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INCLUDING COURSES FOR 1929-1930

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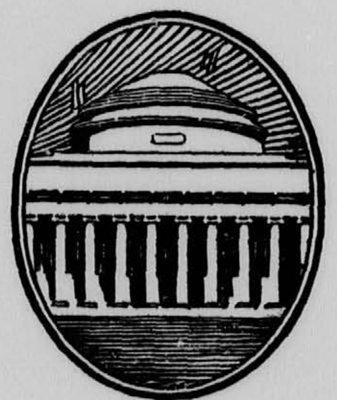

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CATALOGUE

ACADEMIC YEAR 1929-30

INCLUDING
SPECIAL COURSES ARRANGED FOR OFFICERS OF THE UNITED STATES ARMY AND FOR OFFICERS OF THE UNITED STATES NAVY

April, 1929

The Technology Press
Cambridge

CALENDAR FOR ACADEMIC YEAR 1929–1930

	1929
Entrance Examinations at Technology Begin . .	Sept. 18
College Year Begins (Registration Day) . . .	Sept. 30
Christmas Vacation	Dec. 22–Jan. 1 (inclusive)
	1930
Last Exercises, First Term	Jan. 25
Midyear Examination Period	Jan. 27–Feb. 8 (inclusive)
Second Term Begins (Registration Day) . . .	Feb. 10
Spring Recess	April 16–20 (inclusive)
Last Exercise, Second Term	May 29
Annual Examinations Begin	May 31
Commencement Day	June 10
Examinations, College Entrance Examination Board	June 16–21
Summer Session Begins	June 16

CALENDAR FOR ACADEMIC YEAR 1930–1931

	1930
Entrance Examinations at Technology Begin . .	Sept. 17
College Year Begins (Registration Day) . . .	Sept. 29
Christmas Vacation	Dec. 24–Jan. 4 (inclusive)
	1931
Last Exercise, First Term	Jan. 24
Midyear Examination Period	Jan. 26–Feb. 7 (inclusive)
Second Term Begins (Registration Day) . . .	Feb. 9
Spring Recess	April 18–22 (inclusive)
Commencement Day	June 9
Examinations, College Entrance Examination Board	June 15–20
Summer Session Begins	June 15

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HAROLD EUGENE EDGERTON, S.M.
AUSTIN SIBLEY NORCROSS, B.S.
CHESTER PETERSON, S.B.
WILMER LANIER BARROW, B.S.
JACOB CLARENCE PETERS, B.S., A.M.

Research Associate

Richard Dudley Fay, A.B., S.B.

Assistants

Marvin Hewitt Dixon, B.S. E.E.
Frank Malcolm Gager, B.S.
Clifford Eugene Hentz
Curator of Apparatus
John J. McCarthy
Curator of Apparatus
William Lawrence Sullivan, S.B.

Research Assistants

Archibald Hart Brolly, M.S.
Howard Allan Chinn, S.B.
Lloyd Tanner Goldsmith, E.E.
Henry Garrett Houghton, S.M.
Charles Kingsley, Jr., S.B.
Gordon Gwynne Macintosh
LeRoy Allen Mullin, B.S.
Murrice Overall Porter, Jr., B.S.
John Benjamin Russell, Jr., S.B.

ENGLISH AND HISTORY

Henry Greenleaf Pearson, A.B.
Professor of English
In charge of the Department

Archer Tyler Robinson, A.M.
Professor of English
In charge of the courses in History

Henry Latimer Seaver, A.M.
Associate Professor of English

Robert Emmons Rogers, A.M.
Associate Professor of English

Winward Prescott, A.M.
Assistant Professor of English

William Anderson Crosby, A.M.
Assistant Professor of English

Penfield Roberts, A.M.
Assistant Professor of English

Matthew Richard Copithorne, A.B.
Assistant Professor of English

Dean Mattison Fuller, A.B.
Assistant Professor of English

Instructors

Walter Washington Jamison, A.M.
William Chace Greene, Jr., Ph.B., B.A.
Frank Edgar Bailey, Jr., A.M.
Carl Bridenbaugh, B.S.
Donald Malcolm Greer, Ph.D.
Forrest Fay Lange, S.B.
George Worthington Adams, A.M.
David Fales Strong, B.S., A.M.
Henry Andrew Doak, A.M.

FUEL AND GAS ENGINEERING

Robert Thomas Haslam, S.B.
Non-Resident Professor of Fuel and Gas Engineering

Hoyt Clarke Hottel, B.A., S.M.
Assistant Professor of Fuel and Gas Engineering

Instructors

Theodore August Mangelsdorf, S.B.
John Ward Poole, S.M.

Research Associate

Leslie Bartlett Bragg, S.B.

GEOLOGY

WALDEMAR LINDGREN, M.E., SC.D.
William Barton Rogers Professor of Economic Geology
In charge of the Department

HERVEY WOODBURN SHIMER, PH.D., SC.D.
Professor of Paleontology

JOSEPH LINCOLN GILLSON, M.A., SC.D.
Associate Professor of Mineralogy and Petrography

WALTER HARRY NEWHOUSE, PH.D.
Assistant Professor of Economic Geology

FREDERICK KUHNE MORRIS, B.S., M.A.
Assistant Professor of Geology

Special Lecturer
WALTER LUCIUS WHITEHEAD, PH.D.

Instructor
MARTIN JULIAN BUERGER, S.M.

Assistant
ARGYLE CAMPBELL ABBOTT, S.B.

GERMAN

FRANK VOGEL, A.M.
Professor of German
In charge of the Department

HERMAN RUDOLPH KURRELMEYER, PH.D.
Professor of German

Instructor
FRANCIS MORTON CURRIER, A.M.

HYGIENE

GEORGE W. MORSE, M.D., F.A.C.S.
Medical Director
In charge of the Department

LOUIS WARD CROKE, M.D.
Assistant Medical Director

BENJAMIN ERNEST SIBLEY, M.D.
Assistant

HENRY PATRICK MCCARTHY
Director of Physical Training

SANFRID KNUTE JOHNSON
Assistant in Physical Training

ELMER CHAUFFY HUGHES
Student Assistant in Physical Training

MATHEMATICS

HARRY WALTER TYLER, PH.D.
Walker Professor of Mathematics
In charge of the Department

DANA PRESCOTT BARTLETT, S.B.
Professor of Mathematics

FREDERICK SHENSTONE WOODS, PH.D.
Professor of Mathematics
In charge of Graduate Students in Mathematics

FREDERICK HAROLD BAILEY, A.M.
Professor of Mathematics

CLARENCE LEMUEL ELISHA MOORE, PH.D.
Professor of Mathematics
Research Adviser for Mathematics
Chairman of Course IX Committee

HENRY BAYARD PHILLIPS, PH.D.
Professor of Mathematics

NATHAN RICHARD GEORGE, A.M.
Associate Professor of Mathematics

LEONARD MAGRUDER PASSANO, A.B.
Associate Professor of Mathematics

FRANK LAUREN HITCHCOCK, PH.D.
Associate Professor of Mathematics

GEORGE RUTLEDGE, PH.D.
Assistant Professor of Mathematics

NORBERT WIENER, PH.D.
Assistant Professor of Mathematics

PHILIP FRANKLIN, PH.D.
Assistant Professor of Mathematics

DIRK JAN STRUIK, PH.D.
Assistant Professor of Mathematics

Instructors

RAYMOND DONALD DOUGLASS, M.A.

SAMUEL DEMITRY ZELDIN, PH.D.

LEPINE HALL RICE, A.B.

MECHANICAL ENGINEERING

EDWARD FURBER MILLER, SC.D.
Professor of Steam Engineering
In charge of the Department
Director of Engineering Laboratories
Head of Ordnance School of Application
Dean of Army Students

ALLYNE LITCHFIELD MERRILL, S.B.
Professor of Mechanism
Secretary of the Faculty

CHARLES EDWARD FULLER, S.B.
Professor of Theoretical and Applied Mechanics

WILLIAM ATKINSON JOHNSTON, S.B.
Professor of Theoretical and Applied Mechanics

CHARLES FRANCIS PARK, S.B.
Professor of Mechanism
Director of the Mechanical Laboratories
Director of the Lowell Institute School

GEORGE BARTHOLOMEW HAVEN, S.B.
Professor of Advanced Machine Design
In charge of Textile Research

JOSEPH CAINS RILEY, S.B.
Professor of Heat Engineering

CHARLES WILLIAM BERRY, S.B.
Professor of Heat Engineering

HARRISON WASHBURN HAYWARD, S.B.
Professor of Materials of Engineering
Assistant Director, Division of Industrial Coöperation and Research

THEODORE HOWARD TAFT, S.B.
Associate Professor of Heat Engineering

LAWRENCE SOUTHWICK SMITH, S.B.
Associate Professor of Theoretical and Applied Mechanics

GEORGE WRIGHT SWETT, S.B.
Associate Professor of Machine Design

WALTER HERMAN JAMES, S.B.
Associate Professor of Mechanical Engineering Drawing

ADDISON FRANCIS HOLMES, S.B.
Associate Professor of Applied Mechanics

ROBERT HENRY SMITH, M.S.
Associate Professor of Machine Construction

EARLE BUCKINGHAM
Associate Professor of Engineering Standards and Measurements

JESSE JENNINGS EAMES, S.B.
Associate Professor of Experimental Engineering

DEAN ABNER FALES, S.B.
Associate Professor of Automotive Engineering

IRVING HENRY COWDREY, S.B.
Associate Professor of Testing Materials

THOMAS SMITH, B.S., M.E.
Associate Professor of Mechanism

DEAN PEABODY, JR., S.B.
Associate Professor of Applied Mechanics

WILLIAM HENRY JONES, S.B.
Assistant Professor of Experimental Engineering

MYRON WILKINSON DOLE, S.B.
Assistant Professor of Mechanism

JAMES HOLT, S.B.
Assistant Professor of Heat Engineering

RALPH GUY ADAMS, S.B.
Assistant Professor of Testing Materials

Special Lecturers

ROBERT LOUIS BROWNE, B.S.
Thermit Welding

FRED DAVIS
Electric Arc Welding

GEORGE JAEGER
Oxy-Acetylene Welding

CLIFFORD LORING MUZZEY, S.B.
Production

WILLIAM TAYLOR OBER
Electric Butt and Spot Welding

LEWIS DANIEL SPENCE
Automatic Machinery

HAROLD LEMOYNE VAN KEUREN, B.S.
Measuring with Light Waves

Instructors

JAMES RICHARD LAMBIRTH
CHARLES EVERETT LITTLEFIELD
ROY GIBSON BURNHAM, S.B.
JEREMIAH FRANCIS O'NEILL
ARTHUR BROWN ENGLISH
CLAUDE HUGH CLARK
ARTHUR LAWRENCE TOWNSEND, S.B.
CARL LOUIS SVENSON, S.B.
IGOR NICHOLAS ZAVARINE, S.M.
ROBERT BUTTERFIELD CHENEY
GEORGE HOWARD HARDY
BIRTHRAM SHEPPARD
EDWARD ROBINSON SCHWARZ, S.B.
JOHN HARVEY ZIMMERMAN, S.M.
HERBERT CARLTON MOORE, S.B.
ARCHIBALD MCKECHNIE, JR.
NICHOLAS NICHOLAS ALEXANDROFF, S.M.
HERBERT DYER SWIFT, S.B.
ELLSWORTH SPENCER GRAY, S.B.
MARK WILLIAM LIBBEY
MORTON CARTER SWIFT, S.B.

Assistants

HAROLD GUSTAV DICK
GEORGE CLIFTON DURGIN, S.B.
ANDREW WYLES LAWSON
ADOLPH FRED CHARLES MAERTINS, S.B.
MIETH MAESER, A.B., S.B.
FRANCIS WINFIELD PERKINS
Constructor of Apparatus
CARL MAGNUS FRITHIOF PETERSON

Research Assistants

CHARLES LOUIS PETZE, JR., S.B.
ROBERT ADDISON CROSBY, S.B.

