	(Elective)	2	—	4	Willett
16·912	Synoptic. Meteorology	16·911, *16·922*	G(A)	2	(Elective)	2	—	4	Willett
16·921	Meteorological Lab.	16·901, *16·911*	G(A)	1	(Elective)	0	10	0	Willett
16·922	Meteorological Lab.	16·921, *16·912*	G(A)	2	(Elective)	0	8	0	Willett
16·931	Dyn. Meteorology	16·912, 16·922, 8·462, 8·50, *M36*	G(A)	1	(Elective)	5	—	10	Rossby
16·932	Dyn. Meteorology	16·931	G(A)	2	(Elective)	5	—	10	Rossby
16·941	Meteorol. Seminar	*16·931*	G(A)	1	(Elective)	2	—	4	Rossby
16·942	Meteorol. Seminar	16·941, *16·932*	G(A)	2	(Elective)	2	—	4	Rossby
16·961	Phys. Oceanography	8·04	G(A)	1	(Elective)	2	—	4	Rossby
16·962	Phys. Oceanography	16·961	G(A)	2	(Elective)	2	—	4	Rossby

★ Time specially arranged.

BUILDING ENGINEERING AND CONSTRUCTION—17·00–17·99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
17·20	Building Forms and Details	——	2	2	XVII	2	—	2	Voss
17·21	Building Construction	D12	2	1	XVII	3	2	1	R. F. Tucker
17·22	Building Construction	17·21	2	2	XVII	3	1	1	R. F. Tucker
17·31	Building Construction	17·22	3	1	XVII	4	2	2	R. F. Tucker
17·32	Building Construction	17·31	3	2	XVII	4	2	2	R. F. Tucker
17·41	Building Construction	17·32	4	1	XVII	4	2	2	R. F. Tucker
17·42	Building Construction	17·41	4	2	XVII	4	2	2	R. F. Tucker
17·46	Building Construction	——	4	2	$III_{1,2}$	3	—	3	R. F. Tucker
17·50	Job Management	——	4	2	IV-A, XVII	2	—	0	R. F. Tucker
17·51	Structural Analysis	2·01	3	1	XVII	3	2	1	Voss
17·52	Structural Analysis	17·51, 2·04	3	2	XVII	3	2	1	Voss
17·53	Structural Analysis	17·52	4	1	XVII	3	2	1	Voss
17·54	Structural Analysis	17·53	4	2	XVII	3	2	1	Voss
17·73	Materials	——	2	2	XVII	2	—	1	Dietz
17·74	Materials	——	3	1	XVII	4	—	2	Voss

DRAWING

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
D11	Engineering Drawing	M2, M3	1	1	All courses except IV and IV-B	0	6	0	W. H. Lawrence
D12	Descriptive Geometry	D11	1	2	All courses except IV and IV-B	0	6	0	W. H. Lawrence

ECONOMICS AND SOCIAL SCIENCE—EC1–EC99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
Ec11	Political Economy	E12	2	1	VI, VI-A, XV	3	—	3	D. S. Tucker
			3	1	I, II, II-A, III, IV, IV-A, IV-B, V, VI-B, VII, VIII, IX-A, IX-B, X, XI, $XII_{1,2,4}$, XIII, XIII-C*, XIV, XVII, XVIII				
			4	1	XII_3, XVI				
Ec12	Political Economy	Ec11	2	2	XV	3	—	3	D. S. Tucker
			3	1	VI-A(B)				
			3	2	I, II, III, IV, IV-A, IV-B, V, VI, VI-B, VI-C, VII, VIII, IX-A, IX-B, X, XI, $XII_{1,2,4}$, XIII, XIII-C*, XIV, XVII, XVIII				
			4	1	VI-A(A)				
			4	2	XII_3, XVI				
			4	S	II-A				
Ec14	Current Economic Problems	Ec12	3(B)	2	XV	3	—	3	Ingraham
Ec15	Economic Principles	E12	4(B)	1	XIII-A	3	—	5	Armstrong
Ec17	Economic Theory	Ec12	G(A)	1	(Elective)	3	—	6	Ingraham
Ec18	Math. Approach to Economics	Ec12	G(A)	2	(Elective)	3	—	6	H. A. Freeman
Ec28	Business Cycles	Ec12	G(A)	2	(Elective)	3	—	6	Ingraham
Ec31	Statistics	M12	2	1	XV_1	2	—	4	H. A. Freeman
			2	2	XV_2				
Ec37	Advanced Economic Statistics	Ec31	G(A)	1	(Elective)	3	—	6	H. A. Freeman

* Not 1936–37.

Economics and Social Science Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec.	Lab. Draw.	Prep.	Instructor in Charge
Ec38	Statistical Methods for Quality Control	Ec31, M21	G(A)	2	(Elective)	3	—	6	H. A. Freeman
Ec40	Money & Banking	Ec11	2	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, 15·42 or 15·45	G(A)	2	(Elective)	3	—	6	D. S. Tucker
Ec53	Corporations	Ec12	4	1	XIII-C, XV	3	—	4	Armstrong
Ec56	Economics of Transportation	Ec12	4(B).	2	(Elective)	2	—	4	H. A. Freeman
Ec57	Pub. Utilities: Org. & Finance	Ec12	G(A)	1	(Elective)	3	—	6	Armstrong
Ec58	Pub. Utilities: Rates & Regulation	Ec57	G(A)	2	(Elective)	3	—	6	Armstrong
Ec59	Internat. Economic Relations	Ec12	G(A)	1	(Elective)	3	—	6	R. E. Freeman
Ec60	Labor Relations	Ec12	4(B).	2	XIII-A, XV	4	—	4	Fairley
Ec67	Labor Economics	Ec12	G(A)	1	(Elective)	3	—	6	Ingraham
Ec68	Labor Org. & Industry	Ec67 or Ec60	G(A)	2	(Elective)	3	—	6	Fairley
Ec72	American Government	Ec12	3	2	(Elective)	3	—	6	Schaefer
Ec78	Gov't Control of Industry	Ec12	G(A)	2	(Elective)	3	—	6	Thresher
Ec82	Prin. of Sociology	Ec12	3, 4(B).	1, 2	(Elective)	3	—	3	Burdell
Ec83	Soc. Econ. Factors in City Planning	Ec12	5(B).	1	IV-B	2	—	3	Burdell
Ec84	Soc. Econ. Factors in City Planning	Ec83	5(B).	2	IV-B	2	—	3	Burdell
Ec85	Plan. & Housing Legislation	Ec82	G(A)	1	(Elective)	2	—	3	Burdell
Ec86	Methods of Soc. Invest.	Ec12	4(B).	2	IV-B	2	—	3	Burdell

ENGLISH AND HISTORY—E1–E99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec.	Lab. Draw.	Prep.	Instructor in Charge
E1	English (Entrance)	—	—	S	—	2	—	5	Watson
E11	English Composition	—	1	1	All courses	3	—	5	Fassett
E12	English Composition	E11	1	2	All courses	3	—	5	Fassett
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	IV-A, XV	2	—	4	Bartlett
E41	Problem Analysis	—	3	1	IV, IV-B	2	—	2	D. M. Fuller
E42	Problem Analysis	—	3	2	IV, IV-B	2	—	2	T. Smith

GENERAL STUDIES—G1–G99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec.	Lab. Draw.	Prep.	Instructor in Charge
G1	History of Science	—	—	1	—	3	—	3	Woodbury
G2	History of Science	—	—	2	—	3	—	3	Woodbury
G4	History of Engineering	—	—	1	—	2	—	2	Woodbury
G5	Prin. of Psychology	—	—	1	—	2	—	2	Sanford
G6	Social Psychology	—	—	2	—	3	—	3	Sanford
G10	Dev. of Transportation	—	—	2	—	2	—	2	Breed
G11	Soc. & Ind. Hist. Mod. Europe	—	—	1	—	3	—	3	Roberts
G12	Soc. & Ind. Hist. U. S.	—	—	2	—	3	—	3	Bridenbaugh
G13	Social Institutions	—	—	1	—	2	—	2	Burdell
G14	Contemp. Soc. Problems	—	—	2	—	3	—	3	Burdell
G15	Comp. Political Instit.	—	—	1	—	3	—	3	Schaefer
G17	Design Manuf. Products	—	—	1	—	3	—	3	Müller
G31	Humanics	—	—	1	—	3	—	3	Magoun
G32	Humanics	—	—	2	—	3	—	3	Magoun
G41	Contemp. English Lit.	—	—	1	—	3	—	3	Rogers

General Studies Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
G42	Contemp. European Lit.	—	—	2	—	3	—	3	Rogers
G43	American Literature	—	—	2	—	2	—	2	Eaton
G44	Philosophic Dramas of Lit.	—	—	1	—	3	—	3	Rogers
G45	The Bible as Literature	—	—	2	—	3	—	3	Rogers
G48	Introduction to Music	—	—	2	—	2	—	2	Fuller
G49	Literature & Fine Arts	—	—	1	—	2	—	2	Greene
G50	Fine Arts	—	3	2	IV-A	2	—	2	H. L. Seaver
G51	Biography in Science	—	4	2	VI, VI-B, VI-C, VI-A(B)	3	—	3	Pearson
			3	2	VI-A(A)				
G52	Advanced Composition	—	—	1	—	2	—	2	Fassett
G53	Advanced Composition	—	—	2	—	3	—	3	Fassett
G57	Exp. of Graphic Art	—	—	1	—	2	—	2	Chamberlain
G58	Shakespeare	—	—	2	—	3	—	3	Rogers
G59	Prob. of Modern Philos.	—	—	1	—	2	—	2	A. T. Robinson
G60	Geology	—	—	1	—	3	—	3	Shimer
G63	Economic Geography	—	2, 3	2	XIII-C	3	—	3	Prescott
G64	Organic Evolution	—	3	2	IX-A	2	—	2	Shimer
G651	General Science	—	4	1	IV	2	—	2	F. K. Morris
G652	General Science	—	4	2	IV	2	—	2	F. K. Morris
G66	Descriptive Astronomy	—	—	2	—	2	—	2	Goodwin
G74	Prin. San. Sci. & Pub. Health	—	4	2	IV-B	2	—	2	Horwood
G75	Biological Reproduction	—	—	2	—	2	—	2	Bunker
G76	History of Philosophy	—	—	2	—	2	—	2	Wiener
G831	French Literature	—	—	1	—	2	—	2	Langley
G832	French Literature	—	—	2	—	2	—	2	Langley
G931	German Literature	—	—	1	—	2	—	2	Currier
G932	German Literature	—	—	2	—	2	—	2	Currier
G951	Dante in English	—	—	1	—	2	—	2	Langley
G952	Dante in English	—	—	2	—	2	—	2	Langley

MODERN LANGUAGES—L1–L99

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
L31	German, Adv.	L22, or Int. Entrance German	—	1	(Elective)	3	—	5	Kurrelmeyer
L32	German, Adv.	L31	—	2	(Elective)	3	—	5	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
L63	French, Adv.	L62 or Int. Entrance French	1	1	IV, IV-B	3	—	5	Langley
L64	French, Adv.	L63	1	2	IV, IV-B	3	—	5	Langley
L65	French, Adv.	L64	2	1	IV, IV-B	2	—	3	Langley
L66	French, Adv.	L65	2	2	IV, IV-B	2	—	3	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 and IV-B	3	—	6	R. D. Douglass
M111	Calculus	M1, M3, M4	1	1	IV, IV-B	3	—	6	Gelotte
M12	Calculus	M11	1	2	All courses except IV and IV-B	3	—	6	R. D. Douglass
M21	Calculus	M12	2	1	All courses except IV and IV-B	3	—	6	Rutledge
M22	Diff. Equations	M21	2	2	All except $III_{1,2}$, IV, IV-B, $VII_{1,2}$, X, XII_1, XIII-C, XV_2	3	—	6	Zeldin
M23	Algebra & Geometry	M12	2	1	XVIII	3	—	6	Struik
			3	1	XII_2				
M24	Algebra & Geometry	M12	2	2	XVIII	3	—	6	Struik
			3	2	XII_3				
M31	Diff. Equations	M22	3	1	VI, VI-C, VI-A(B)	2	—	4	Franklin
			3	2	VI-A(A)				
M331	Math. Theory of Statistics	M22	4(B)	1	(Elective)	3	—	6	Wadsworth
M332	Math. Theory of Statistics	M331	4(B)	2	(Elective)	3	—	6	Wadsworth
M36	Calculus, Adv.	M22	G(A)	1	(Elective)	3	—	6	R. D. Douglass
			3	1	XIII-A				
M37	Calculus, Adv.	M36	G(A)	2	(Elective)	3	—	6	R. D. Douglass
			3	2	XIII-A				
M381	Calculus, Adv.	M22	G(A)	1	(Elective)	3	—	6	Cameron
M382	Calculus, Adv.	M381	G(A)	2	(Elective)	3	—	6	Cameron
M41	Diff. Equations	M21	4	1	X	3	—	6	Hitchcock
			G	1	Chem. War.				
M441	Projective Geometry	M22	4(B)	1	XVIII	3	—	6	Struik
M442	Elem. Diff. Geometry	M441	4(B)	2	XVIII	3	—	6	Struik
M451	Fourier's Series & Integrals	M22	G(A)	1	(Elective)	3	—	9	Wiener
M452	Fourier's Series & Integrals	M451	G(A)	2	(Elective)	3	—	9	Wiener
M461	Theory of Numbers	M22	G(A)	1	(Elective)	3	—	9	Hopf
M462	Theory of Numbers	M461	G(A)	2	(Elective)	3	—	9	Hopf
M54	Mathematical Lab.	M22	4(B)	2	(Elective)	3	—	6	R. D. 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	Funct. of Complex Variable	M22	G(A)	1	(Elective)	3	—	9	Rutledge
M562	Funct. of Complex Variable	M561	G(A)	2	(Elective)	3	—	9	Rutledge
M563	Funct. of Complex Variable	M22	G(A)	S	(Elective)	3	—	6	Franklin
M571	Diff. Equations	M22	G(A)	1	(Elective)	3	—	9	J. Douglas
M572	Diff. Equations	M571	G(A)	2	(Elective)	3	—	9	J. Douglas
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	3	—	6	Hitchcock
M641	Adv. Diff. Geometry	M631	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	Potential Theory	M22	G(A)	1	(Elective)	3	—	9	Hopf
M672	Potential Theory	M671	G(A)	2	(Elective)	3	—	9	Hopf
M681	Calculus of Variations	M22	G(A)	1	(Elective)	3	—	9	J. Douglas
M682	Calculus of Variations	M681	G(A)	2	(Elective)	3	—	9	J. Douglas
M691	Characteristic Value Prob.	M22	G(A)	1	(Elective)	3	—	9	Hopf

Mathematics Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
M692	Characteristic Value Prob.	M691	G(A)	2	(Elective)	3	—	9	Hopf
M73	Review of Mathematics	——	3	S	XIII-A	20	—	0	R. D. Douglass
M731	Mechanics	M22	3(B).	1	XVIII	3	—	6	Crout
			4(B).	1	XIII-A				
M732	Mechanics	M731	3(B).	2	XVIII	3	—	6	Crout
			4(B).	2	XIII-A				
M75	Mathematics	——	G.	S	II (A.O.)	4	—	6	Wadsworth
M76	Th. of Probability	M21	G(A)	2	(Elective)	3	—	9	Struik
M77	Vector Analysis	M22	3(B).	1	XII_4, XVIII	3	—	6	Hitchcock
			3(B).	2	$VIII_1$				
M791	Th. & App. Elasticity	M22	G(A)	1	(Elective)	3	—	9	Crout
M792	Th. & App. Elasticity	M791	G(A)	2	(Elective)	3	—	9	Crout
M831	Analysis	M22	3(B).	1	XII_4, XVIII	3	—	6	Franklin
M832	Analysis	M831	3(B).	2	XII_4, XVIII	3	—	6	Franklin
M841	Analysis	M832	4(B).	1	XVIII	3	—	6	Franklin
M842	Analysis	M841	4(B).	2	XVIII	3	—	6	Franklin
M90	Math. Reading	——	G(A)	1 & 2	(Elective)		★		Phillips

★ Time specially arranged.

MILITARY SCIENCE—MS1–MS99

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
MS11	Military Science	——	1	1	All courses	0	3	0	Johnston
MS12	Military Science	——	1	2	All courses	0	3	0	Johnston
MS21	Military Science	——	2	1	All courses	3	—	0	Hyde
MS221	Coast Artillery	——	2	2	All courses	3	—	0	Ruddell
MS222	Engineer Corps	——	2	2	I, II, III, IV-A, VI, VI-A, VII_3, IX-B, XI, XV_1a, $_1b$, XVI, XVII	3	—	0	Bridges
MS223	Signal Corps	——	2	2	VI, VI-A, VI-B, VI-C, VIII, IX-B, XIV, XV_1b, XVI	3	—	0	Lawton
MS224	Ordnance Dept.	——	2	2	$II_{1, 2, 3, 5}$, $III_{3, 4}$, V, VIII, X, XIV, XV_1b, XV_2, XVI	3	—	0	Nisley
MS226	Chemical Warfare Ser.	——	2	2	V, VII, X, XIV, XV_2	3	—	0	Johnston
MS31	Military Science, Adv.	——	3	1	All courses	0	1	0	Nisley
MS311	Coast Artillery, Adv.	A basic course	3	1	All courses	2	1	2	Fisken
MS312	Engineer Corps, Adv.	A basic course	3	1	I, II, III, IV-A, VI, VI-A, VII_3, IX-B, XI, XV_1a, $_1b$, XVI, XVII	2	—	2	Bridges
MS313	Signal Corps, Adv.	A basic course	3	1	VI, VI-A, VI-B, VI-C, VIII, IX-B, XIV, XV_1b, XV_1c, XVI	2	1	2	Lawton
MS314	Ordnance Dept., Adv.	A basic course	3	1	$II_{1, 2, 3, 5}$, $III_{3, 4}$, V, VIII, X, XIV, XV_1b, XV_2, XVI	1	—	1	Nisley
MS316	Chemical Warfare Ser.	A basic course	3	1	V, VII, X, XIV, XV_2	2	—	2	Johnston
MS32	Military Science, Adv.	——	3	1	All courses	0	1	0	Nisley
MS321	Coast Artillery, Adv.	A basic course	3	2	All courses	2	1	2	Fisken
MS322	Engineer Corps, Adv.	A basic course	3	2	I, II, III, IV-A, VI, VI-A, VII_3, IX-B, XI, XV_1a, $_1b$, XVI, XVII	2	—	2	Hyde
MS323	Signal Corps, Adv.	——	3	2	VI, VI-A, VI-B, VI-C, VIII, IX-B, XIV, XV_1b, XV_1c, XVI	2	1	2	Lawton
MS324	Ordnance Dept., Adv.	A basic course	3	2	$II_{1, 2, 3, 5}$, $III_{3, 4}$, V, VIII, X, XIV, XV_1b, XV_2, XVI	1	—	1	Nisley

Military Science and Tactics Continued

No.	Subject	Prerequisite	Year	Term	Taken by	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
MS326	Chemical Warfare Adv.	Ser. A basic course	3	2	V, VII, X, XIV, XV_2	2	—	2	Johnston
MS41	Military Science, Adv.	MS31	4	1	All courses	0	1	0	Johnston
MS411	Coast Artillery, Adv.	——	4	1	All courses	2	—	1	Ruddell
MS412	Engineer Corps, Adv.	——	4	1	I, II, III, IV-A, VI, VI-A, VII_3, IX-B, XI, XV_1a, $_1b$, XVI, XVII	1	—	1	Hyde
MS413	Signal Corps, Adv.	——	4	1	VI, VI-A, VI-B, VI-C, VII, IX-B, XIV, XV_1b, XV_1c, XVI	1	—	1	Lawton
MS414	Ordnance Dept., Adv.	——	4	1	$II_{1, 2, 3, 5}$, $III_{3, 4}$, V, VIII, X, XIV, XV_1b, XV_2, XVI	1	—	1	Nisley
MS416	Chemical Warfare Adv.	Ser. ——	4	1	V, VII, X, XIV, XV_2	2	—	2	Johnston
MS42	Military Science, Adv.	MS31, MS32	4	2	All courses	0	1	0	Johnston
MS421	Coast Artillery, Adv.	——	4	2	All courses	2	—	1	Ruddell
MS422	Engineer Corps, Adv.	——	4	2	I, II, III, IV-A, VI, VI-A, VII_3, IX-B, XI, XV_1a, $_1b$, XVI, XVII	1	—	1	Hyde
MS424	Ordnance Dept., Adv.	——	4	2	$II_{1, 2, 3, 5}$, $III_{3, 4}$, V, VIII, X, X-B, XIV, XV_1b, XV_2, XVI	1	—	1	Nisley
MS98	Mil. Hist. & Policy U. S.	——	3, 4	1	All courses	2	—	0	Vestal

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

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 1,500 men have borrowed more than $900,000 from the Technology Loan Fund; that, during 1936–37, $85,000 and $91,000 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 an applicant may not exceed $1,500 during his undergraduate period, or $2,000 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 coverage 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 150 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 July 1 of the year in which they plan to enter, and who have satisfied all entrance requirements not later than August 1.

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, Cleveland, Denver, District of Columbia, Kansas City, New York, Philadelphia, Pittsburgh, St. Louis, and Schenectady. These are open to American citizens of good character and health whose standing in their preparatory school studies has been high and who have satisfied with high standing all entrance requirements.

ARMY AND NAVY (1930). Sons of regular Army, Navy, and Marine Corps Officers, who are admitted as undergraduate students to the Institute, will pay half the regular tuition, $250, upon the recommendation of the Faculty Committee on Undergraduate Scholarships, the total number not to exceed ten each year. Preference will be given to qualified applicants admitted to the first-year class. Applications should be addressed to the Office of the Dean of Students and should be accompanied by documentary evidence that the applicant's father is a commissioned officer in the regular Army, Navy, or Marine Corps. 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, recommended by the Superintendent of Schools, to whom application must be made not later than June 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 a Bridgeport Scholarship until he has fulfilled all entrance requirements of the Institute.