MILITARY SCIENCE AND TACTICS

HAROLD EDWARD CLOKE
Colonel, Coast Artillery Corps, D.O.L.
Professor of Military Science and Tactics
In charge of the Department

ROBERT COLLINS EDDY
Lieutenant-Colonel, Coast Artillery Corps, D.O.L.
Assistant Professor of Military Science and Tactics
Executive Officer

SYDNEY SMITH WINSLOW, M.S.
Major, Coast Artillery Corps, D.O.L.
Assistant Professor of Military Science and Tactics
In charge of Coast Artillery Unit

RICHARD HERBERT SOMERS, M.B.A.
Major, Ordnance Department, D.O.L.
Assistant Professor of Military Science and Tactics
In charge of Ordnance Unit

VERNON WEBSTER HALL
Captain, Coast Artillery Corps, D.O.L
Assistant Professor of Military Science and Tactics

GEORGE SENSENY EYSTER, A.B.
Captain, Signal Corps, D.O.L.
Assistant Professor of Military Science and Tactics
In charge of Signal Corps Unit

CRAWFORD MCMANN KELLOGG, A.B.
Captain, Chemical Warfare Service, D.O.L.
Assistant Professor of Military Science and Tactics
In charge of Chemical Warfare Unit

ANDERSON THOMAS WILLIAM MOORE
1st Lieutenant, Corps of Engineers, D.O.L.
Assistant Professor of Military Science and Tactics
In charge of Engineer Unit

ELMER ELLSWORTH BARNES
1st Lieutenant, Corps of Engineers, D.O.L.
Assistant Professor of Military Science and Tactics
With Engineer Unit

SAMUEL GORDON FRIERSON
1st Lieutenant, Air Corps, D.O.L.
Assistant Professor of Military Science and Tactics
In charge of Air Corps Unit

Instructors

ALFRED FLOYD TRUAX
Technical Sergeant, D.E.M.L.
Signal Corps

MARK BRADEN ASHLEY
Staff Sergeant, D.E.M.L.
Infantry

HAROLD FRANCIS MCDONNELL
Staff Sergeant, D.E.M.L.
Corps of Engineers

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

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

JOHN BURKE FITZGERALD
Armorer
Sergeant, D.E.M.L.
Coast Artillery Corps

MINING AND METALLURGY

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

George Booker Waterhouse, Ph.D.
Professor of Metallurgy
In charge of the Option in Metallurgy

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

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

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.
Assistant Professor of Physical Metallurgy.

Instructors

Rufus Cook Reed, S.B.
Franklin LeRoy Foster, S.B.
James Weston Pratt, S.B.

Assistants

Allan Lawrence Tarr, S.B.
John Palmer Walsted, M.S.

NAVAL ARCHITECTURE AND MARINE ENGINEERING

James Robertson Jack
Professor of Naval Architecture and Marine Engineering
In charge of the Department
Director of the Nautical Museum
Dean of Navy Students

William Hovgaard
Professor of Naval Design and Construction
In charge of Course XIII-A

Henry Hiram Wheaton Keith, S.B.
Professor of Naval Architecture

George Owen, S.B.
Professor of Naval Architecture

Lawrence Boylston Chapman, S.B.
Associate Professor of Ship Operation and Marine Engineering

Evers Burtner, S.B.
Assistant Professor of Naval Architecture and Marine Engineering

Instructor

Frederick Alexander Magoun, S.M.

PHYSICS

(Including Electrochemical Engineering)

Charles Ladd Norton, S.B.
Professor of Industrial Physics
In charge of the Department
Director of the Research Laboratory of Industrial Physics
Director of Division of Industrial Coöperation and Research

Harry Manley Goodwin, Ph.D.
Professor of Physics and Electrochemistry
In charge of the course in Electrochemical Engineering
Dean of Graduate Students

William Suddards Franklin, Sc.D.
Professor of Physics

William Johnson Drisko, S.B.
Professor of Physics

Newell Caldwell Page, S.B.
Professor of Electricity

Maurice deKay Thompson, Ph.D.
Associate Professor of Electrochemistry

Gordon Ball Wilkes, S.B.
Associate Professor of Industrial Physics

Arthur Cobb Hardy, M.A.
Associate Professor of Optics and Photography

William Raymond Barss, Ph.D.
Assistant Professor of Physics

Max Knobel, Ph.D.
Assistant Professor of Physics

John Torrey Norton, S.B.
Assistant Professor of Physics

Manuel Sandoval Vallarta, Sc.D.
Assistant Professor of Physics

Louis Henry Young, S.B.
Assistant Professor of Physics

Thomas Harry Frost, S.M.
Assistant Professor of Physics

Donald Charles Stockbarger, Sc.D.
Assistant Professor of Physics

Henry Guinness de Laszlo, Ph.D.
Assistant Professor of Physics

Hans Muller, D.Sc.
Assistant Professor of Physics

Instructors

Royal Merrill Frye, A.M.
Francis Weston Sears, S.M.
Robert Edgar Hodgdon, B.S.
Oscar Kenneth Bates, S.M.
Alexander Loxley Massey Dingee, S.B.
Russell Weaver Conant, S.B.
Nathaniel Herman Frank, Sc.D.
John Kimball Phelan, B.S.
Bertram Eugene Warren, S.M.
George Parsons Swift, S.M.
Sherwood Fiske Brown, S.B.
Robert Burns Morrissey, S.B.
Temple Chapman Patton, S.B.

Research Associates

Frederick Harwood Norton, S.B.
William Phelps Allis, Sc.D.
George Ashmun Morton, S.M.
Charles Ladd Norton, Jr., S.B.
Arnold Flint Taylor, S.B.

Assistants

Elof Benson
Curator of Apparatus
Samuel David Bryden, Jr., S.M.
Laurence Burns, S.B.
James Eli Forbes, S.B.
Arthur George Hall
Lyman Baker Johnson, S.M.
Henry Francis King, S.M.
Rene Joseph Marcou, B.S.
Carl Gustav Selig
Constructor of Apparatus
Leonardo Hernandez Tomacelli, S.B.

Research Assistant

Alden Groce Handy, B.S.

ROMANCE LANGUAGES

Ernest Felix Langley, Ph.D.
Professor of French
In charge of the Department

Instructors

Jaques Henri Pillionnel, A.M.
Jean-Marie Chalufour, B.S.

COURSE IN MILITARY ENGINEERING

Committee in Charge of Course

EDWARD FURBER MILLER, Sc.D.
Colonel, O. R. C.
Professor of Steam Engineering
In charge of the Department of Mechanical Engineering
Director of Engineering Laboratories
Head of Ordnance School of Application
Dean of Army Students

HAROLD EDWARD CLOKE
Colonel, Coast Artillery Corps
Professor of Military Science and Tactics
In charge of the Department of Military Science

VANNEVAR BUSH, M.S., ENG.D.
Lieutenant-Commander U. S. N. R.
Professor of Electric Power Transmission

DIVISION OF GENERAL STUDIES

(*In charge of Faculty Committee on General Studies*)

Special Lecturers

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International Law

HECTOR M. HOLMES
Business and Patent Law

STEPHEN SUMNER TOWNSEND
Director of Choral Music

IRVING C. WHITTEMORE
Psychology

CHARLES RICE GOW, Sc.D.
Professor of Humanics

DIVISION OF MUNICIPAL AND INDUSTRIAL RESEARCH

WILLIAM AUSTIN BASSETT, S.B.
Professor of Municipal and Indusirial Research
In charge of the Division

JUDSON CHARLES DICKERMAN, S.B.
THOMAS LESLEY HINCKLEY, S.B.
EVERETT BALLOU FRENCH, S.B.
EDWARD HENRY REEVES, M.S.

DIVISION OF INDUSTRIAL COÖPERATION AND RESEARCH

CHARLES LADD NORTON, S.B.
Director

FRANK LOVERING LOCKE, S.B.
Personnel Director

EARL BOWMAN MILLARD, PH.D.
Assistant Director

HARRISON WASHBURN HAYWARD, S.B.
Assistant Director

FRANCIS EDWARD ANDERSON, S.B.
Assistant

STAFF OF THE SCHOOL OF CHEMICAL ENGINEERING PRACTICE

(For details see Department of Chemical Engineering, page 10)

W. P. Ryan
F. W. Adams
C. H. Gilmour
G. S. Willey
C. M. Cooper
M. D. Haynes
G. V. Slottman

STAFF OF THE RESEARCH LABORATORY OF APPLIED CHEMISTRY

(For details see Department of Chemical Engineering, page 10)

H. O. Forrest
P. K. Frolich
H. C. Hottell
E. W. Brugmann
E. V. Fasce
T. E. Warren
J. H. Boyd
F. P. Broughton
R. H. Brown
K. H. Butler
D. L. Campbell
G. L. Carpenter
H. Y. Chang
J. O. Collins
L. W. Cummings
R. L. Copson
G. L. Cox
R. L. Davidson
M. R. Fenske
K. R. Fitch
R. K. Flege
C. Hadlock
S. B. Littauer
C. C. Lockhart
W. B. McCluer
J. L. Moore
G. L. Matheson
D. Quiggle
J. K. Roberts
B. E. Roetheli
W. B. Sellars
J. A. Serrallack
G. A. Stachelhaus
E. J. Tauch
P. S. Taylor
L. B. Turner
F. E. Walsh
A. White

STAFF OF THE RESEARCH LABORATORY OF ELECTRICAL ENGINEERING

(For details see Department of Electrical Engineering, page 14)

D. C. Jackson
F. A. Laws
V. Bush
C. Kingsley, Jr.
J. B. Russell, Jr.
M. O. Porter, Jr.
T. S. Gray

STAFF OF RESEARCH LABORATORY OF INDUSTRIAL PHYSICS

(For details see Department of Physics, page 20)

C. L. Norton
W. J. Drisko
N. C. Page
G. B. Wilkes
W. R. Barss
J. T. Norton
L. H. Young
O. K. Bates

STAFF OF THE RESEARCH LABORATORY OF ORGANIC CHEMISTRY

(For details see Department of Chemistry, page 11)

J. F. Norris
S. P. Mulliken
T. L. Davis
A. A. Morton
A. A. Ashdown
N. A. Milas
H. S. Davis
Director, Amer. Petroleum Fellowship
J. F. Piccard

STAFF OF THE RESEARCH LABORATORY OF PHYSICAL CHEMISTRY

(For details see Department of Chemistry, page 11)

F. G. Keyes
W. R. Whitney (*Non-Resident*)
L. J. Gillespie
J. A. Beattie
G. Scatchard
L. B. Smith
G. Dietrichson
D. D. Jacobus
L. Harris
N. B. Carter
J. R. Coe
H. J. Northup
C. L. Gallagher
C. B. Wooster, *Nat. Res. Fellow*

STAFF OF THE AERONAUTICAL RESEARCH LABORATORY

(For details see Course in Aeronautical Engineering, page 7)

E. P. Warner
W. G. Brown
S. Ober
J. R. Markham
F. M. Thomas

STAFF OF THE RESEARCH LABORATORY FOR AIRCRAFT ENGINES

C. F. Taylor
E. S. Taylor

SPECIAL TEACHERS — SUMMER SESSION, 1929

JULIET O. BELL, A.B.
Staff Associate
American Child Health Association

IRVING EDISON BENDER, A.M.
Graduate Student
School of Citizenship and Public Affairs
Syracuse University

JAMES BEEBEE BRINSMADE, PH.D.
Associate Professor of Physics
Williams College

BANCROFT HUNTINGTON BROWN, PH.D.
Assistant Professor of Mathematics
Dartmouth College

WALTER FRANCIS DOWNEY, ED.M.
Head Master
The English High School, Boston

ERNEST NAPOLEON GELOTTE, S.B.
Little & Russell, Architects, Boston

ARTHUR WARREN HANSON, M.B.A.
Assistant Professor of Accounting
School of Business Administration
Harvard University

WILLIAM COLLAR HOLBROOK, B.A.
Instructor in Romance Languages
Harvard University

OLIVE A. KEE, ED.M.
Assistant, Department of Mathematics
The Teachers College, Boston

ALEXANDER CARTWRIGHT LANIER, M.E.
Professor of Electrical Engineering
University of Missouri

JOSEPH RICHARD LUNT, A.M.
Head of Science Department
The Teachers College, Boston
Acting Director of Science
Boston Public Schools

LILLIAN J. MACRAE, A.B.
First Assistant, Science Department
The Teachers College, Boston

FRED ROBINSON MILLER, A.B.
Head of Science Department
The English High School, Boston

HAROLD DAWES PARCELL, A.M.
Instructor in French
Harvard University

CLYDE ORVAL RUGGLES, PH.D.
Professor of Public Utility Management
Graduate School of Business Administration
Harvard University

CHARLES LEONARD STONE, A.M.
Professor of Psychology
Dartmouth College

CLYDE CANNON WEBSTER, A.M.
Instructor in French
Harvard University

GENERAL INFORMATION

Purpose of the Massachusetts Institute of Technology. Its primary purpose is to afford to students such a combination of general, scientific and professional training as will fit them to take leading positions as engineers, scientific experts, and teachers and investigators of science. It is also one of its important functions to contribute to the existing store of scientific knowledge and to the promotion of industrial development through the prosecution in its laboratories of original researches in pure and applied science.