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."

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 Head Master, or Principal, of the applicant's school, and such application must be filed with the Head Master, or Principal, not later than June 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.

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 June 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 June 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.

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.

NEW ENGLAND C. M. T. C. (1931). Established by the Institute and carrying a stipend of full tuition for the freshman year. It is awarded to a member of one of the Citizens' Military Training Camps of the First Corps Area, United States Army, selected from the "Whites" or the "Blues," based upon the reports and records transmitted to the Headquarters of the First Corps Area. Application must be made to the Commanding General of the First Corps Area not later than August 1 of the year in which the applicant plans to enter the Institute. The applicant must furnish evidence to the Commanding General that he has not sufficient funds to defray all expenses at the Institute together with such other information as may be requested. Preference will be given to individuals who, at the time of making application, have fulfilled all entrance requirements of the Institute, with the further stipulation that no man will be eligible to receive the New England C. M. T. C. Scholarship until he has fulfilled all entrance requirements of the Institute.

VERMONT (1924). Gift of $6,000 (in 1928 increased to $8,000, and to $18,000 in 1935) 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 by the alumni of the State of Vermont to "some worthy student . . . preferably from Vermont, who shall meet regular scholastic and other requirements." Applications for this scholarship by entering fresh-

men should be addressed directly to Redfield Proctor, Proctor, Vermont.

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 and 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 13 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."

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."

FRED L. AND FLORENCE L. COBURN (1932). Bequest of $5,000 from Fred L. Coburn, the income of which "shall be expended by said Trustees in giving aid and assistance to students of M. I. T. . . . preference being given by said Trustees to students residing in Somerville, Massachusetts."

COFFIN MEMORIAL (1929). This gift from the executors of the estate of Charles A. Coffin—a bequest—carried out the wishes of Mr. Coffin. The fund is to be used for loans or other aid to students as determined by the Executive Committee.

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."

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. . . ."

JOHN ROACH (1936). Bequest of $6,000 from Emeline Roach, "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.

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."

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."

JONATHAN WHITNEY (1912). Bequest of Mrs. Francis B. Greene, "to assist poor and deserving young men and women obtaining an education at M. I. T."

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 from persons personally acquainted with his academic work, are also 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 ($500). 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.

Applications 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.

TEACHING FELLOWS AND ASSISTANTS

Graduate students desiring appointments as Teaching Fellows or Assistants, with the intention of pursuing at the same time graduate work leading to a higher degree, should apply directly to the Head of the Department which they wish to enter. All staff appointments of this kind are made upon recommendation of the Head of the Department. Staff members may apply, however, in the usual way for scholarship grants to defray their tuition, and such applications, if endorsed by departmental committees, usually receive favorable consideration by the Committee on the Graduate School to the extent that scholarship funds are available. For this reason it is important that applications be filed not later than March 1.

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 or general study.

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 grant 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.

FUNDS APPLICABLE TO FELLOWSHIPS AND GRADUATE SCHOLARSHIPS

AUSTIN (1899). Bequest of Edward Austin to assist meritorious students and teachers in payment for their studies. Approximately $18,000 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, $1,100.

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. Only in exceptional cases where a recipient has greatly distinguished himself is the award made for a second year to the same student. (Not available 1936–37.)

COLLAMORE (1916). Bequest of Helen Collamore to aid women students in graduate courses. Stipend, $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.

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, $200.

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 1936–37.)

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 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. Stipend, $1,000.

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 post-graduate or undergraduate. Stipend, $150.

HENRY SALTONSTALL (1901). Bequest of Henry Saltonstall to aid students, whether undergraduates or graduates, pursuing advanced courses. Stipend, $500.

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.

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, $500.

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 reserch in the field of Industrial Chemistry. Stipend, $500.

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, $500.

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, $22,000.

SPECIAL FELLOWSHIPS AND GRADUATE SCHOLARSHIPS

1936–37

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.

REDFIELD PROCTOR TRAVELING FELLOWSHIP. Gift of Redfield Proctor of the Class of 1902, for graduate study abroad in an English-speaking university, approved by the Dean of the Graduate School. Open to any graduate of the Institute, or in case there is no suitably qualified candidate among the graduates of the Institute, open to any graduate student who has been in residence for at least one year. Stipend, $1,500.

SLOAN FELLOWSHIP IN AUTOMOTIVE ENGINEERING. Gift of Alfred P. Sloan, Jr., of the Class of 1895 for Graduate Study and Research in the field of Automotive Engineering. Stipend, $1,000.

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; $3,500 available.

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 on the basis of written work in second-year English subjects.

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 paper 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.

STRATTON (1930). Established by the late President Samuel W. Stratton. Prizes of $50, $30, and $20 awarded for the best presentation of scientific papers by undergraduates, the final competition being held at a public meeting.

The following annual prizes are 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 $150 for the best design submitted by a present student of Harvard, Technology, or the Boston Architectural Club on one of the regular conjunctive programs.

BOSTON SOCIETY OF ARCHITECTS WEEK-END (1923). Gift of the Society. Prizes of $50 for week-end conjunctive problems with Harvard and the Boston Architectural Club.

CHAMBERLIN (1913). Gift of Boston Society of Architects. Prize of $25 to a student in the graduate class in Architecture.

F. W. CHANDLER (1914). Gift of Boston Society of Architects in memory of Professor Chandler. Five prizes of $10 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.

FREEHAND DRAWING (1920). Prize of $25 to the student whose work is judged to be the best in a competition at the end of the year.

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 members 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; two prizes of $25.

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

STUDENT HOUSING

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 (Graduate 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% 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 upon pledging. 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. Students whose names are placed on the waiting list for Dormitory accommodations should report to the Office of the Cashier, 10–180, on Registration Day for assignment to rooms released by transfer.

The Graduate House

Ware, Atkinson, Runkle, Holman, Nichols, and Crafts Halls—the Faculty Group—are reserved exclusively for Graduate Students. They have a capacity of 206 men.

The Crafts Library and Living Room are on the first floor of Crafts, and in Ware, the Macomber and Ware Rooms are similarly located. The Fabyan Dining Room, with a maximum capacity of sixteen guests, and the Ping Pong Room are 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 Faculty, who is familiar with the general aims and problems of graduate students, is resident house master and he, with the assistance of a student house committee, has supervision of the Graduate House.

The general social activities of the Graduate House include informal gatherings on Tuesday and Thursday evenings in the Buttery in Crafts, several Sunday afternoon teas during the academic year, and the Graduate House dinners, held on Wednesday evenings. A distinguished guest is invited to each of these dinners. Participation in all of these functions is urged for all residents of the Graduate House.

The separation of graduate and undergraduate students is based on the principle that the most natural, cultural development comes from social intercourse between men of different interests but of equivalent intellectual outlook and that their social effectiveness depends on these contacts.

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 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 cooperates 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 four dollars 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 re-

sponsible 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 inner spring mattress with cover, pillow, couch cover, blankets, chiffonier, desk and chair, study chair, bookcase, rug, draperies, desk lamp, wastebasket, and interconnecting telephone. All linen and towels are furnished, and regularly replaced, by porters who make up 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 the rental of space, it should be observed that the rental includes heat, light, continuous hot and cold water, intercommunicating telephone service, porter and chamber service, soap and towel supply, and laundry service for bed linen and towels.

Application for Rooms

Applications for the Graduate House should be made to Dr. A. A. Ashdown, House Master, and for the Undergraduate Houses, to D. L. Rhind, Bursar. The following single rooms are reserved for entering Freshmen: Bemis, 101, 105, 109, 113, 201, 205, 209, 213, 301, 305, 309, 313, 401, 405, 409, 413, 501, 505, 509, 513; Goodale, 103, 105, 109, 113, 203, 205, 209, 213, 303, 305, 309, 313, 403, 405, 409, 413, 503, 505, 509, 513; Walcott, 101, 112, 201, 206, 210, 212, 301, 306, 310, 312, 401, 406, 410, 412, 501, 506, 510, 512; Munroe, 202, 209, 212, 302, 309, 312, 402, 409, 412, 502, 509, 512; Hayden, 101, 105, 108, 112, 201, 205, 208, 212, 301, 305, 308, 312, 401, 405, 408, 412, 501, 505, 508, 512; Wood, 102, 108, 112, 202, 208, 212, 302, 308, 312, 402, 408, 412, 502, 508, 512.

Applications for double and triple suites must bear the signatures of the two or three men who desire to occupy them.

Allotment of Rooms

As far as possible, 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 Freshmen 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 successful applicants as soon as possible after March 15, and the leases, properly executed, must be returned to the Bursar, Room 10–180, within one month. Otherwise, the rooms will 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. During the summer terms 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 presented on pages 214 to 219.

Rentals for the academic year will be by formal lease bearing the signatures of applicants, as well as 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 four weeks of occupancy. The summer rates are, Graduate House $4.50 per man per week, except a few less desirable single rooms which rent at $3.50 per man per week. Undergraduate Houses $4.00 per man per week.

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.

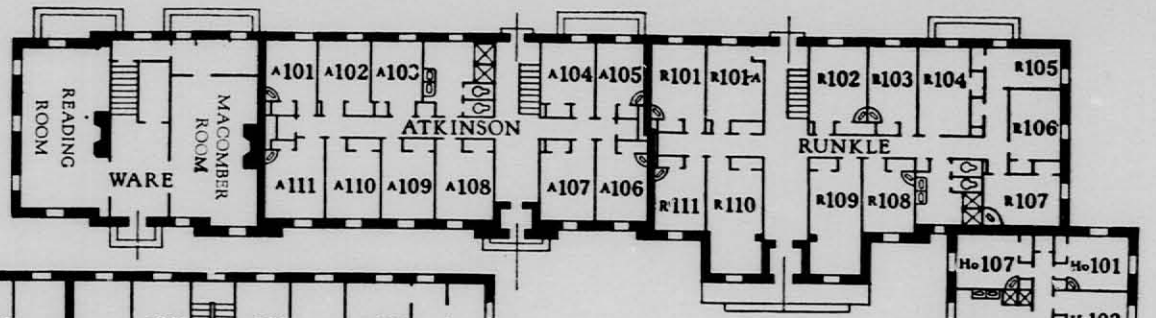
Other students who desire to move from the Dormitories and who do not contemplate leaving the Institute will be refunded a proportionate part of their payments, less $10, on condition that another student can be immediately secured to take over the remaining portion of the lease, and provided the application for release is filed prior to noon of the Wednesday following Registration Day of the first term.

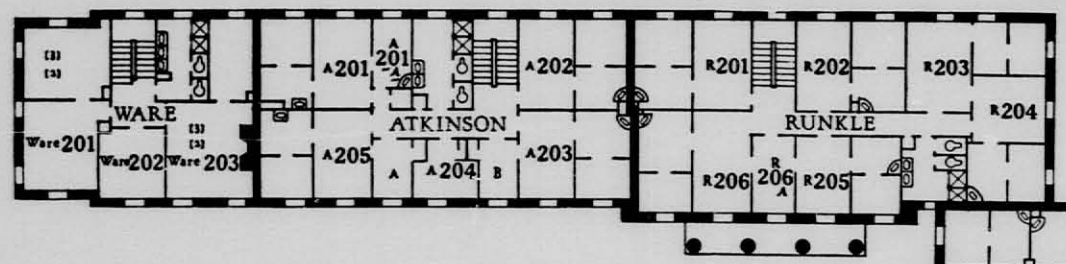
Students who apply for release, except as specified above, will be refunded a proportionate part of their payments, less $50, when and if another student can be secured to take over the remaining portion of the lease. This last arrangement can be made only with the consent of the Dormitory Board.

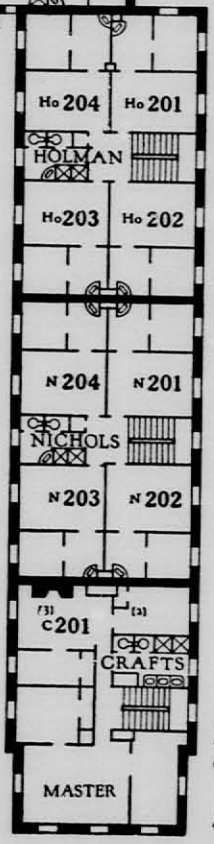
(*Continued on page 220*)

GRADUATE HOUSE

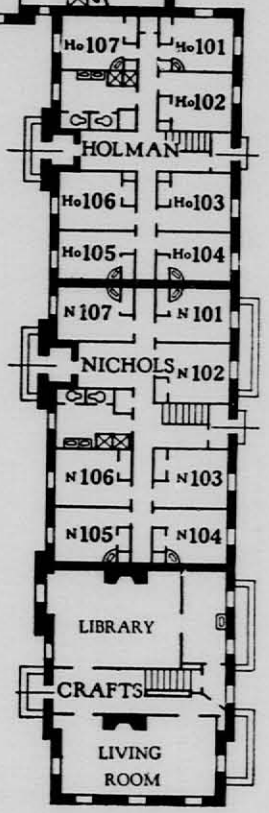
Reserved exclusively for Graduate Students







Second Floor



First Floor

HOLMAN, NICHOLS, AND CRAFTS
WARE, ATKINSON AND RUNKLE

(Faculty Group)

GRADUATE

A	101—$190	
	102— 180	
	103— 180	
	104— 180	
	105— 190	
	106— 200	
	107— 190	
	108— 190	
	109— 190	
	110— 190	
	111— 200	
R	101 —$200	
	101A— 190	
	102 — 200	
	103 — 200	
	104 — 190	
	105 — 160	
	106 — 160	
	107 — 175	
	108 — 200	
	109 — 230	
	110 — 230	
	111 — 200	
W	201 — 500 (2)	
	600 (3)	
	202 — 220	
	203 — 500 (2)	
	600 (3)	
A	201 —$360 (2)	
	201A— 140	
	202 — 360 (2)	
	203 — 400 (2)	
	204 — 165	
	204A— 150	
	204B— 150	
	205 — 400 (2)	
R	201 — 360 (2)	
	202 — 360 (2)	
	203 — 350 (2)	
	204 — 360 (2)	
	205 — 400 (2)	
	206 — 430 (2)	
	206A— 150	

GRADUATE

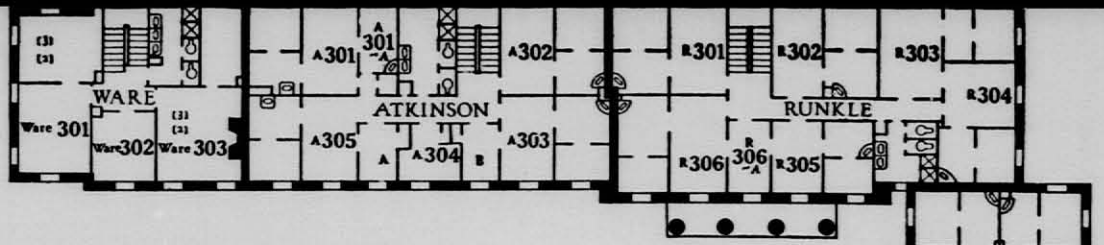
Ho	101—$190	
	102— 180	
	103— 180	
	104— 190	
	105— 200	
	106— 190	
	107— 200	
N	101— 190	
	102— 180	
	103— 180	
	104— 190	
	105— 200	
	106— 190	
	107— 200	
Ho	201— 360 (2)	
	202— 360 (2)	
	203— 400 (2)	
	204— 400 (2)	
N	201— 360 (2)	
	202— 360 (2)	
	203— 400 (2)	
	204— 400 (2)	
C	201— 500 (2)	
	600 (3)	

Double suites—if occupied by one man—deduct $100 from listed prices.

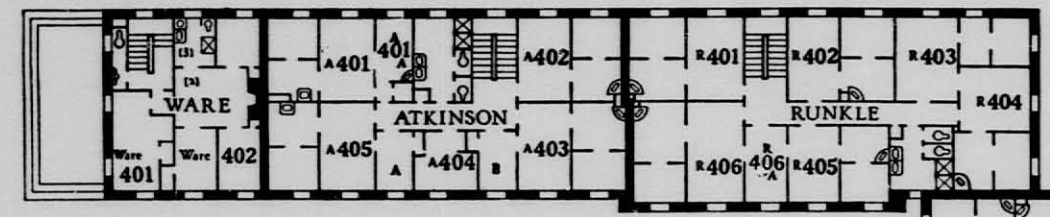
W301—$500 (2)
600 (3)
W302— 220
W303— 500 (2)
600 (3)

A301 —$360 (2)
301A— 140
302 — 360 (2)
303 — 400 (2)
304 — 165
304A— 150
304B— 150
305 — 400 (2)

R301 —$360 (2)
302 — 360 (2)
303 — 350 (2)
304 — 360 (2)
305 — 400 (2)
306 — 430 (2)
306A— 150



Fourth Floor

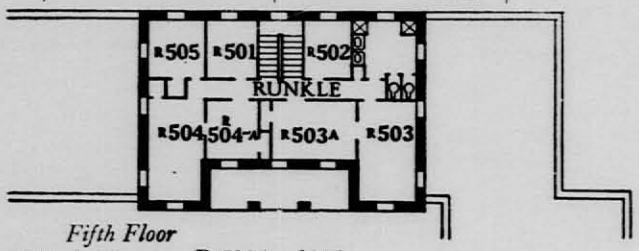


W 401—$250
402— 600 (2)
690 (3)
A 401— 360 (2)

A401A—$140
402 — 360 (2)
403 — 400 (2)
404 — 165
404A— 150

A404B—$150
405 — 400 (2)
R401 — 360 (2)
402 — 360 (2)
403 — 350 (2)

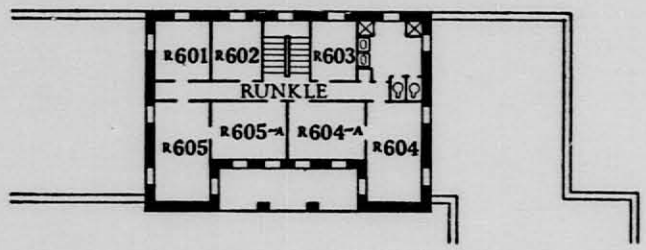
R404 —$360 (2)
405 — 400 (2)
406 — 430 (2)
406A— 150



Fifth Floor

R 501—$140
502— 135
503— 215

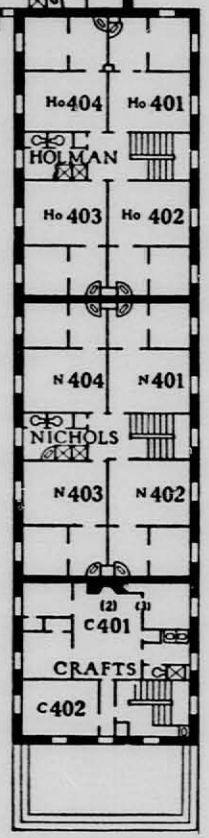
R 503A—$215
504 — 220
504A— 185
505 — 150



Sixth Floor

R 601—$140
602— 135
603— 130

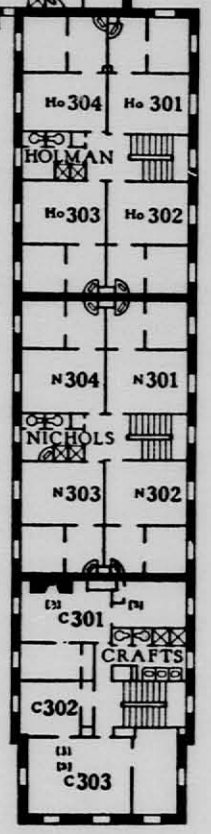
R 604 —$185
604A— 185
605 — 185
605A— 185



Fourth Floor

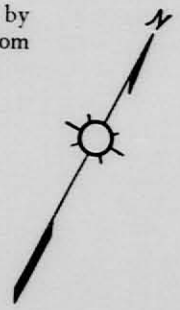
GRADUATE

Ho 301—$360 (2)
302— 360 (2)
303— 400 (2)
304— 400 (2)
N 301— 360 (2)
302— 360 (2)
303— 400 (2)
304— 400 (2)
C 301— 500 (2)
600 (3)
302— 230
303— 500 (2)
600 (3)
Ho 401— 360 (2)
402— 360 (2)
403— 400 (2)
404— 400 (2)
N 401— 360 (2)
402— 360 (2)
403— 400 (2)
404— 400 (2)
C 401— 600 (2)
690 (3)
402— 240



Third Floor

Double suites—if occupied by one man—deduct $100 from listed prices.