The Institute offers to its students both undergraduate and graduate courses of study. The former lead to the degree of Bachelor of Science or Bachelor in Architecture; the latter, to the degrees of Master in Architecture, Master of Science, Doctor of Philosophy, Doctor of Science or Doctor of Public Health. It also affords to advanced students and to more experienced investigators excellent opportunities for the pursuit of original scientific investigations in its departmental special research laboratories.

Historical Sketch. The foundation of the Massachusetts Institute of Technology was laid in a "Memorial" prepared in 1859 by Professor William Barton Rogers, and presented, by a Committee, to the Legislature of the Commonwealth of Massachusetts of 1860. In this Memorial "reference is made to the expected early establishment of a comprehensive Polytechnic College, furnishing a complete system of industrial education supplementary to the general training of other institutions and fitted to equip its students with every scientific and technical principle applicable to the industrial pursuits of the age."

On April 10, 1861, an Act was passed by the General Court of Massachusetts to incorporate The Massachusetts Institute of Technology "for the purpose of instituting and maintaining a society of arts, a museum of arts, and a school of industrial science, and aiding generally by suitable means the advancement, development and practical application of science in connection with arts, agriculture, manufactures and commerce."

The first meeting of the Institute for organization was held April 8, 1862, but the Civil War led to the postponement of the opening of the School of Industrial Science. A preliminary session of the school was opened on February 20, 1865, fifteen students attending. The regular courses of instruction began October 2, 1865.

For fifty years the Institute developed on the original site granted by the state. During this time the number increased from fifteen students to nineteen hundred, the staff of instruction from ten to three hundred, and the number of courses of study leading to the degree of Bachelor of Science from six to fifteen.

Location. After occupying for fifty years its original location in Boston the Institute moved to a new site on the Charles River Basin. This site comprises a tract of approximately eighty acres extending along the esplanade on the Cambridge side of the river and affording an extensive panoramic view of the city of Boston. Here are located the educational buildings, the infirmary, the Walker Memorial, the dormitories, the athletic field and the power plant. Many street car and subway lines afford easy access from all parts of Boston, Cambridge, the suburbs and the railroad stations for trains from the north, south and west. The location of the Institute in proximity to the great collections and libraries of Boston and Cambridge, and in the neighborhood of a great manufacturing district is of great advantage to technological students.

The Department of Architecture is located in Boston and occupies the Rogers Building on the old site on Boylston Street.

EDUCATIONAL BUILDINGS

Libraries. The Institute Library, which is one of the leading scientific and technical libraries of the United States, contains about two hundred and fifty thousand volumes and receives regularly more than one thousand current periodicals. It includes the Central Library and a number of departmental libraries and reading rooms.

The main collection of books is in the Central Library under the great dome (building 10, fifth floor). This room, easily reached by the elevator from the main lobby, affords a convenient place for reading and study. It is open on week days during term time from 9 a.m. to 10 p.m. except Saturdays when it is closed at four o'clock. Books may be borrowed for two weeks' use.

Laboratories. The most marked characteristic of the Institute from the material point of view consists of its numerous large and well equipped laboratories. Recognition of the value of laboratory instruction as a fundamental element in general education and of the proper function of such instruction is of comparatively recent origin, dating only from the latter half of the last century. Emphasis has been placed on such work from the beginning, the Institute having taken the initiative in the establishment of laboratory instruction in scientific and engineering subjects.

The principal laboratories are listed below:

The Mechanical Engineering Laboratories, including the following: Steam and Compressed Air, Hydraulic, Refrigeration, Testing Materials, Gas Engine, Power Measurement and Mechanic Arts.

The Laboratory of Soil Mechanics.
The Laboratories of Mining Engineering and Metallurgy.
The Laboratories of Chemistry.
The Research Laboratories of Organic and Physical Chemistry.
The Laboratories of Chemical Engineering.
The Research Laboratory of Applied Chemistry.
The Laboratories of Electrical Engineering.
The Research Laboratories of Electrical Engineering.
The Laboratories of Biology and Public Health.
The Laboratories of Physics, including Laboratories of General Physics and the special laboratories of Heat, Optics, Electricity, Electrochemistry and Industrial Physics (Research).
The Mineralogical and Geological Laboratories.
The Guggenheim Aeronautical Laboratory.

The Institute laboratory work is effectively supplemented by visits to engineering and industrial establishments, and by excursions directed by members of the Faculty.

DORMITORIES

The first unit of the Institute Dormitories, erected in 1916, is located on Charles River Road, east of the Walker Memorial. It is built along the north and east sides of the lot that contains the President's house.

The unit consists of six halls named Ware, Atkinson, Runkle, Holman, Nichols and Crafts, in honor of professors at the Institute in its earlier years. Each hall has a separate entrance, and is four stories high, except in the case of Runkle, which has rooms on six floors. The unit has accommodations for two hundred fifteen men.

The first section of a second dormitory unit was constructed during the winter of 1923–24, and was made possible by the gift of $100,000 from the Class of '93, at its thirtieth reunion. It is located on the Institute campus near Walker Memorial.

This hall, named Ninety-Three, will accommodate eighty men, and is five stories high. Adjoining Ninety-Three are four new halls —

constructed during the fall of 1927 — containing one hundred and thirty-six single rooms. One of these halls has been named "Nineteen One," the funds having been contributed by that class. The other halls have not yet been named.

A circular giving details in regard to application for and allotment of rooms, equipment, rentals, payments, occupancy, government of the dormitories, and other information may be had on application to Horace S. Ford, Bursar of the Institute.

As the exercises of the school begin at nine o'clock in the morning, and end by five o'clock in the afternoon, students may conveniently live in any of the nearer cities or towns on the lines of the various railroads, if they prefer to do so. The Technology Christian Association keeps a list of desirable rooms available for students.

EXPENSES

An estimate of expenses for the school year, a period of 38 weeks, is given below:

For a Period of 38 Weeks

Tuition	$400.00
Board	380.00
Room	230.00
Books and materials	90.00
	$1,100.00

To assist students in securing 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, without danger of permanent impairment of health. 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.

RECREATIONAL FACILITIES

The Walker Memorial, built in memory of a late president, General Francis A. 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 of the building is the gymnasium with lockers and dressing rooms. There are offices for the various student activities, squash courts and rooms for handball. There are recreation and reading rooms, an excellent and growing library and on the first floor a large dining hall with cafeteria service at low prices. In the grill room a *table d'hote* lunch is served and other dining rooms are provided for class dinners and dinners of any Technology organization. In the basement are found bowling alleys and a billiard room. A matron is in attendance and excellent opportunities are afforded for the entertainment of guests.

Adjacent to this building are tennis courts; a regulation football field, which is also used for soccer; a baseball diamond; a quarter-mile cinder track with a 220-yard straightaway; and accommodations for the field events.

In order to take care of the needs of the track men for the winter an outdoor board track with a 70-yard straightaway is provided. There is near the athletic field, another gymnasium with a regulation basket ball court. Bleachers which will accommodate approximately 400 are built along one side. In addition there is a movable boxing ring 24 feet square; wrestling mats and indoor jumping pits. Also connected with this building are eight squash courts.

A boathouse on the Charles River is fully equipped with indoor rowing apparatus, showers, lockers, etc. A number of singles and wherries are 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.

UNDERGRADUATE ACTIVITIES

Massachusetts Institute of Technology Undergraduate Association. The student government of the undergraduates at Technology is in the hands of the Institute Committee, a body representing every important student activity.

The Technology Christian Association. The Technology Christian Association aims to be of practical service to every student at the Institute, and to help Technology realize its highest ideals. Its purpose is "to foster among the members of the Institute the best ideals of Christian living and to enlist them in active Christian service."

All students and members of the Institute who are in sympathy with the objects of the Association and wish to coöperate in promoting them are eligible to membership.

There are no membership dues, but the Association depends for support upon the voluntary contributions of the students. The general secretary is a college graduate, and gives full time to the direction of the work. The expenses of the secretarial office are collected from the alumni and other friends of the Institute, and are expended under the direction of an advisory board.

Athletics. The purpose of athletics at Technology is not to develop highly trained athletes, but rather to encourage all students to participate in some form of physical recreation. The control of athletics is vested in the M. I. T. Athletic Association, an undergraduate student organization. It is composed of all captains and managers of varsity teams as working members and assistant managers, and the officials of class teams as associate members. Funds are secured by undergraduate dues elsewhere referred to, the dues being collected by the Technology authorities, but disbursed by the students. An Advisory Council of Alumni works with the students and exercises the functions which its name implies.

No attempt is made to concentrate on the few men composing a single varsity team, but coaching and instruction is given to all men reporting for a given sport. As a corollary to this, the success of a given athletic activity is gauged by the number of men it attracts. Varsity and class teams are maintained in a wide variety of athletic exercise. Among the activities may be named: track and field sports, cross country, rowing, basket ball, boxing, fencing, golf, gymnastics, hockey, rifle shooting, soccer, swimming, tennis, squash racquets, wrestling, while class teams only are developed in football and baseball. Squads range from the twenty to thirty men who report for fencing to the two hundred to three hundred men who are interested in track or in rowing. A coaching system is being gradually developed for most of these activities.

The physical equipment for the conduct of these various sports is being steadily improved.

Tech Show. The Tech Show, which is produced each year in the spring, is a musical comedy written, staged, acted and orchestrated entirely by undergraduates.

Combined Musical Clubs. The Combined Musical Clubs of the Institute consist of the Glee, Mandolin and Banjo Clubs. The Musical Clubs are among the oldest activities in the school, the Glee Club having been founded in the fall of 1880.

Undergraduate Publications. *The Tech*, the newspaper of Technology, established in 1881, is published three times a week throughout the academic year.

Technique is the yearbook of the Institute and forms a permanent record of all the notable undergraduate activities. It also contains a photograph of each member of the Senior Class.

Voo Doo is Technology's monthly humorous publication.

The Tech Engineering News is the professional journal of the undergraduates and is published monthly throughout the school year. Its purpose is to disseminate news of scientific and industrial interest by publishing articles written by prominent alumni and engineers, the results of original investigations conducted in the Institute laboratories, news of scientific interest and articles on topics of timely importance.