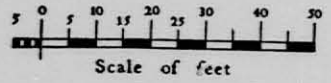
UNDERGRADUATES HOUSES

MUNROE, HAYDEN AND WOOD HALLS (Alumni Group)

Reserved for Undergraduates

MUNROE

201—$220	211—$225
202— 220	212— 225
203— 220	213— 225
204— 230	
205— 220	
206— 540 (2), 705 (3)	
207— 230	
208— 225	
209— 225	
210— 225	



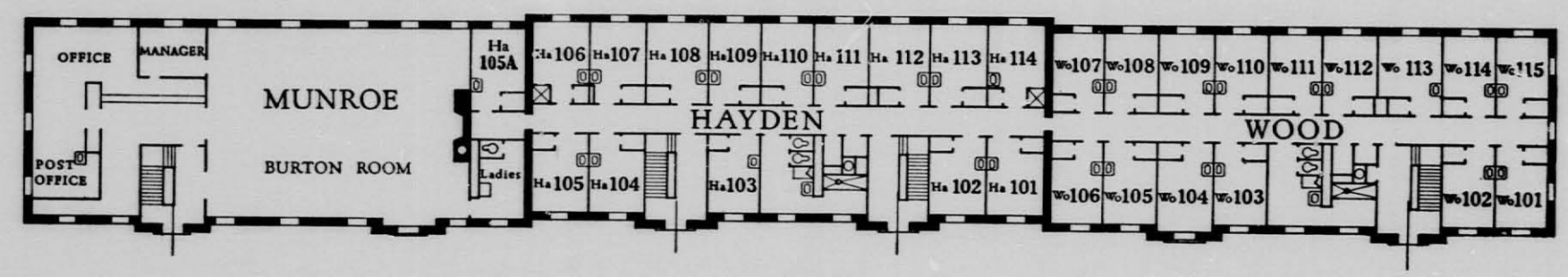
HAYDEN

101 —$210	201—$220
102 — 210	202— 220
103 — 210	203— 220
104 — 210	204— 220
105 — 210	205— 220
105A— 220	206— 230
106 — 220	207— 230
107 — 220	208— 230
108 — 220	209— 225
109 — 215	210— 225
110 — 215	211— 225
111 — 215	212— 230
112 — 220	213— 230
113 — 220	214— 230
114 — 220	

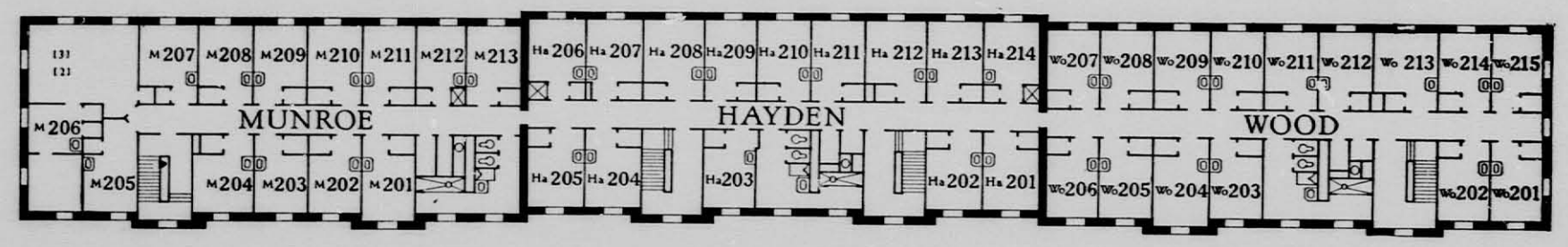
WOOD

101—$220	201—$230
102— 205	202— 215
103— 205	203— 215
104— 210	204— 215
105— 205	205— 215
106— 205	206— 215
107— 215	207— 225
108— 215	208— 225
109— 215	209— 225
110— 215	210— 225
111— 215	211— 225
112— 215	212— 225
113— 220	213— 230
114— 215	214— 225
115— 230	215— 240

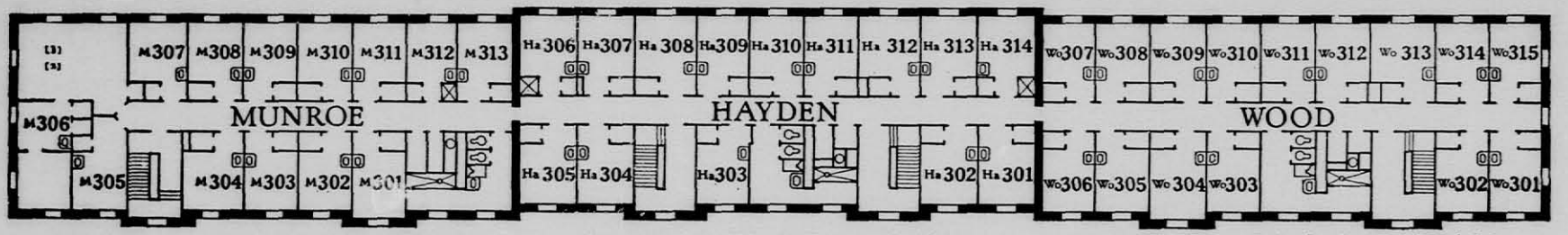
First Floor



Second Floor



Third Floor

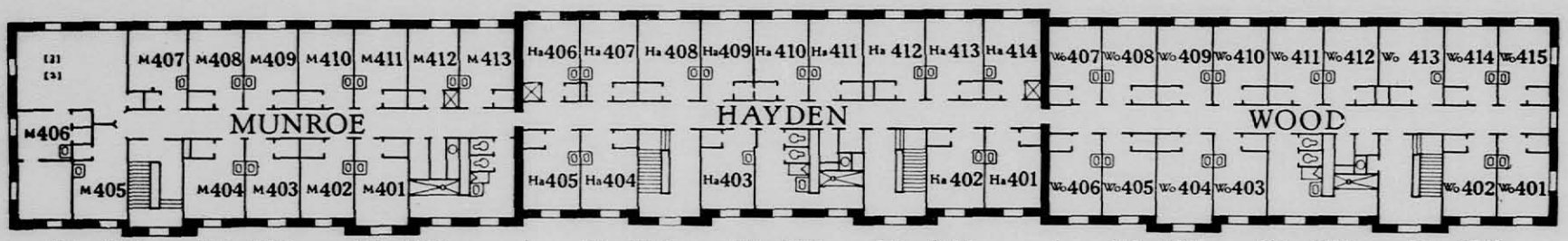


301—$215	308—$215	402—$205
302— 210	309— 215	403— 205
303— 210	310— 215	404— 215
304— 220	311— 215	405— 205
305— 210	312— 215	406— 500 (2)
		660 (3)
306— 520 (2)	313— 215	407— 215
690 (3)		
307— 220	401— 205	408— 210

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

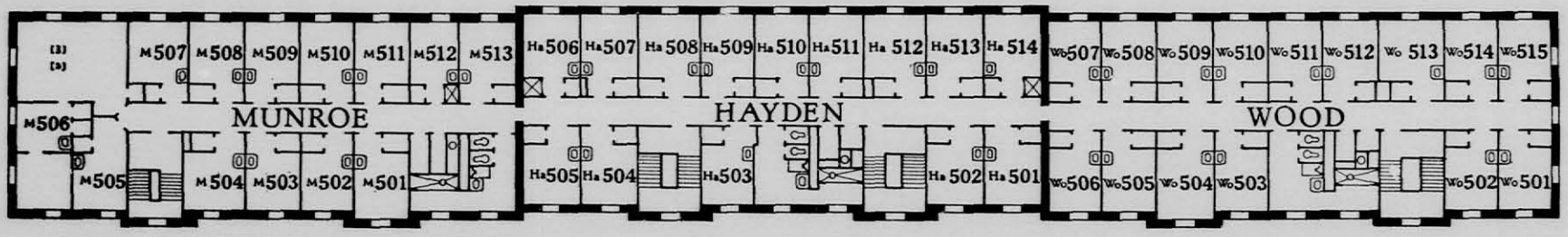


409—$210	504—$205	509—$200
410— 210	505— 195	510— 200
411— 210	506— 480 (2)	511— 200
412— 210	630 (3)	512— 200
413— 210	507— 205	513— 200
501— 195	508— 200	
502— 195		
503— 195		

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

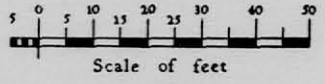
101—$215	201—$225
102— 205	202— 215
103— 205	203— 215
104— 215	204— 225
105— 205	205— 215
106— 205	206— 215
107— 215	207— 225
108— 225	208— 235
109— 215	209— 225
110— 215	210— 225
111— 225	211— 235
112— 215	212— 225
113— 215	213— 225
114— 225	214— 235

BEMIS

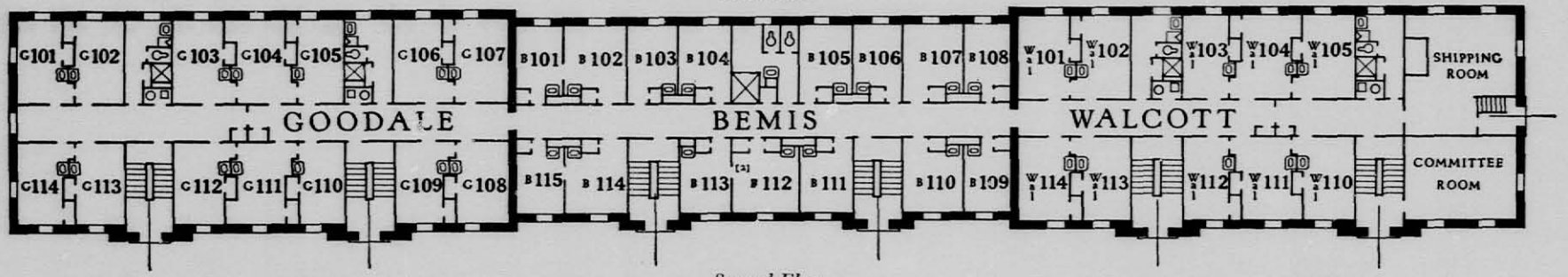
101—$175	201—$185
102— 200	202— 215
103— 175	203— 185
104— 175	204— 185
105— 175	205— 185
106— 175	206— 185
107— 200	207— 215
108— 175	208— 185
109— 185	209— 195
110— 210	210— 225
111— 185	211— 195
112— 270 (2)	212— 280 (2)
113— 185	213— 195
114— 210	214— 225
115— 185	215— 195

WALCOTT

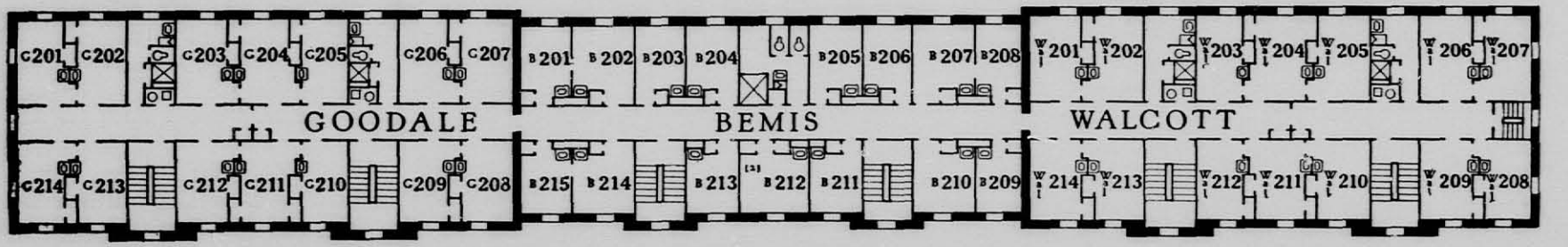
101—$215	201—$225
102— 205	202— 215
103— 205	203— 215
104— 215	204— 225
105— 205	205— 215
110— 215	206— 215
111— 225	207— 235
112— 215	208— 235
113— 215	209— 225
114— 225	210— 225
	211— 235
	212— 225
	213— 225
	214— 235