GENERAL REGULATIONS

Academic Year. Exercises of the Institute begin on the last Monday in September and end early in June. The calendar appears on page 3. The exercises of the Institute 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.

Summer Session. Subjects are offered which correspond to most of those given during the regular school year. Certain entrance subjects are also given at the Institute in the summer, the passing of any one of which will excuse an applicant from taking the regular entrance examination in that subject.

Professional summer schools in Civil Engineering, Mining Engineering, Metallurgy, Chemistry and Geology are also carried on. This work is supplementary to that given during the regular terms.

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 any subjects without having fulfilled the usual preparation requirements are classified as provisional students in such subjects. Students admitted without examination, students whose work is generally low and students readmitted to the Institute after dismissal or after withdrawal incident to low standing are classified as provisional in all subjects. Provisional admission to any subject may be cancelled at any time that the work of the student is unsatisfactory.

Any 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 shall be made up before the beginning of the second year, except as extension of 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 examination 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., and the rooms are closed. Students who withdraw during the term should immediately notify 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 to the Dean of adequate evidence of sickness or other valid reason for the absence, the Faculty 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; 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 such 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.

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 and afternoon for the care of the sick and injured, and gymnastic facilities are available for all students. 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.

The new Homberg Memorial Infirmary has added greatly to the existing facilities. This building cares for seventeen ward and private room patients and is fully equipped to meet the needs of the Department. 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 special nursing, medicines or supplies.

Every man is required to have a complete physical examination each year, and if any defects are found an effort is made to correct them. With a view to correcting certain defects a course in gymnastics is given by an instructor especially trained in this work. Students who are found to be markedly underweight may, if they desire, enter a special class which has been organized to ascertain and remove the cause of this condition. Accurate measurements are taken at the first of the year of all the men entering physical training.

At the end of each year bronze medals, the gift of the late Samuel Cabot, '70, are given to the five students who make the greatest improvement in strength, measurements, and general gymnastic efficiency, as indicated by the physical examinations and as shown in regular class work. Five more students are given Honorable Mention.

Military Science. The War Department has established the following Senior Division Units of the Reserve Officers Training Corps at the Institute:

Coast Artillery Corps.
Engineering Corps.
Signal Corps.
Ordnance Department.
Air Corps.
Chemical Warfare Service.

All physically fit male students who are citizens of the United States, under twenty-eight years of age, and who are rated as first- or second-year students, are required by the rules of the Institute to register for the basic Military Science subjects.

Students who are permanently physically disqualified for all military service will be excused from all Military Science upon the student's petition, approved by the Medical Director.

Students temporarily disabled may be excused from such portion of the course as the Medical Director deems advisable.

Students who enter as second-year students will be excused from the first-year basic Military Science subjects.

Students who have satisfactorily completed the two years of the basic course and desire to qualify themselves for Reserve Commissions in any of the branches listed above may, with the approval of the Professor of Military Science and Tactics and the professor in charge of his Institute course, enroll for the two years of the Advanced Course. Students so enrolled receive commutation of rations at the rate of thirty cents per day from the beginning of the first term of the third year to graduation in the fourth year.

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. In case of injury to any building, or to any of the 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 caused 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. In case the offense be a less serious one, the student may be placed upon probation.

It is the aim of the Faculty so to administer the discipline of the school as to maintain a high standard of integrity and a scrupulous regard for truth. 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 make appeal for special consideration of his individual case. All petitions must be submitted on printed blanks furnished for the purpose, which may be obtained at the Information Office, Room 10–100.

Advisers. The Dean is the general consulting officer for students, and coöperates with the President in matters touching discipline and general student relations. In coöperation with the Technology Christian Association a number of upperclassmen are selected to act as advisers to incoming students. These men are assigned to students who have taken entrance examinations, and they will help new men in matters of registration, in the selection of rooms, etc.

On request to the Dean, advisers from the instructing staff will also be assigned to new students.

It is not intended that the advisers shall become, in any sense, guardian 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.

FEES, DEPOSITS, PAYMENTS, ETC.

Tuition Fees. The tuition fee for all students pursuing regular courses is $400 per year and must be paid *in advance* as follows: $200 before the opening of each term, the date and hour to be specified in the Registration Instructions issued prior to the opening of each term.

The tuition fees for students taking Course I-A or VI-A after the second year or X-A are $134 for the first term and $133 for the two succeeding terms.

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 to the Bursar, Room 10–180, 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 Breakage, Military Uniforms, etc. To cover chemical breakage and military uniforms, all first year men will be required to make a deposit of $15, from which the laboratory breakage charges and damage to military uniforms are to be deducted.

All upper classmen and graduate students taking courses requiring the use of the Division of Chemical Laboratory Supplies will be required to make a deposit of $25 against which supplies and breakage will be charged.

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

If the total of the breakage, etc., 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 all students registered the Institute will appropriate the sum of $3.50 per term per student ($7 per year) to be used as follows: The proceeds will be devoted to the promotion of student life at the Institute with special reference to the physical and social welfare of the students. No part shall 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	$0.36
Class Dues	.44
Athletics	5.80
Reserve and Contingent Fund	.40

Payments. *No bills are sent.* All payments should be made to Horace S. Ford, Bursar, Massachusetts Institute of Technology, Cambridge, Mass. *Students are strongly advised to make payments by mail as they will find it greatly to their convenience to do so.*

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.

Payment is required also for apparatus injured or destroyed in the laboratories, and for the cost of repair of damage by students to any other property of the Institute.

SCHOLARSHIPS, FELLOWSHIPS AND PRIZES

UNDERGRADUATE SCHOLARSHIPS

The Institute holds funds bequeathed or given to it from which undergraduate scholarships are awarded, and for several years the amount annually available for this purpose has averaged over $70,000.

It is the policy of the Faculty Committee on Undergraduate Scholarships to apply the available scholarship funds to the assistance of as many well qualified, needy students as possible by assigning, in general, amounts less than full tuition. Awards are made, except in a few special instances, only to students who have completed at least a year of satisfactory work at the Institute.

The facts considered in making assignments are the needs of the student and his ability as indicated by his scholastic record. Awards are divided between the terms of the year and the amount assigned to the second term may be cancelled if the recipient's record for the first term is unsatisfactory.

Applications for undergraduate scholarship aid should be made not later than February 15 on blanks to be obtained at Room 3-108. Applications by entering students for the Cambridge Scholarships should be filed before July 1 of the year in which they plan to enter the Institute.

The scholarships described below are arranged in the alphabetical order of their names, the figures in parenthesis being the dates of establishment:

Elisha Atkins Scholarship Fund (1894). Founded by Mrs. Mary E. Atkins of Boston with a gift of $5,000.

Edward Austin Fund (1899). By the will of Edward Austin, the Institute received a bequest of $400,000, the income of which is available for "needy, meritorious students and teachers to assist them in payment of their studies."

Thomas Wendall Bailey Fund (1914). By the will of Thomas Wendall Bailey, the Institute received a bequest, the income of which is used "in rendering assistance to needy students in the Department of Architecture."

Charles Tidd Baker Fund (1922). By the will of Charles Tidd Baker, the Institute received a bequest of $20,000, one-half of the net income of which is "applied each year to the assistance of poor and worthy students."

Billings Student Fund (1900). By the will of Robert C. Billings, the Institute received a bequest of $50,000 "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 Fund (1915). By the will of Frank W. Boles, the Institute received a bequest of $10,000 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 Scholarship Fund (1915). By the will of Hannah B. Abbe, the Institute received a bequest of $10,000 to constitute a fund "known as the Jonathan Bourne Scholarship Fund, the income only to be used in aid of deserving students."

Harriet L. Brown Scholarship Fund (1922). By the will of Harriet L. Brown, the Institute received a bequest "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 Scholarships (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 scholarships are for full tuition and are awarded by competition on the results of the regular entrance examinations. They are confined to students who make application furnishing evidence of need, and who obtain clear entrance records. They may be continued in the second, third and fourth years upon application, providing the holder maintains a satisfactory scholastic record and continues to furnish evidence of need. Forms of application for these scholarships, including complete regulations concerning them, may be obtained at Room 3-108. Applications by entering students should be filed before July 1 of the year in which they plan to enter the Institute.

Camp Devens Scholarship (1926). This scholarship was established by the Institute and is awarded to the member of the Citizens Military Training Camp at Camp Devens, Massachusetts, selected from the "Whites" or the "Blues," based on the reports and records transmitted to the First Corps Area Headquarters of the United States Army. Applicants must be men who have not sufficient funds to pay all expenses while at Technology, and must either pass, or have passed, the entrance examinations to the Institute. The scholarship will be awarded for the freshman year and will be renewed for the second and succeeding years upon application, providing the holder maintains a satisfactory scholastic record and continues to furnish evidence of need.

Mabel Blake Case Fund (1920). By the will of Caroline S. Freeman, the Institute received a bequest of $25,000 to constitute "a fund known as Mabel Blake Case Fund, income to be used to aid deserving students (preferably women) who are in need of assistance."

Nino Tesher Catlin Scholarship Fund (1926). From Maria T. Catlin, the Institute received a gift 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 . . . if possible . . . to a member of the Lambda Phi Fraternity."

Lucius Clapp Scholarship Fund (1905). From Lucius Clapp, the Institute received a gift to form a fund of which the net income is used "to aid worthy students who may not be able to complete their studies without help."

Class of '96 Scholarship Fund (1923). This fund was received from the M. I. T. 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.

Lucretia Crocker Scholarship Fund (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 Scholarship Fund (1903). By the will of James H. Danforth, the Institute received a bequest of $5,000 for scholarship purposes as a memorial to his brother, Isaac Warren Danforth.

Ann White Dickinson Scholarship Fund (1898). By the will of Ann White Dickinson, the Institute received a bequest of $40,000 "to establish free scholarships in M. I. T. . . . such persons enjoying benefit . . . shall be worthy young men of American origin."

Thomas Messinger Drown Scholarships (1928). By the will of Mary Frances Drown, the Institute received a bequest of $50,000, the net income of which was "to be used to establish scholarships for deserving undergraduate students, to be known as the Thomas Messinger Drown Scholarships."

Farnsworth Scholarship (1889). Founded by Mrs. Mary E. Atkins of Boston with a gift of $5,000.

Charles Lewis Flint Scholarship Fund (1889). By the will of Charles L. Flint, the Institute received a bequest of $5,000, the income of which was designated for the "support of some worthy student, preference to be given to some graduate of the English High School, Boston."

Sarah S. Forbes Scholarship Fund (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 by them in 1913 to the Institute. The income is available "for the maintenance and education of a scholar in M. I. T."

Norman H. George Fund (1919). By the will of Norman H. George, the Institute received a bequest "to be used for the assistance of needy and worthy students in obtaining an education in M. I. T."

Health Education Scholarships (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 the last day of July each year 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 for these scholarships should be made directly to the Head of the Department of Biology and Public Health.

George Hollingsworth Scholarship Fund (1916). By the will of Rose Hollingsworth, the Institute received a bequest of $5,000 to found a scholarship to be known as the George Hollingsworth Scholarship.

T. Sterry Hunt Scholarship Fund (1894). By the will of T. Sterry Hunt, for seven years Professor of Geology at Technology, the Institute received a bequest of $3,000 to found a scholarship in his name. This scholarship is restricted to students of Chemistry and preference is given to those in the higher years.

William F. Huntington Scholarship Fund (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 Fund (1928). By the will of Col. David L. Jewell, of Wollaston, Quincy, Norfolk County, Massachusetts, the Institute received a bequest of $25,000 "to establish a fund 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 Scholarship (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 Scholarship Fund (1910). By the will of William Litchfield, the Institute received a bequest of $5,000 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 Scholarship Fund (1890). By the will of Elisha Thacker Loring, the Institute received a bequest of $5,000, the income of which is available for "the assistance of needy and deserving pupils."