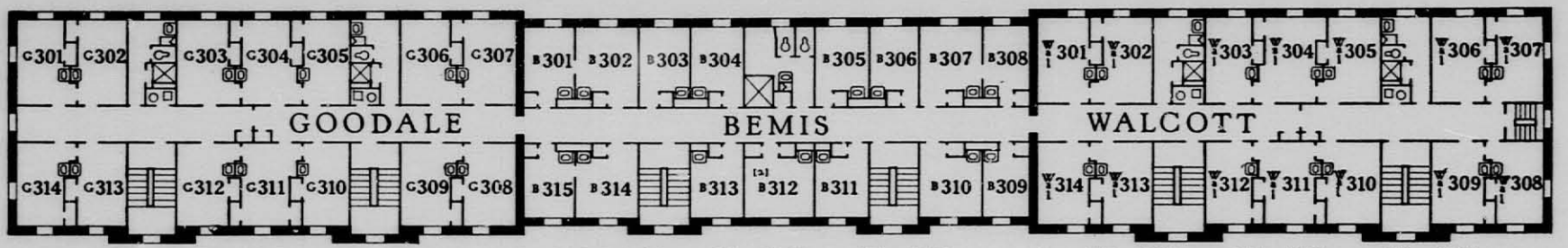
First Floor



Second Floor



Third Floor

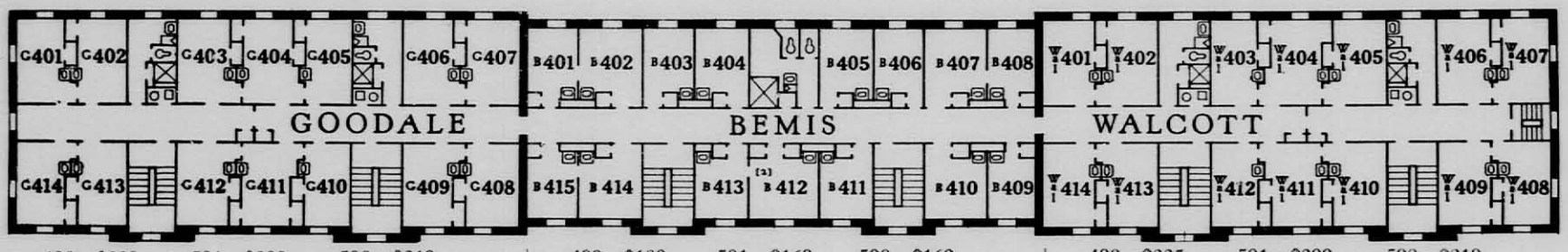


301—$215	308—$225	401—$210
302— 205	309— 215	402— 200
303— 205	310— 215	403— 200
304— 215	311— 225	404— 210
305— 205	312— 215	405— 200
306— 205	313— 215	406— 200
307— 215	314— 225	407— 210

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

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
307— 230	314— 225	407— 225

Fourth Floor

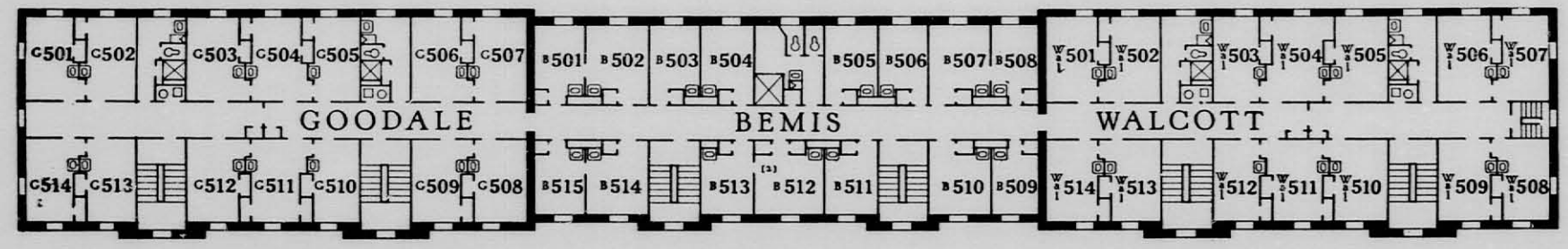


408—$220	501—$200	508—$210
409— 210	502— 190	509— 200
410— 210	503— 190	510— 200
411— 220	504— 200	511— 210
412— 210	505— 190	512— 200
413— 210	506— 190	513— 200
414— 220	507— 200	514— 210

409—$180	501—$160	508—$160
410— 205	502— 185	509— 170
411— 180	503— 160	510— 195
412— 260 (2)	504— 160	511— 170
413— 180	505— 160	512— 250 (2)
414— 205	506— 160	513— 170
415— 180	507— 185	514— 195
		515— 170

408—$225	501—$200	508—$210
409— 210	502— 190	509— 200
410— 210	503— 190	510— 200
411— 220	504— 200	511— 210
412— 210	505— 190	512— 200
413— 210	506— 190	513— 200
414— 220	507— 210	514— 210

Fifth Floor



(*Continued from page 213*)

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 either the Cashier's Office, 10–180 in the main educational group, or 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 for each man 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 fifteen other points near the entrances of the halls.

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 and Parking. Ample facilities for storage are provided in the basement of the halls without charge. Trunks are not permitted in the rooms. 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. Power and light are furnished directly from the Institute's power plant. 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.

ALPHABETICAL LIST OF SUBJECTS OF INSTRUCTION

(With reference to pages containing description)

Subjects	Page
Absorption and Extraction	154
Abstract Design	136
Accounting	161
Acoustics, Illumination and Color	150
Advertising	163
Aerial Surveying	120
Aerodynamics of Airplane Design	164
Aeromechanics	164
Aeronautical and Meteorological Instruments	164
Aeronautical and Meteorological Instrument Laboratory	165
Aeronautical Instruments	165
Aeronautical Laboratory	165
Aeronautical Problems	165
Aeronautical Seminar	165
Aeronautics	165
Air Conditioning, Advanced	127
Air Examination	148
Aircraft Production Methods	165
Aircraft Propeller Design	164
Aircraft Structures	164
Airplane Design Practice	164
Airplane Design Problems	164
Airplane Shop Work	165
Airship Structures	164
Airship Theory	164
Algebra	173
Algebra and Geometry	173
Algebra of Quantum Theory	174
Alternating Current Mach., Adv.	143
American Government	168
American Literature	172
Analysis	175
Analysis of Business Statements	161
Analytical Chemistry	138
Analytical Mechanics	174
Analytical Treatment of Chemical Engineering Processes	154
Applications of Electricity in Industry	141, 142
Applications of Metallography	134
Applications of Science to Prospecting	131
Applied Chemical Thermodynamics	155
Applied Chemistry	138, 153
Applied Colloid Chemistry	155
Applied Economic Geology	158
Applied Electrochemistry	134
Applied Hydromechanics	125
Applied Mechanics	124
Applied Nutrition	147
Applied Photoelasticity	124
Applied Spectroscopy	152
Architectural Design	137
Architectural History	136
Architectural Practice	136
Astronomy and Spherical Trigonometry	119
Atomic Structure	151
Atomic Structure Laboratory	151
Automatic Machinery	129
Automotive Engineering	129
Automotive Engine Design	129
Automotive Engine Problems	129
Automotive Engines	129
Automotive Fuels	156
Automotive Vehicles	129
Automotive Vehicle Design	129
Bacteriology	147, 148
Bible as Literature, The	172
Biochemistry	149
Biography in Science	172
Biological Reproduction	172
Biology	147
Biology of Food Supplies	147
Botany	147
Bridge Design	121
Building Construction	166
Building Forms and Details	166
Business Audit, The	163
Business Cycles	167
Business Law and Organization	162
Calculus	173
Calculus of Variations	174
Carbohydrates	139
Central Stations	141
Ceramics	135
Characteristic Value Problems	174
Chemical Engineering	153, 154
Chemical Engineering Design	155
Chemical Engineering Literature	153
Chemical Literature	140
Chemistry	138
Chemistry of Dyes	139
Chemistry of Foods	138
Chemistry of Heterocyclic Compounds	139
Chemistry of Water and Sewage	138
City Planning Administration	136
City Planning Design	136, 137
City Planning, History & Principles of	136
City Planning Research	136
City Planning Theory & Practice	136
Colloid Chemistry	155
Colloid Seminar	155
Colloquium, Undergraduate	150
Color, Composition, Theory and Application	135
Color Measurements	151
Communicable Diseases	148
Communications Laboratory	144
Communications Practice	146
Comparative Anatomy	147
Comparative Political Institutions	171
Composition, Advanced	172
Concrete Research	122
Construction	137
Construction Details of Aircraft	165
Contemporary English Literature	171
Contemporary European Literature	172
Contemporary Social Problems	171
Continuous Groups	174
Control Through Business Records	161
Corporation Finance and Investments	161
Corporations	168
Corrosion	155
Corrosion and Heat Resisting Alloys	134
Crystal Physics	151
Crystallography	157
Current Economic Problems	167
Dante in English	173
Descriptive Astronomy	172
Descriptive Geometry	167
Design in Manufactured Products	171
Design of Production Machinery	128
Design of Harbor Works	120
Design of Reinforced Concrete Structures	122
Development of Transportation	171
Diesel Engine Design	129
Diastrophism and Vulcanology	158
Differential Equations	173, 174
Differential Geometry	173, 174
Distillation	154
Distillation and Absorption	154
Drying	154
Dynamic Meteorology	165
Dynamic Strength of Metals	126
Dynamics	125
Dynamics of Aircraft Engines	125
Dynamics of Engines	124
Economic Balance	155
Economic Balance in Chemical Industry	155
Economic Geography	172
Economic Geology	158
Economic Geology Laboratory	158
Economic Geology of Fuels	158
Economic Geology of Non-Metallic Deposits	158
Economic Geology Seminar	158
Economics of Transportation	168
Economic Statistics, Adv.	167
Economic Theory	167
Economics of Mining	131
Economic Principles	167
Electric Furnaces	134
Electric Insulation and Its Behavior	142
Electric Machine Development	144
Electric Machinery Design	142
Electric Power Circuits	143
Electric Power Distribution	144
Electric Railways	141
Electrical Communications, Laboratory	142
Electrical Communications, Principles of	142, 144
Electrical Engineering, Elements of	142
Electrical Engineering Laboratory	145
Electrical Engineering, Principles of	141
Electrical Engineering Seminar	143
Electrical Equipment of Buildings	143
Electrical Measurements Lab.	145
Electrochemical Laboratory	134
Electrochemistry	134, 153
Electromagnetic Theory	152
Electromagnetic Wave Theory	152
Electronic Laboratory	151
Electronic Phenomena	151
Electronics	151
Engineering Chemistry	140
Engineering Construction	120
Engineering Drawing	167
Engineering Electronics	142, 144
Engineering Equipment	154
Engineering Laboratory	128
Engineering Thermodynamic	126
English Composition	169
Epidemiology	149
Essentials of Anatomy	147
Estimating and Management of Construction Operation	136
European Civilization and Art	136
Excitation of Spectra	152
Experimental Electronics	151
Experimental Physics	150
Experimental Research Problem	156
Explosives Plant Engineering	154
Expressions of Graphic Art	172
Ferromagnetism	134
Field Geology	157
Field Geology Methods	157
Financial Administration of Industry	161
Fine Arts	172
Fire Assaying	132
Flow of Fluids	154
Fluid Mechanics	125
Food Analysis	138
Food Engineering	127
Food Technology, Adv.	149
Forging	125
Foundations	121
Foundry Practice	125
Fourier's Series and Integrals	173
Freehand Drawing	135
Free Radicals and Organo-Metallic Compounds	139
French	177
French Literature	172
Fuel Engineering	155
Fuel Engineering Design	155
Fuel Engineering Laboratory	156
Fuel Engineering Practice	155
Functional Pathology	149
Functions of Complex Variable	174
Functions of a Real Variable	174
Fundamental Ceramic Processes	135
Furnace Design	155
General Science	172
Geodesy	119, 120
Geological Climates Seminar	158
Geological Surveying	157
Geology	157, 172
Geology of Coal and Petroleum	158
Geology of Materials	158
Geology of North America	158
Geology of Petroleum	158
Geomorphology	157
German	176, 177
German Literature	173
Glass Blowing	135
Gold and Silver Metallurgy, Adv.	133
Government Control of Industry	168
Graphics	135
Graphic Statics	121
Health Education	149
Health Hazards in Special Industries	149
Heat and Thermodynamics	152
Heat Engineering	126
Heat Engineering in Industrial Plants	127
Heat Measurements	126, 127
Heat Transmission	154
Heat Transmission, Advanced	126
Heat Treatment	134
Heating and Ventilation Design	128
Heating, Ventilation and Air Conditioning	127
High Pressure Processes	155
Highway Design	120
Highway Transportation Adv.	120
Histology, Adv.	147
Historical Development of Physics	152
History of Chemistry	140
History of Engineering	171
History of Philosophy	172
History of Science	171
Humanics	171
Hydraulic and Sanitary Design	123
Hydraulic and Sanitary Engineering	122
Hydraulic Laboratory	128
Hydraulics	122
Hydrodynamics and its Application to Aeronautics	164
Hydromechanics	125
Identification of Organic Compounds	139
Illuminating Engineering, Principles	142, 144
Index Fossils	158
Industrial Accounting	161
Industrial Chemical Engineering	154
Industrial Chemical Laboratory	153
Industrial Chemistry	153
Industrial Hygiene	148
Industrial Marketing	162
Industrial Microbiology	148