Lowell Institute Scholarship Fund (1923). This fund was received as a gift from the alumni of the Lowell Institute School to found an M. I. T. scholarship for graduates of that school.

George H. May Scholarship Fund (1914). From George H. May of the Class of 1892, the Institute received a gift of $5,000 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 Masters of the Newton High Schools." Beneficiaries under this fund are expected to issue a note agreeing to repay the face value, without interest, of amounts received.

Milton High School Scholarship 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.

James H. Mirrlees Scholarship Fund (1886). From James Buchanan Mirrlees of Glasgow, Scotland, the Institute received a gift of $2,500 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 Scholarship (1895). By the will of Mrs. Betsy F. W. Nichols, the Institute received a bequest of $5,000 to constitute a scholarship called 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 in the award is given to students in the Course in Chemistry.

Charles C. Nichols Scholarship (1904). By the will of Charles C. Nichols, the Institute received a bequest of $5,000 to constitute a scholarship.

John Felt Osgood Scholarship Fund (1909). By the will of Eliza B. Osgood, the Institute received a bequest of $5,000 "to establish and maintain a scholarship in Electricity in memory of my husband, John Felt Osgood."

George L. Parmelee Scholarship Fund (1921). By the will of George L. Parmelee, he bequeathed to the Institute "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 Scholarship Fund (1887). By the will of Richard Perkins, the Institute received $100,000, the income from half of which is available for the "support of free scholarships in said Institute."

Alumni Regional Scholarships (1926). As a means of obtaining the coöperation of 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 have been established. These awards are open to American citizens of good character and health whose standing in their preparatory school studies has been high. An applicant must have passed his entrance examinations with a good record and have fulfilled all other requirements for admission.

William Barton Rogers Scholarship (1904). In commemoration of the early association of President William Barton Rogers with William and Mary College of Virginia, the Institute established a scholarship with the value of $400 a year, to be known as the William Barton Rogers Scholarship. It is granted to a student nominated by the faculty of William and Mary College.

John P. Schenkl Scholarship Fund (1922). By the will of Johanna Pauline Schenkl, the Institute received a bequest of $20,000 "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 Scholarship Fund (1871). Founded with a gift of $5,000 from the English High School Association in memory of Thomas Sherwin. Holders of this scholarship must be graduates of the English High School of Boston and must be pursuing a regular course at the Institute.

Stevenson Taylor Scholarship (1928). The American Bureau of Shipping has established a scholarship in memory of Stevenson Taylor, its late President. The scholarship, which is tenable for two years, carries an annual stipend of $500 and is awarded in alternate years to a deserving third-year student (who must be an American citizen) in the Ship Operation Option of the Course in 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 Fund (1924). By a gift from the Boston Society of Civil Engineers, this fund was established to aid a worthy student in Civil Engineering. The Institute is required to advise the Society annually of the disposition of this income.

F. B. Tough Scholarship (1924). This fund is established "for the purpose of extending financial assistance to worthy students." Preference is given to students in Mining or Oil Production.

Susan Upham Scholarship Fund (1892). From Susan Upham the Institute received a gift of $1,000, the income to be used "to assist students deserving financial aid."

Samson R. Urbino Fund (1927). By the will of Samson R. Urbino the Institute received a bequest of $1,000, the income of which is "to be used to aid students who need assistance, Germans preferred."

Vermont Scholarship (1924). From Redfield Proctor of the Class of 1902, the Institute received a gift of $6,000 (in 1928 increased to $8,000) 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."

Ann White Vose Scholarship Fund (1896). By the will of Ann White Vose, the Institute received a bequest 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 Mechanical Engineering Scholarship Fund (1925). By the will of Arthur M. Waitt, the Institute received a bequest of $10,000, the income of which is used in "assisting needy and deserving students in the second, third and fourth year classes of the Mechanical Engineering Course of said Institute."

Louis Weissbein Scholarship Fund (1915). By the will of Louis Weissbein, the Institute received a bequest of $4,000 "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 Jewish students in the Department of Architecture.

Frances Erving Weston Scholarship Fund (1912). By the will of Frances Erving Weston, the Institute received a bequest, the income of which is available "to aid a native born American Protestant girl of Massachusetts."

Samuel Martin Weston Scholarship Fund (1912). By the will of Frances Erving Weston, the Institute also received a bequest to found a scholarship in memory of her husband, Samuel Martin Weston. The income from this fund is available "to aid a native born American Protestant boy, preference to be given one from Roxbury."

Amasa J. Whiting Fund (1927). By the will of Mary W. C. Whiting, the Institute received a bequest of $2,000 "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 Fund (1912). By the will of Mrs. Francis B. Greene, the Institute received a bequest, the income of which is "applied to assist poor and deserving young men and women obtaining an education at M. I. T."

Morrill Wyman Fund (1915). By the will of Morrill Wyman, the Institute received a bequest, 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."

The Youth's Companion Scholarship (1926). Through its department known as the Y. C. Lab, a junior national scientific society composed of boys interested in engineering, technical and scientific pursuits, the *Youth's Companion* established a four-year scholarship carrying full tuition. The award is made by the Governors of the Y. C. Lab to an applicant who has passed the entrance requirements of the Institute. Continuance of the scholarship during the second and succeeding years depends upon the recipient maintaining a satisfactory scholastic standing.

FELLOWSHIPS AND GRADUATE SCHOLARSHIPS

Fellowships and graduate scholarships amounting to approximately sixty-three thousand dollars will be available in 1929–30 to assist students in pursuing graduate work leading to the Master's and Doctor's degrees.

Applications for financial aid should be filed with the Secretary of the Committee on Graduate Courses and Scholarships on or before the first of March. This rule applies both to original applications and to renewals of previous grants. If funds are available, applications for grants will be considered during the school year.

An application for scholarship aid must be accompanied by an application for a course of advanced study leading to the Master's or Doctor's degree and an official transcript of the applicant's college record, if these papers have not been filed previously. Both applications must be made on forms which may be obtained from the Dean of Graduate Students or the Secretary of the Committee on Graduate Courses and Scholarships.

In the award of graduate scholarships the committee will consider first, the ability of the candidate to pursue advanced study and research; second, his pecuniary need. Scholarship awards become available in two installments, namely at the beginning of each of the two regular terms. Grants are not made unreservedly, but their continuance from term to term is dependent on the recipient maintaining a satisfactory standard of scholarship.

The awards made to students proceeding towards the Master's degree will in general be in sums sufficient to cover tuition, that is, $400. The same is true of awards made to students proceeding towards the doctorate, who have not previously been in residence at the Institute for at least one term.

A limited number of traveling scholarships are open to Institute graduates and to members of the instructing staff. Students planning to study abroad should consult the Dean of Graduate Students in regard to special privileges offered by universities and technical schools of various countries in coöperation with the Institute of International Education.

The recipient of a scholarship grant is expected to complete the period of study for which he has received the grant. In case he discontinues his work before the end of such period he will be expected to refund the entire amount of the grant received, unless released therefrom for satisfactory reasons by the Committee on Graduate Courses and Scholarships.

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.

Holders of Institute Traveling Fellowships are expected to present to the Secretary of the Committee on Graduate Courses and Scholarships on or before the first of April and the first of October of each year a full report of the progress of their work. This report should include not only a statement of all 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.

Fellows who have studied abroad under Institute grants may be requested to give at the Institute one or more lectures embodying the result of their advanced study and research at some time subsequent to the conclusion of their graduate work, the subject, number of lectures, and time at which they are to be given to be arranged in consultation with the professor in charge of the department of study in which the fellowship was awarded.

ENDOWMENT FUNDS APPLICABLE TO FELLOWSHIPS AND GRADUATE SCHOLARSHIPS 1929–1930

Austin Fund (1899). Founded by a bequest of Edward Austin, to assist meritorious students and teachers in the pursuit of their studies. From this fund approximately $24,000 will be available for graduate scholarships to meet the tuition fees of full time students and of members of the Instructing Staff who are working towards the Master's or Doctor's degrees.

Austin Research Fellowship (1909). Carrying an award of $1,000, open to candidates for the Doctor's degreees who have shown exceptional ability in the field of research.

Jonathan Whitney Fund (1912). The income from this fund, established by Mrs. Frances B. Greene, is available for the purpose of aiding students who need financial assistance in obtaining an education at the Institute; $2,000 available for tuition of graduate students.

William Sumner Bolles Fellowship (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 or promise. Stipend $1,250.

Malcolm Cotton Brown Fellowship (1922). Established by Charles A. Brown and Caroline C. Brown in memory of their son, Lieut. Malcolm Cotton Brown, '19, for the purpose of stimulating advanced study and research in Physics. The income is available annually to a senior in high standing in the course in Physics. Only in exceptional cases where the recipient has greatly distinguished himself is the award made for a second year to the same student. Stipend $1,000.

Henry Saltonstall Fellowship (1901). Founded by the bequest of Henry Saltonstall. The income to be used to aid students, whether undergraduates or graduates, pursuing advanced courses. Stipend $550.

James Savage Fellowship (1873). Founded by the late James Savage, the income to be awarded to 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 $600.

Susan H. Swett Fellowship (1888). Founded by Susan H. Swett, the income to support a graduate student. Awarded annually to 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 reëligible for a second year. Stipend $500.

Louis Francisco Verges Fellowship (1924). Established by Caroline A. Verges, the income to be awarded to a meritorious student, either graduate doing research in the field of the sugar industry, or if there be no such candidate, an undergraduate in the Department of Civil Engineering. Stipend $500.

Charles H. Dalton Scholarship (1896). Founded by Charles H. Dalton, the income to be used 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 $350.

Moore Traveling Fellowship (1914). The income from a fund, the gift of Mrs. F. Jewett Moore, is available 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 $700.

Ellen H. Richards Memorial Research Fund (1912). Established by subscription. The income of this fund will be devoted to the promotion of research in Sanitary Chemistry, the branch of science to the development of which Mrs. Richards so greatly contributed. The income will be utilized by the Institute for the award of fellowships to advanced students competent to pursue this line of research, for the employment of research assistants, and in such other ways as will best promote investigation in the field in question.

Richard Lee Russel Fund (1904). Founded by Theodore E. Russel in memory of his brother Richard Lee Russel. The income to be devoted to assisting some worthy student of high standing in the Department of Civil Engineering to continue his studies either as postgraduate or undergraduate. Stipend $110.

Willard B. Perkins Fund (1898). Founded by a bequest of Willard B. Perkins, of the Class of '72. The income, amounting to one thousand dollars, available every fourth year for a traveling scholarship in Architecture. (Available 1930–31).

Rebecca R. Joslin Graduate Scholarship Fund (1924). The income from this fund is available as a loan to students pursuing advanced work in Chemical

Engineering. Any student receiving benefit from this fund is expected to abstain from smoking and the use of tobacco in any form.

Collamore Fund (1916). Bequest of Helen Collamore, the income to be applied primarily to the aid of women students in graduate courses; $700 available.

Henry Bromfield Rogers Fund (1921). Founded by Anna Perkins Rogers. The income from this fund is used for fellowships or scholarships for women graduates of the Institute or other colleges, whose graduate work is carried on at the Institute; $1,200 available.

SPECIAL FELLOWSHIPS AND GRADUATE SCHOLARSHIPS, 1929–1930

Institute of Technology Graduate Scholarships. Open to students in all Departments; $17,000 available.

Traveling Fellowship in Architecture. Fifteen hundred dollars to be devoted to travel and study abroad under the direction of the Department of Architecture. This fellowship is open to regular and special students who have passed at least two consecutive years in the school, one of which must have been in the graduate year.

Crane and Sloan Research Fellowship in Automotive Engineering. Established by Henry M. Crane and Alfred P. Sloan, Jr. Several fellowships, each carrying a stipend of $1,000, are available to properly qualified graduate students engaged upon fundamental research in the field of Automotive Engineering.

du Pont Fellowship. Offered by the du Pont de Nemours Company; open to graduate students in Chemistry and Chemical Engineering. Stipend $750.

du Pont Scholarship. Donated by the du Pont de Nemours Company and open to a student in Mechanical Engineering. Stipend $400.

Daniel Guggenheim Fellowship in Meteorology. Established by the Daniel Guggenheim Fund for the Promotion of Aeronautics, Inc. Open to graduate students, properly qualified to undertake advanced work in Meteorology. Stipend $1,000.

Nickerson Fellowship (1929). Offered by William E. Nickerson. Open to a graduate of the Institute, of high scholarship attainments. Stipend $500.

Proctor Fellowship in Physics (1929). Offered by Redfield Proctor. Open to a graduate of high standing in the senior class of the Department of Physics for graduate study in Physics abroad. Stipend $1,000.

Swope Fellowships. Offered by Gerard Swope. Two fellowships, one of $1,000 and one of $500, have been established to enable students in the Honors Group in the Department of Electrical Engineering to proceed with graduate study, and one fellowship of $1,000 has been established for a similar purpose in the Department of Physics.

Textile Research Fellowship. Offered by the Arkwright Club to encourage properly qualified students to pursue graduate study and research in the field of textiles; $2,000 available.

PRIZES

The following annual prizes are offered to the students of the Department of Architecture, and are awarded through competitions in Design.

The Boston Society of Architects' Prize. The gift of the Society. A prize of one hundred and fifty dollars for the best design submitted by a present or former student of Harvard, Technology or the Boston Architectural Club on one of the regular conjunctive programs.

The Chamberlin Prize. The gift of Mr. W. E. Chamberlin, class of 1877. Twenty-five dollars awarded to a student in the graduate class in Design.

The F. W. Chandler Prizes. The gift of the alumni of the Department and of Professor Chandler's friends. Five prizes of ten dollars each awarded for sketch problems in the third, fourth and graduate years.

The "Class of 1904" Prize. The gift of the class of 1904. A prize of fifteen dollars awarded to a student in the junior class in Design.

Rotch Prizes. The gift of Mr. Arthur Rotch. Two prizes of two hundred dollars awarded at the end of the senior 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.

Student Medal of the American Institute of Architects. This medal is awarded on the recommendation of the Department to the member of the graduating class whose record for the course is the best.

Department of Architecture Medals. At the end of each academic year the bronze medal of the Department is given to the winner of each prize, also to students in Grades IV and V with the highest number of "medal" values.

Summer Sketching Prizes. A prize of twenty-five dollars for the best set of outdoor summer sketches in pencil or pen and ink, and a prize of equal amount for the best set of outdoor summer sketches in water colors or wash.

William R. Ware Prizes. In memory of the founder of the department. Fifty and twenty-five dollars for first and second prizes 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 Prize. The American Bureau of Shipping awards a prize of one hundred dollars in gold annually to the student graduating in Naval Architecture and Marine Engineering who attains the highest average in scholarship throughout for the last two years of the course. The prize is awarded to American citizens only.

The following prize is offered to students in Aeronautical Engineering:

James Means Prize Fund. An annual prize is to be given for a paper on an aeronautical subject.

COURSES OF STUDY OFFERED

The Institute gives instruction in English, History and Political Science, and in other general studies which are essential to a liberal education. It also gives a thorough training in the fundamental sciences of chemistry, physics and mathematics, and in the important application of the principles of these sciences to the various branches of engineering and applied science. It lays far more stress on the development of the power to deal effectively with new engineering or scientific problems than on the acquirement of an extensive knowledge of details. In order to attain these results, much of its classroom instruction is given to small sections of students, and in its laboratories and drawing-rooms students receive a large amount of personal attention. The independent solution of assigned problems forms a large part of nearly all its courses. A large proportion of liberal studies of a literary and general scientific character are insisted upon and courses upon technological methods and other highly specialized subjects are largely excluded; for, while the latter are sometimes important in special industries, they are not essential to a broadly trained engineer, who can readily acquire later the necessary technical knowl-

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The sum of the time assigned to exercises and of that estimated as being normally necessary for the outside preparation for them in all courses is from forty-eight to fifty hours each week.

Following the first, second or third year, certain of the professional courses require attendance at summer classes.

In addition to the prescribed subjects, all students in most regular courses are required to devote a specified amount of time to elective work in General Studies.

Courses of study leading to the Bachelor's degree are offered in the several branches of science and engineering named below. (See pages 67 to 136 for course schedules.)

Special attention is, however, called to the fact that admission to the Institute does not guarantee subsequent admission to any particular professional course nor to certain special courses, which may be open only to the extent of professional equipment and may be restricted to citizens of the United States or to minors whose parents are citizens of the United States.

Aeronautical Engineering, Course XVI.
Architecture, Course IV.
Architectural Engineering, Course IV-A.
Biology and Public Health, Course VII, with options in Biology and Public Health (1), Industrial Biology (2) and Public Health Engineering (3).
Building Construction, Course XVII.
Chemical Engineering, Course X, and Chemical Engineering Practice, X-B.

Chemistry, Course V.

Civil Engineering, Course I, with options. (1) General; (2) Transportation Engineering and (3) Hydroelectric Engineering. Also Coöperative Course in Railroad Operation, I-A.

Electrical Engineering, Course VI. Also option in Communications Engineering, VI-C, and Coöperative Course in Electrical Engineering, VI-A.

Electrochemical Engineering, Course XIV.

Engineering Administration, Course XV, with options in Civil, Mechanical and Electrical, and Chemical Engineering.

General Science, Course IX-A.

General Engineering, Course IX-B.

Geology, Course XII.

Mathematics, Course IX-C.

Mechanical Engineering, Course II.

Mining Engineering and Metallurgy (including Petroleum Production), Course III, with options in Mining Engineering (1), Petroleum Production (2), Metallurgy (3) and Physical Metallurgy (4).

Military Engineering.

Naval Architecture and Marine Engineering, Course XIII (1) with an option in Ship Operation (2).

Physics, Course VIII.

Sanitary Engineering, Course XI.

In most of these courses distinct options or electives in professional subjects are offered which enable the student to concentrate more of his attention upon some one side of his profession. In no case, however, is the specialization carried so far as to preclude a thorough training in all the fundamental branches of the subject.

It will be observed that in addition to the courses in the various branches of engineering, the Institute offers courses in the other important branches of applied science. Thus the courses in industrial chemistry, metallurgy, public health and industrial biology serve to prepare students as scientific experts and for professional positions in manufacturing establishments and government laboratories. Thorough courses in pure science, namely, in chemistry, physics, biology, geology and general science, are also offered. These give the training required for teaching positions in technological institutions, colleges and preparatory schools, and for research positions in the departments of the Government, the industries and in private laboratories. The course in Biology and Public Health furnishes, too, an exceptional training for the subsequent study of medicine in medical schools of the graduate type. Special opportunities leading to the Certificate in Public Health and in Public Health Education are also offered.

The course in Architecture is a course of an artistic as well as a scientific character, involving a large amount of instruction and training in the fine arts.

The course in Engineering Administration provides a training for men who expect to enter upon administrative work in enterprises which demand a knowledge of scientific and engineering principles.

Choice of Professional Course. All these courses, except Architecture, are identical in the first year. The student therefore may change his course of study at any time before the beginning of the second year. In making the choice, of course, the primary consideration should be the student's tastes and aptitudes, as shown by the results of his previous work at the Institute and in his preparatory school, rather than any supposed pecuniary or other advantages attaching to special professions.

General Studies. The object of these studies is to promote breadth of intellectual interest. Most of the student's time beyond the second year is necessarily devoted directly or indirectly to increasing his future professional efficiency and even in the earlier years this has been the underlying purpose of most of the work. Without attempting any discrimination between general and professional, or liberal and technical studies, the Faculty has aimed to include in the list of general studies subjects so far removed from the professional field that the student shall acquire in some measure new points of view and a wider mental horizon. Even subjects which have an implied relationship to the professional fields are presented with such emphasis on their broader general aspects as to serve the purpose indicated.

PROFESSIONAL SUMMER SCHOOLS

To bring the students into closer relations with the practical side of their professions, professional summer schools are held in the departments of Civil Engineering, Mining and Metallurgy and Geology. 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, compass, transit and level, the entire fieldwork in surveying and railroad engineering is given at Camp Technology on the shore of Gardner's Lake near the village of East Machias, Maine. This locality is well adapted for the carrying out of all the operations involved in the various problems of plane surveying; for performing the fieldwork necessary for the making of large and small scale topographic maps; and for the making of railroad location surveys. Gardner's Lake is specially favorable for carrying on the fieldwork necessary to hydrographic surveying. The Machias and East Machias rivers are available for stream gaging by means of floats and by the various types of meters. Some of the smaller streams afford opportunity for weir measurements.

The camp property comprises about eight hundred and fifty acres of rolling land in the form of a strip varying in width from one-fourth to one mile with a shore line of five miles on the lake. The main group of buildings consists of an administration building connected by covered passages with buildings on either side and in the rear. This group of buildings contains three recitation rooms accommodating some one hundred and thirty students, a drafting room with space for seventy-two students, a dining room seating one hundred and sixty, office accommodations for an instructing force of twenty-four, a large lounge room, three sleeping rooms, a camp store and post office, an instrument room, kitchen, icehouse, toilet room and lavatories, and a dormitory for the service staff. Sleeping quarters for students are provided in eight wooden barracks, each containing six double rooms; tents on raised platforms are also available for twenty students. An additional barracks building is used by members of the faculty in residence at the camp, and another large wooden building furnishes sleeping accommodations for other members of the instructing staff. The latter building also provides drafting space for twenty-four. The camp is equipped with excellent sanitary facilities, a wholesome water supply from driven wells and an electric light plant. An infirmary which serves as an emergency hospital contains the quarters of the physician who is in constant attendance throughout the camp session.

The camp is intended primarily for students of Courses I, I-A, XI, and XV Option 1, but students from other courses having the requisite preparation will be admitted.

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 $100.

Summer School of Surveying for Mining Engineers and Geologists. 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 for students in Course XII, between their third and fourth year. The camp, which is about two hours' distance from New York City, on the Lackawanna Line, has been selected because of its unequaled situation with reference to mines, famous geological exposures and topography. The fee is $100. Deposit for board and incidental expenses is $85.

Summer School in Mining Practice. Mining Practice, 3'08, required of all students in Course III, Options 1 and 2, either between the second and third or between the third and fourth years, is given at the Summer Mining Camp. The fee is $10; deposit for board and incidental expenses, $20.

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. There is no registration fee, but each student will pay his own expenses estimated at $75 round trip from Boston.

Summer School of Surveying. Students in Courses III, Option 3, VI and VI-A are required to take Surveying and Plotting, 1'02, in the early part of the summer following their second year. The instruction is given in Cambridge and vicinity. The fee for this course is $30.

Summer School in Field Geology. A ten-day summer course in an area in the Highlands of New Jersey where an interesting geological history is presented, and where Cambrian and Ordovician sediments are conspicuously folded and faulted. Instruction and practice is given in detailed geological mapping and in field methods of geological work. September 13 to 23 inclusive. Tuition fee $25. Deposit for living and incidental expenses $30.

REQUIREMENTS FOR ADMISSION

Admission to the First Year. To be admitted as a first-year student the applicant must have attained the age of seventeen years and must meet the entrance requirements as follows: (Numbers in parentheses indicate the ordinary "unit" rating. They are given for purposes of comparison and require no attention from candidates for admission to the Institute.)