Subjects	Page
Industrial Plant Engineering	124
Industrial Problems	163
Industrial Stoichiometry	153
Industrial Traffic Management	161
Inorganic Chemistry	138
Inorganic Laboratory	138
International Economic Relations	168
Introduction to Aeronautical Mechanics	164
Introduction to Business Management	161
Introduction to Colloid Chemistry	155
Introduction to Geophysical Prospecting	159
Introduction to Mining and Metallurgy	131
Introduction to Music	172
Introduction to Radiation Chemistry	139
Introduction to Theoretical Physics	152
Introduction to Thermodynamics	139
Introductory Meteorology	165
Invertebrate Zoölogy	147
Investment Analysis	168
Investment Finance	167
Italian	177
Job Management	166
Journal Meeting in Inorganic Chemistry	140
Journal Meeting in Organic Chemistry	140
Journal Meeting in Physical Chemistry	140
Kinetic Theory and Statistical Mechanics	140
Labor Economics	168
Labor Organization and Industry	168
Labor Relations	168
Lattice Theory of the Solid State	151
Law of Business Organizations	162
Law of Contracts	162
Law of the Market	162
Light Alloys	133
Limnology	147
Limnological Fieldwork	148
Line Spectra	151
Literature and Fine Arts	172
Literature and History	169
Logic of Science	140
Machine Design	128
Machine Drawing	128
Machine Tool Laboratory	129
Machine Tool Practice	129
Management Laboratory	162
Manufacturing Analysis	162
Manufacturing Engineering	129
Manufacturing Practice	130, 145, 146
Map Reading and Topographical Drawing	120
Marine Engineering	159, 160
Marine Engine Design	160
Marketing	162
Marketing of Consumer Goods	162
Marketing Research	162
Materials	166
Materials of Engineering	125, 126
Mathematical Analysis by Mechanical Methods	144
Mathematical Approach to Economics	167
Mathematical Laboratory	174
Mathematical Reading	175
Mathematical Theory of Statistics	173
Mathematics	174
Mechanical Equipment of Buildings, Heating and Ventilation	127
Mechanical Processes	125
Mechanical Vibration	160
Mechanics	152, 174
Mechanics and Theory of Elasticity	125
Mechanism	128
Metallography	133
Metallography and Corrosion	134
Metallurgical and Electrochemical Laboratory	132
Metallurgical Calculations, Adv.	133
Metallurgical Plant Design	133
Metallurgical Plant Visits	133
Metallurgical Plants	133
Metallurgy	132, 133
Metallurgy, Heat Treatment of Steel	133
Metallurgy, Non-Ferrous	133
Metallurgy of Common Metals	133
Metamorphic Geology	158
Meteorological Instruments	165
Meteorological Laboratory	165
Meteorological Seminar	165
Methods of Electrochemical Analysis	140
Methods of Social Investigation	169
Methods of Theoretical Physics	152
Metrology and Dimensional Engineering Standardization	129
Microbiology	148
Micropaleontology	158
Microscopy and Photomicrography	151
Military History and Policy of the United States	176
Military Science	175, 176
Mineralogical Seminar	157
Mineralogical Research	157
Mineralogy	157
Mine Valuation	131
Mining, Economics	131
Mining, Elements of	131
Mining Engineering	131
Mining Methods	131
Mining Practice	131
Mining, Principles of	131
Model Making	159
Modeling	135
Modern Algebra	174
Molecular Structure of Carbon Compounds	139
Monetary and Banking Problems	167
Money and Banking	167
Motion Picture Photography	151
Municipal Engineering	120
Municipal Sanitation	148
Naval Architecture	159
Navigation	120
Network Theory, Adv.	144
Non-ferrous Metallurgy	133
Nuclear Physics	152
Oil and Gas Land Valuation	134
Oil and Gas Law	135
Oil Field Visits	134
Optical Ceramics	135
Optical Crystallography	157
Optical Measurements	150
Optical Methods	140
Optics	150
Optics Seminar	151
Ordnance Engineering	124
Ore Dressing	131, 132
Ore Dressing, Design	132
Ore Dressing, Economics	132
Ore Dressing Laboratory	131
Organic Chemistry	138, 139
Organic Chemistry and Laboratory	139
Organic Evolution	158, 172
Organic Chemistry Laboratory	139
Organic Physical Chemistry	140
Organic Substances in Metabolic Processes	139
Organization and Administration of Public Service Companies	143
Outline of Petroleum Production	134
Paleontology	158
Parasitology	147
Pathology	149
Personal Hygiene and Nutrition	147
Perspective	135
Petrographic Research	157
Petrography	157
Petroleum Engineering	134, 135
Petroleum Production	134
Petrological Seminar	157
Philosophic Dramas of Literature	172
Photoelasticity Research	124
Photography	150
Physical Chemistry	139, 140
Physical Chemistry Laboratory	139
Physical Geology Seminar	158
Physical Measurements	150
Physical Metallurgy	133, 134
Physical Oceanography	165
Physical Properties of Ceramic Products	135
Physical Training	177
Physics	150
Physics of Metals	134
Physiology	147
Planktonology	148
Planning and Housing Legislation	169
Planning Principles	137
Plant Diseases	148
Plasticity	125
Polar Molecules	151
Political Economy	167
Potential Theory	174
Powder, Explosives and War Agents	139
Power Generating Stations	143
Power Plant Engineering	127
Power Plants Advanced	127
Power System Stability	143
Power Systems Laboratory	143
Power Transmission Equipment	141
Practical Spectroscopy	152
Precision of Measurements	150
Preparation for Manufacturing	129
Principles of Combustion	155
Principles of Fabric Structure	130
Problem Analysis	169, 170
Problems in Accounting Policy	161
Problems of the Chemical Engineer	153
Problems of Modern Philosophy	172
Production	162
Production Metallurgy	132
Professional Practice in Civil Engineering	123
Professional Relations	136
Projective Geometry	173
Psychology	171
Public Health Administration	148
Public Health Field Work	149
Public Health Laboratory Methods	148
Public Health Problems	149
Public Utilities: Organization and Finance	168
Public Utility Practice	146
Public Utilities: Rates and Regulation	168
Qualitative Analysis	138
Quantitative Analysis	138
Quantitative Organic Analysis	139
Quantitative Spectroscopic Analysis	152
Quantity Surveying	120
Quantum Mechanics	152
Radiation Chemistry, Adv.	140
Radiation Measurements	152
Radiation Measurements Laboratory	152
Radio Communications, Principles of	142
Railroad Electric Traction	143
Railway Design	120
Railway and Highway Curves	120
Railway and Highway Fieldwork	120
Railway Signaling	120
Railway Transportation, Adv.	120
Recent Advances in Organic Chemistry	139
Refrigeration, Advanced	126
Refrigeration and Air Conditioning Laboratory	128
Refrigeration Engineering	127
Reinforced Concrete Design	121
Reinforced Concrete Structures, Design of	122
Reports	169
Research	140
Research Conferences	156
Research Conferences in Inorganic, and Organic Chemistry	140
Research Conferences in Physical Chemistry	140
Research Problems	149
Review of Mathematics	174
River Engineering	122
River Hydraulic Laboratory	122
Roads and Pavements	120
Sales Management	162
Sanitary Chemistry	138
Sanitary Design	123
Sanitary Engineering	123
Sanitary Science and Public Health, Principles of	172
Sanitation	148
School of Chemical Engineering Practice	156
School Health Administration	149
Sedimentation	158
Seismological Laboratory	120
Seismology	158
Seminar in Chemical Engineering	156
Seminar in Inorganic Chemistry	138
Seminar in Nuclear Physics	152
Seminar in Radiant Heat Transmission	156
Serological Methods	148
Shades and Shadows	135
Shakespeare	172
Ship Construction	159
Ship Design	159
Ship Operation	160
Site Planning Construction Details	136
Social and Economic Factors in City Planning	169
Social and Industrial History of the United States	171
Social and Industrial History of Modern Europe	171
Social Institutions	171
Sociology, Principles of	168
Soil Mechanics	121
Solid Geometry	173
Sound in Electrical Communications	145
Spanish	177
Special Problems in Aeronautical and Meteorological Instruments	165
Special Problems in Ceramics	135
Special Problems in Crystal Physics	151
Special Problems in Electronics	151
Special Problems in Nuclear Research	152
Special Problems in Theoretical Physics	153
Special Problems in Spectroscopy	151
Special Topics in Chemical Engineering	154
Spectroscopy	152
Spectroscopy Seminar	151
Standards of Measurement in Industrial Management	163
Stationary Structures	121
Statistical Mechanics	152
Statistical Methods for Quality Control	167
Statically Indeterminate Structures	122
Statistics	167
Steam Turbine Engineering	129
Storage Batteries	142
Storage and Transportation of Foodstuffs	127
Stratigraphic Geology	158
Structural Analysis	137, 166
Structural Design	120, 137
Structural Geology	158
Structural Mechanics	124
Structural Mechanics, Elementary	124
Structural Theory, Advanced	121, 122