1. Must pass examinations in:
   Algebra (2).
   Plane Geometry (1).
   Solid Geometry (½).
   Trigonometry (½).
   Physics (1).
   English (3).
   Foreign Language — **ONE** of the combinations below (*a*, *b* or *c*):
   (*a*) French, elementary (2) and French, intermediate (1).
   (*b*) German, elementary (2) and German, intermediate (1).
   (*c*) French, elementary (2) and German, elementary (2).
2. Must pass **examination** or present school **record of certificate grade** in:
   History (1).
3. Must pass **examination** or present school **record of passing grade** in:
   Chemistry (1).
4. Must pass **examination** or present school **record of passing grade** for:
   Electives.
   Two units if language group (*a*) or (*b*) is offered.
   One unit if language group (*c*) is offered.

Electives may be offered from the following list: others will be considered. (Application for the acceptance of other subjects may be addressed to the Committee on Admissions.)

Biology (1).
Botany (1).
English, additional (1).
French, intermediate* (1).
German, intermediate* (1).
History, additional (1).
Latin (2). (Not less than two units accepted.)
Spanish (1).
Zoölogy (1).

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 and Geneva. Applicants taking examinations under the College Entrance Examination Board should do so under "Plan A." Information in regard to these examinations may be obtained by writing to the Secretary of the College Entrance Examination Board, 431 West 117th Street, New York.

In September the Institute conducts its own examinations which are held in Cambridge only. Correspondence in regard to these examinations and other questions relating to admission or courses of study should be addressed to the Committee on Admissions.

Candidates are advised to attend the June examinations in order that any deficiencies may be made up during the summer.

*If offered in excess of the requirement under *c*.

C. E. E. B. Examinations, June 17–22, 1929. 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, 1929, will be published by the Board about March 1.

Table of Equivalents. The following table shows for which subjects records of the College Entrance Examination Board are accepted as covering requirements for admission to the Institute.

M. I. T. Subjects	*C. E. E. B. Subjects*
Algebra	Mathematics A, or A1 and A2
Chemistry	Chemistry
English	English Cp or 1–2
French (Elementary)	French Cp 2
French (Intermediate)	French B
Geometry, Plane	Mathematics C or cd (minor requirement)
Geometry, Solid	Mathematics D
German (Elementary)	German Cp 2
German (Intermediate)	German B
History	History A to D inclusive*
Physics	Physics
Plane Trigonometry	Mathematics E
Electives	History A to D inclusive: Latin Cp 2; French B or Cp 3; French Cp 4; German B or Cp 3; German Cp 4; Spanish; Botany; Zoölogy; Biology.

Records of 60 or above will be accepted, except as noted below.

Candidates are expected to take the separate examinations in Geometry, C and D, but a record in Geometry CD (major requirement) will be accepted. If the single examination in Geometry CD is taken, a record of at least 70 is required.

Records in Mathematics Cp 3 and Mathematics Cp H are not accepted.

Candidates are expected to take, if practicable, the divided examinations in both French and German, but if the single examination, Cp 3, is taken, a record of 60 or above will be accepted as covering both elementary and intermediate.

* No examination in American History without Civil Government will be offered.

Schedule of Examinations to be Held at Institute in September 1929 and 1930

(Application in advance for admission to the examinations is not necessary. Candidates will register during the examination period.)

1929		1930
September 18	**Wednesday**	**September 17**
Algebra		9.00 a.m. to 12.00 m.
Physics		2.00 p.m. to 4.00 p.m.
September 19	**Thursday**	**September 18**
English		9.00 a.m. to 11.00 a.m.
Plane Geometry		11.15 a.m. to 1.00 p.m.
French (Elementary)		2.00 p.m. to 4.00 p.m.
September 20	**Friday**	**September 19**
Solid Geometry		9.00 a.m. to 10.45 a.m.
German (Elementary)		11.00 a.m. to 1.00 p.m.
Trigonometry		2.00 p.m. to 4.00 p.m.
September 21	**Saturday**	**September 20**
French (Intermediate)		9.00 a.m. to 11.00 a.m.
German (Intermediate)		11.00 a.m. to 1.00 p.m.
History (U. S. or Ancient)		2.00 p.m. to 4.00 p.m.

Entrance Examination Fee. (See Page 37.)

Division of Entrance Examinations. Candidates are allowed to spread their entrance examinations over three consecutive periods (a period meaning June and September of the same year).

A preliminary candidate is one who is taking examinations a year or more in advance of his anticipated admission. He may take examinations either in June or September, but is not allowed to repeat in September any examinations in which he has failed in June. The examinations in Physics and Trigonometry should be taken not more than one year before admission and the study of Mathematics and English should have been continued during the year immediately preceding admission.

Application for Admission. Candidates should write to the Committee on Admissions for blank forms on which to make application, and also for blanks on which to present school records when completed.

Conditions. A candidate for admission in September of any year must take at that time examinations in all subjects not already passed.

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. An applicant passing any of these subjects will be excused from taking the corresponding entrance examination.

General Preparation. The student 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 examination is important, for the character and the amount of instruction given in the Institute leave little opportunity to make up deficiencies. The training given in the best high and preparatory schools will, in general, afford suitable preparation.

In entrance mathematics, importance will be attached to accuracy in the numerical work of the papers and to satisfactory freehand sketches in geometry and trigonometry. Familiarity with the metric system is required.

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. A considerable portion of the mathematics should be given during the final years of preparation.

The requirements of age and scholarship specified herewith are regarded as a minimum in all ordinary cases, and only exceptional circumstances will justify any relaxation.

Registration in advance for admission to the first year is at present unnecessary, as admission depends only upon the satisfactory completion of the entrance requirements.

DEFINITIONS OF REQUIRED SUBJECTS

Mathematics. The present formulation of the requirements was adopted in 1923 on the recommendation of a commission appointed by the College Entrance Examination Board.

The requirements conform in substance to the recommendations of the National Committee on Mathematical Requirements appointed in 1918 by the Mathematical Association of America.

Elementary Algebra. This requirement consists of the College Board Mathematics A1 and Mathematics A2 combined. The corresponding examination at the Institute (in September only) covers both parts of the Elementary Algebra.

Algebra to Quadratics (Mathematics A1). (1) The meaning, use, evaluation, and necessary transformations of simple formulas, and the derivation of such formulas from rules expressed in words. (2) The graph, and graphical representation in general. The construction and interpretation of graphs. (3)

Negative numbers; their meaning and use. (4) Linear equations in one unknown quantity, and simultaneous linear equations involving two unknown quantities, with verification of results. Problems. (5) Ratio, as a case of simple fractions; proportion, as a case of an equation between two ratios; variation. Problems. (6) The essentials of algebraic technique. (7) Exponents and radicals; simple cases. (8) Numerical trigonometry.

Quadratics and Beyond (Mathematics A2). (1) Numerical and literal quadratic equations in one unknown quantity. Problems. (2) The binomial theorem for positive integral exponents, with applications. (3) Arithmetic and geometric series. (4) Simultaneous linear equations in three unknown quantities. (5) Simultaneous equations, consisting of one quadratic and one linear equation, or of two quadratic equations of certain types. Graphs. (6) Exponents and radicals. (7) Logarithms.

A summer course (M1) is given in Algebra, covering the above subjects.

Plane Geometry. The usual theorems and constructions given in good textbooks, including the general properties of plane rectilinear figures; the circle and the measurement of angles; similar polygons; areas; regular polygons and the measurement of the circle.

The solution of numerous original exercises, including loci problems.

Applications to the mensuration of lines and plane surfaces.

The scope of the requirement in Plane Geometry is indicated by a syllabus published by the College Entrance Examination Board. The examination will consist partly of book propositions and partly of originals. In the former type of question the candidate will be asked to give proofs of standard theorems which are assumed to have been presented to him in his course of study, or to reproduce standard constructions. In the latter type are included the demonstration of theorems which are not assumed to be familiar to the candidate, problems of measurement and calculation, and problems in the working out of unfamiliar constructions and the identification of unfamiliar loci. Questions calling for simple geometrical knowledge and understanding may fall under either type.

The originals on the examination will in general depend for their solution on propositions mentioned in the syllabus, but occasionally the original will be so framed that a solution will occur more readily to the candidate who is familiar with such important geometrical facts as the properties of the 30° and the 45° right triangles.

With regard to constructions, the candidate is expected to be able to perform and to describe accurately those listed at the end of the syllabus published by the College Entrance Examination Board, and also, as originals, others based on these. He is not required to give proofs of constructions unless a proof is specifically called for by the question, and such proofs will not be regarded as constituting a part of the book-work requirement, but will have the status of originals. The candidate is expected to be provided with ruler and compasses.

Solid Geometry. The usual theorems and constructions of good textbooks, including the relations of planes and lines in space; the properties and measurement of prisms, pyramids, cylinders, and cones; the sphere and the spherical triangle.

The solution of numerous original exercises, including loci problems.

Applications to the mensuration of surfaces and solids.

The scope of the requirement in Solid Geometry is indicated in a syllabus published by the College Entrance Examination Board. The examination will consist partly of questions on book propositions and partly of originals.

A summer course (M3) is given in this subject.

Plane Trigonometry. In this requirement are included the following topics: (1) Definition of the six trigonometric functions of angles of any magnitude, as ratios. The computation of five of these ratios from any given one. Functions of 0°, 30°, 45°, 60°, 90°, and of angles differing from these by multiples of 90°. (2) Determination, by means of a diagram of such functions as in (A+90°) in terms of the trigonometric functions of A. (3) Circular measure of angles; length of an arc in terms of the central angle in radians. (4) Proofs of the fundamental formulas, and of simple identities derived from them. (5) Solution of simple trigonometric equations. (6) Theory and use of logarithms, without the introduction of work involving infinite series. Use of trigonometric tables, with interpolation. (7) Derivation of the Law of Sines and the Law of Cosines. (8) Solution of right and oblique triangles (both with and without logarithms) with special reference to the applications. Value will be attached to the systematic arrangement of the work.

A summer course (M4) is given in this subject.

Chemistry. Applicants must present evidence of familiarity with the rudiments of chemistry. More importance is attached to aptitude in manipulation and in critical observation, and to a practical knowledge of the composition, methods of preparation, and reactions of the common chemical substances, than to a knowledge of theoretical conceptions, such as the determination of atomic and molecular weights, molecular structure, valence, etc. A certificate in Chemistry must indicate a passing grade and must show 150 hours of work.

A summer course (5·00) is given in this subject.

Physics. The candidate will be expected to be familiar with the fundamental principles of Physics. It is especially desirable that he should have a good knowledge of general mechanics and of the mechanics of solids, liquids, and gases. A knowledge of physical hypotheses is comparatively unimportant. Textbook instruction should be supplemented by classroom experiments. A sufficiently extended treatment of the subject will be found in any of the principal textbooks now in use in secondary schools. Ability to solve simple problems will be expected.

It is furthermore expected that the student will receive training in laboratory work. Deficiency in laboratory work will not necessarily lead to rejection, provided the school from which the student comes is unable to furnish such instruction. In this case, however, a certificate of such inability will be required from the principal of the school.

The laboratory work required for entrance should consist of at least twenty-five well selected experiments, chosen with the view of illustrating and teaching fundamental laws and principles rather than methods of physical measurement. This work should preferably come during the school year immediately preceding the student's entrance. A satisfactory selection may be made from Experiments 1 to 51 of the College Entrance Examination Board.

A summer course (8·00) is given in this subject.

English. The examination in English is intended as a test of the candidate's ability to express himself clearly and simply, and of his capacity for using his past experience and reading in expressing elementary processes of thought.

In preparation for the examination the candidate should have done a considerable amount of reading, chosen from authors of recognized worth. The books adopted by the National Conference on Uniform Entrance Requirements are taught in most secondary schools, and the candidate may, if necessary, use these in his preparation. In any case it is expected that the aim of preparatory study will be, first, to develop in the pupil a consciousness that words, if understood, convey definite ideas and, secondly, to form in him the habit of comparing these ideas with his own experience and his own views.