Subjects	Page
Structures	121
Super-High-Voltage Engineering	144
Surface and Colloid Chemistry	139
Surveying	119
Surveying, Geodetic	119
Surveying, Hydrographic	122
Surveying and Topographical Drawing	119
Synoptic Meteorology	165
Technical Aspects of Entomology	147
Technology of Food Products	149
Technology of Food Supplies	149
Terminal Facilities	160
Testing Materials Laboratory	126
Textile Manufacturing, Elements of	130
Textile Manufacturing Principles of	130
Textile Microscopy	130
Textile Research Laboratory	130
Textile Technical Analysis	130
Theoretical and Applied Elasticity	175
Theoretical Biology	147
Theoretical Geophysics	158
Theoretical Physics, Introduction to	152
Theoretical Seminar	153
Theories and Applications of Catalysis	140
Theory and Application of Mechanisms	128
Theory and Practice of City Planning	136
Theory and Practice of Flotation	132
Theory of Architecture	136
Theory of Elasticity	125
Theory of Models	122
Theory of Interior Ballistics	154
Theory of Metal Hardening	134
Theory of Numbers	173
Theory of Probability	174
Theory of Relativity	153
Theory of Solutions	140
Theory of Structures	121, 164
Theory of Warship Design	159
Thermodynamics	140
Thermodynamics and Chemistry	140
Thermodynamics of Hydrocarbons	155
Thermodynamics of Mixtures	126
Thesis	140, 163
Thesis Reports	153
Torpedoes	127
Transient Analysis by the Laplacian Transformation	144
Transportation Engineering	120
Trigonometry	173
Vector Analysis	175
Vibrations	144
Vibrations and Sound	150
Vibration Theory, Int. to	119
Vibration Problems	119
Vital Statistics	148
Warship Design	159
Water Power Design, Adv.	123
Water Power Engineering	122
Welding Engineering and Practice	125
Wire Communication, Principles of	142
X-Ray Diffraction	151
X-Ray Metallography	134
X-Rays and Crystal Physics	151
Zymology	149

ALPHABETICAL INDEX

	Page
Academic Year	24
Administrative Officers	8
Admission:	
Methods of Admission	32
Subjects Required	32
Without Examinations	32
By Examination	33
Application for	34
Of Special Students	35
To First Year	32
With Advanced Standing	34
Advisers	26
Aeronautical Engineering:	
Course Schedule	74
Description of Subjects	164
Graduate Study	115
Staff	11
Tabulation of Subjects	198
Architectural Engineering:	
Course Schedule	47
Graduate Study	98
Architecture:	
Course Schedule	46
Description of Subjects	135
Graduate Study	96
Special Students	35
Staff	11
Tabulation of Subjects	185
Army Ordnance	93
Athletics	30
Automotive Engineering	93
Biology and Public Health:	
Course Schedule	58
Description of Subjects	147
Graduate Study	105
Staff	12
Tabulation of Subjects	191
Biophysics	57
Board, Cost of	27
Books, etc., Cost of	27
Building Engineering and Construction:	
Course Schedule	75
Description of Subjects	166
Tabulation of Subjects	199
Buildings, Description of	27
Business and Engineering Administration:	
Course Schedules	72
Description of Subjects	161
Graduate Study	114
Staff	12
Tabulation of Subjects	197
Cabot Medals	211
Calendar	2
Camp Technology	29, 37
Ceramics	96
Changes in Course Schedules for R. O. T. C.	79
Chemical Engineering:	
Course Schedule	63
Description of Subjects	153
Graduate Study	110
Staff	13
Tabulation of Subjects	194
Chemical Engineering Practice:	
Course Schedule (X-B)	63
Graduate Study (X-A)	110
Staff	13
Chemistry:	
Course Schedule	49
Description of Subjects	138
Graduate Study	98
Staff	13
Tabulation of Subjects	187
City Planning:	
Course Schedule	48
Graduate Study	97
Civil and Sanitary Engineering:	
Course Schedule Civil Engineering	39
Description of Subjects	119
Graduate Study	89
Staff	14
Summer Surveying Camp	37
Tabulation of Subjects	178
College Entrance Examination Board:	
Dates of Examinations	33
Table of Equivalents	33
Committees and Boards	22
Conduct	25
Committees on Joint Projects	22
Coöperative Arrangements with Liberal Arts Colleges	24
Corporation, Members of	7
Courses:	
For Officers of U. S. A. and U. S. N.	86
R. O. T. C.	77
Schedules of	39
Courses of Study	36
Degrees:	
Degrees Granted	24
Requirements for Bachelors Degrees	37
Deposits to cover Chemical Breakage, Military Uniforms, etc.	26
Description of Subjects	119
Dining Service	220
Division of Industrial Coöperation	20
Dormitories	212
Dormitory Board	212
Drawing:	
Description of Subjects	167
Staff	12
Tabulation of Subjects	199
Economics and Social Science:	
Description of Subjects	167
Graduate Study	116
Staff	15
Tabulation of Subjects	199
Educational Buildings	27
Laboratories	29
Library	29
Electrical Communications:	
Course Schedule	52
Electrical Engineering:	
Course Schedule	50
Description of Subjects	141
Graduate Study	102
Staff	15
Tabulation of Subjects	189
Electrical Engineering, Coöperative:	
Course Schedule	53
Electrochemical Engineering:	
Course Schedule	70
Graduate Study	96
Engineer Corps, U. S. A.	90
English and History:	
Description of Subjects	169
Staff	16
Tabulation of Subjects	200
Entrance:	
Admission by Examination	33
Admission without Examinations	32
Division of Examinations	33
Examination Fee	26
Examination Schedule	34
Examination Subjects	32
Examinations of C. E. E. B.	33
Summer Courses in Entrance Subjects	34
Equivalents, College Board	33
Examinations:	
College Entrance Board	33
For Admission (Time and Place)	33
For Admission, Divided	33
For Entrance Conditions	24
Expenses for School Year	27
Faculty	
Ex-officiis Members	10
Emeriti Members	10
Faculty Committees	21
Faculty Council	9
Fees, Deposits, Payments:	
Deposits	26
Dues	27
Entrance Examination Fee	26
Late Registration Fine	26
Other Fees	26
Payments	27
Tuition	26
Fellows	210
Fellowships	210
First-Year Course Schedules	38
French: (See Modern Languages)	
Fuel Engineering	111
General Engineering:	
Course Schedule	62
General Information	23
General Regulations:	
Academic Year	24
Advisers	26
Attendance	25
Conduct	25
Final Examinations	25
Health of Students	25
Petitions	26
Provisional Admission	24
Registration	24
Requirements for Bachelor's Degree	24
General Science:	
Course Schedule	62
General Studies, Division of:	
Description of Subjects	170
Object	170

	Page
Staff	20
Tabulation of Subjects	200
Geology:	
Course Schedules	66
Description of Subjects	157
Graduate Study	112
Staff	16
Tabulation of Subjects	195
German (See Modern Languages)	
Government and Administration	23
Graduate House	212
Graduate School:	
Administration	82
Chairmen of Committees	82
Coöperation with Harvard University	84
Degrees:	
Doctor of Philosophy, Science or Public Health	86
Master in Architecture	84
Master in City Planning	84
Master of Science	84
History and Organization	83
Requirements for Admission	83
Tuition	26
Harvard University, Coöperation with	84
Heads of Departments and Courses	9
Health of Students	25
Heating and Ventilating Engineering	93
Holidays	24
Homberg Memorial Infirmary	25
Hours of Attendance	25
Hygiene:	
Description of Subjects	177
Staff	17
Tabulation of Subjects	204
Illuminating Engineering:	
Course Schedule	51
Industrial Biology:	
Course Schedule	58
Industrial Coöperation:	
Staff	20
Instructing Staff	11
Laboratories	29
Library	29
Staff	21
Vail Library	104
Loans, Scholarships, Fellowships and Prizes	27
Location	23
Lowell Institute Lectures	80
Lowell Institute School	80
Staff	80
Marine Transportation Course Schedule	69
Mathematics:	
Course Schedule	76
Description of Subjects	173
Graduate Study	118
Staff	17
Tabulation of Subjects	202
Mechanical Engineering:	
Course Schedule	40
Description of Subjects	124
Graduate Study	91
Staff	17
Tabulation of Subjects	180
Mechanical Engineering, Coöperative	
Course Schedule	41
Metallurgy:	
Course Schedule	44
Description of Subjects	131
Graduate Study	95
Staff	18
Summer School	37
Tabulation of Subjects	183
Methods of Admission	32
Military Science and Tactics:	
Description of Subjects	175
Staff	18
Tabulation of Subjects	203
Mining and Metallurgy:	
Course Schedule, Mining Engineering	43
Description of Subjects	131
Graduate Study	94
Summer Mining Camp	29
Summer Schools	37
Staff	18
Tabulation of Subjects	183
Modern Languages:	
Description of Subjects	176
Staff	19
Tabulation of Subjects	201
Naval Architecture and Marine Engineering:	
Course Schedule	68
Description of Subjects	159
Staff	19
Tabulation of Subjects	196
Naval Construction:	
Course Schedule	113
Numbering System	38
Objectives and Policies of the Institute	5
Officers:	
Administration	8
Emeriti	10
Of Instruction	10
Payments	27
Petitions	26
Petroleum Engineering Graduate Study	94
Petroleum Production:	
Course Schedule	44
Summer School	37
Physical Metallurgy:	
Course Schedule	45
Graduate Study	95
Physics:	
Course Schedule, General	60
Course Schedule, Applied	61
Description of Subjects	150
Graduate Study	108
Staff	19
Tabulation of Subjects	192
Placement	27
Prizes	211
Professional Summer Schools	37
Provisional Admission	24
Public Health Engineering:	
Course Schedule	59
Recreational Facilities	30
Refrigeration Engineering	93
Registration	24
Requirements for Admission	32
Requirements for Bachelor's Degree	37
Research Fellows	21
Reserve Officers Training Corps:	
Advanced Course	77
Basic Course	77
Chemical Warfare Unit	78
Coast Artillery Unit	78
Engineer Unit	78
Ordnance Unit	78
Signal Unit	78
Undergraduate Schedules	77
Rooms, Cost of	214
Sanitary Engineering:	
Course Schedule	64
Schedules of Courses	39
Scholarships:	
Fellowships and Graduate	209
Freshman	205
Special Fellowships	210
Traveling Fellowships	209
Undergraduate	207
Special Students	35
Staff Instructing	11
Student Aid and Prizes	205
Student Housing	30, 213
Graduate House	30, 213
Undergraduate Houses	30, 213
Subjects:	
Alphabetical List	221
Of Instruction, Descriptions	119
Of Instruction, Tabulated	178
Summer Camps	29
Summer Schools, Professional:	
Civil Engineering	37
Metallurgy	37
Mining Practice	37
Petroleum Production	37
Surveying	37
Surveying for Mining Engineers	37
Table of Contents	3
Teaching Fellows and Assistants	86
Technology Loan Fund	205
Textile Engineering	93
Torpedo Engineering	93
Traveling Fellowships	209
Tuition Fees	26
Undergraduate Activities:	
Athletics	30
Institute Committee	31
M. I. T. Athletic Association	30
Music, Drama and Public Speaking	31
Nautical Association	31
Student Professional Societies	31
Technology Christian Association	31
Undergraduate Publications	31
Undergraduate Houses	212
Vacations	24
Walker Memorial	30
Year, Academic	24