The candidate will be required to write upon subjects familiar to him, or to comment on a literary treatment of some such subject. When questions of a literary sort are asked, they are intended rather as a test of the candidate's power to read intelligently than of his knowledge of specific books.

The composition should be correct in spelling, punctuation, grammar, idiom, and the formation of paragraphs, and should be plain and natural in style. The candidate will be judged by how well he writes rather than by how much he writes.

A summer course (E1) is given in this subject.

French (Elementary). The requirement for Elementary French is a systematic course of four or five periods a week extending over at least two school years, each year representing not less than 120 full sixty-minute periods or the equivalent. Training in pronunciation and in the understanding of easy spoken French is regarded as an essential part of this requirement.

The examination in Elementary French covers the following:

(*a*) Ability to read simple prose at sight and to translate it into clear and idiomatic English.

(*b*) Proficiency in elementary grammar, to be tested by the translation of easy English into French and by questions on the following topics: inflection of nouns and adjectives for gender and number; pronominal adjectives; the forms and positions of pronouns, especially the personals; the partitive construction; the forms and use of numerals; the use of the subjunctive, except unusual cases; the conjugation of the regular and of the more common irregular verbs. Special attention will be given to the verbs.

A summer course (L51 and L52) is given in this subject.

French (Intermediate). This course should consist of recitations partly conducted in French. It should comprise a continuation of the study of grammar, the study of a book on composition, translation into French of connected passages, dictation, reading and translation of some standard modern authors.

At the end of the course the student should be able to pronounce French reasonably well, to understand easy spoken French, express simple ideas in French, especially those dealing with travel, and read works of ordinary difficulty with considerable ease.

A summer course (L61 and L62) is given in this subject.

German (Elementary). The requirement for Elementary German is a systematic course of four or five periods a week extending over at least two school years, each year representing not less than 120 full sixty-minute periods or the equivalent.

Training in pronunciation and in the understanding of easy spoken German is regarded as an essential part of this requirement.

The examination in Elementary German covers the following:

(*a*) Ability to read simple prose at sight and to translate it into clear and idiomatic English.

(*b*) Proficiency in elementary grammar, to be tested by the translation of easy English into German, and by questions on the following topics: the conjugation and synopsis of the regular and of the more usual irregular verbs; declension of readily classified nouns, of adjectives, articles, pronouns; comparison of adjectives and adverbs; use of the more common prepositions; the simpler uses of the modal auxiliaries; simple cases of indirect discourse, and the rules for the order of words.

A summer course (L11 and L12) is given in this subject.

German (Intermediate) This course should include a systematic review of grammar. The reading, scientific as well as literary, should become more difficult, and the syntax, idiom and synonyms of the language should be carefully studied in a series of composition exercises.

By the end of the course the student 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 with a good pronunciation.

A summer course (L21 and L22) is given in this subject.

Note. It is expected that the translations from French and German will be written in correct and expressive English; and these papers may at any time be examined as additional evidence in determining the student's proficiency in composition.

History. The History requirement may be met by presenting a record of certificate grade or by passing the examination in any of the following subjects: Ancient, European, English or American History. The Institute offers only examinations in Ancient and United States History. In United States History a thorough acquaintance with the history of the Thirteen Colonies and of the United States to the present time is required, together with an elementary knowledge of the government of the United States. In Ancient History the requirement covers the history of Greece and Rome to the fall of the Roman Empire in the West.

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Each of the above subjects is intended to represent one year of historical work, wherein the study is given five times a week, or two years of historical work, wherein the study is given three times a week.

The examination in History will be so framed as to require comparison and the exercise of judgment on the pupil's part, rather than of mere memorizing. The examinations will presuppose the use of good textbooks, collateral reading and practice in written work. Geographical knowledge may also be tested.

Candidates expecting to take the Course in Architecture are advised to prepare in Ancient History.

DEFINITIONS OF ELECTIVE SUBJECTS

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.

These requirements are to be met by the presentation of certificates made out on forms supplied by the Institute.

Excuse from the elective requirement, or the acceptance of an equivalent, may be allowed in the case of applicants considerably above the usual age, or those coming from foreign countries. In general it is desired that electives should not be chosen with reference to anticipation of subjects in the Institute curriculum. Applicants desiring advance credit for such work will be expected to pass the usual examinations for advanced standing.

Elective Biological Subjects. Applicants may offer either (*a*) an extended course in Botany, Zoölogy or in General Biology and Elementary Physiology; or (*b*) briefer courses in any two of the same subjects. In the latter case evidence should be given of knowledge of general principles and of some laboratory and field work.

Elective English. The work of secondary schools varies so much in this subject that no definite requirement is formulated at present. Any applicant who has carried work in English materially beyond the entrance requirements may present for approval as his elective a statement of the amount and kind of work done. Elective additional English, however, cannot be accepted unless the required English has been passed.

Elective Latin. Satisfactory evidence should be presented that the applicant has acquired the elements of Latin Grammar, that he has had an elementary course in Latin Composition and has read four books of Caesar or the equivalent. As a smaller amount of Latin would be of no practical advantage, this is the minimum amount that can be accepted.

The study of Latin is recommended to persons who purpose to enter the Institute and who can give the subject adequate attention while preparing for the regular requirements for admission.

Elective Spanish (Elementary). Elementary Grammar, including the common irregular verbs; reading, translation from Spanish into English and from English into Spanish.

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 excuse from entrance examinations and provisional credit for entrance subjects and those given at the Institute in so far as he has covered these subjects. Students who present but a single year of college work and offer chemistry are not credited with first-year chemistry except on the basis of an examination taken in that subject at the Institute in September. Students presenting but one year's work in English without History must take English and History E12, unless they pass an examination covering History of E11 and E12 in September or January. Students who intend to take any of these examinations should notify the Registrar and send for an examination schedule. In case a student has not been credited with all required entrance subjects he will, unless especially excused, be expected to make up the remainder 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 statement 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 Course IV, will be graded in design in accordance with their performance in their first problem.

For information concerning opportunities for graduate work and research applicants are referred to the Bulletin "Graduate Study and Research."

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 take in their first year of residence courses in English, graphics (descriptive geometry), shades and shadows, perspective, and architectural history, unless these subjects have been passed at the September examinations for advanced standing, or excuse has been obtained on the basis of equivalent work accomplished elsewhere. They will register for theory of architecture, freehand drawing, design, and other professional courses. Satisfactory records must be obtained in order to continue architectural subjects. 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.

To become eligible for the Traveling Fellowship the special student must, in addition to securing satisfactory records in the undergraduate courses in English E11 and 12, graphics, shades and shadows, perspective freehand drawing, architectural history, modeling, theory of architecture, European civilization and art, philosophy of architecture and design, obtain a satisfactory record in graduate design.

Special students who desire to take the course in architectural engineering must pass or offer equivalents for the entrance examinations in mathematics and physics.

Coöperation with Harvard University. The following agreement is at present in effect between Harvard University and the Massachusetts Institute of Technology:

"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."

Graduate students desiring to take advantage of this privilege must present a note of approval from the chairman of their Departmental Committee to the Dean of Graduate Students in order to obtain from him a letter of recommendation to the Dean of the Graduate School of Harvard University.

REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE

To receive the Degree of Bachelor of Science or Bachelor in Architecture, the student must have attended the Institute not less than one academic year, which must in general be that next preceding his graduation. He must have completed the 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.

GRADUATE COURSES

(For complete information regarding graduate work, see the bulletin on Graduate Study and Research.)

The Institute offers opportunities for graduate study and research in all professional departments. The degrees awarded are those of

Master of Science, Master in Architecture, Doctor of Science, Doctor of Philosophy, and Doctor of Public Health.

Applicants, except in cases of unusual attainments, must have taken their first degree from a scientific school, college or university of good standing.

Degrees of Master of Science and Master in Architecture are awarded upon the satisfactory completion of advanced study and research approved by the Faculty and extending over not less than one year.

The degrees of Doctor of Science, Doctor of Philosophy and Doctor of Public Health are awarded on the completion of a program of advanced study and the performance of an investigation of high grade. As a rule the study and research must be pursued under the direction of the Faculty for three years. Graduates of the Institute of unusual ability or those who have had exceptional preparation may be able to complete the requirements in two years.

COURSES FOR OFFICERS OF THE UNITED STATES ARMY AND UNITED STATES NAVY

The Institute offers courses in Ordnance Design, Torpedo Design and Naval Construction leading to the Degree of Master of Science, to officers of the United States Navy; a course in Chemical Warfare leading to the degree of Master of Science, and a course in Military Engineering leading to the degree of Bachelor of Science, to officers of the United States Army. A special course in Army Ordnance is also given for officers of the United States Army.

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, Air Service and Chemical Warfare. For information and course schedules, see pages 137 to 144.

UNDERGRADUATE COURSE SCHEDULES FOR 1929–1930

THE NUMBERING SYSTEM

Subjects are grouped and numbered according to the professional course or department under which the instruction is given. Courses are indicated by roman numerals.

For description of subjects see pages 145 to 252.

Course or Department	Subject Numbers
Civil Engineering (I)	1.00 to 1.99
Mechanical Engineering (II)	2.00 to 2.99
Mining and Metallurgy (III)	3.00 to 3.99
Architecture and Architectural Engineering (IV, IV-A)	4.00 to 4.99
Chemistry (V)	5.00 to 5.99
Electrical Engineering (VI)	6.00 to 6.99
Biology and Public Health (VII)	7.00 to 7.99
Physics (VIII)	8.00 to 8.99
General Science (IX)	9.00 to 9.99
Chemical Engineering (X)	10.00 to 10.99
Geology (XII)	12.00 to 12.99
Naval Architecture and Marine Engineering (XIII)	13.00 to 13.99
Aeronautical Engineering (XVI)	16.00 to 16.99
Building Construction (XVI)	17.00 to 17.99
Drawing	D1 to D99
Economics	Ec1 to Ec99
English and History	E1 to E99
Fuel and Gas Engineering	F1 to F99
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. (Hours in class are placed first, followed by preparation hours.) The hours of preparation represent the estimated time for the average student.

FIRST YEAR. All Courses (Except IV)

First Term		*Second Term*	
Chemistry, Elem. 5·01	8 – 5	Chemistry, Elem. 5·02	8 – 5
Descriptive Geometry D21	3 – 1	Descriptive Geometry D22	3 – 1
English & History E11	3 – 5	English & History E12	3 – 5
Mathematics M11	3 – 6	Mathematics M12	3 – 6
Mechanical Drawing D11	3 – 0	Military Science MS12	3 – 0
Military Science MS11	3 – 0	Physical Training PT2	1 – 0
Physical Training PT1	1 – 0	Physics 8·02	4 – 5
Physics 8·01	4 – 5	Working Drawings D12	3 – 0
Units of exercise and preparation:	28 – 22	Units of exercise and preparation:	28 – 22

FIRST YEAR. COURSE IV

First Term		*Second Term*	
Architectural History 4·411	3 – 3	Architectural History 4·412	3 – 3
English & History E11	3 – 5	Design I 4·712	12 – 0
French L63	3 – 6	English & History E12	3 – 5
Graphics 4·06	6 – 0	French L64	3 – 6
Mathematics M11	3 – 6	Mathematics M12	3 – 6
Military Science MS11	3 – 0	Military Science MS12	3 – 0
Perspective 4·12	3 – 0	Physical Training PT2	1 – 0
Physical Training PT1	1 – 0	Theory of Architecture 4·312	1 – 0
Shades & Shadows 4·11	3 – 0	Units of exercise and preparation:	29 – 20
Theory of Architecture 4·311	1 – 0		
Units of exercise and preparation:	29 – 20		

I. CIVIL ENGINEERING

The course in Civil Engineering is designed to give the student sound training, both theoretical and practical, in the sciences upon which professional practice is based. Particular care is taken to enforce the application of the principles taught, and the student is made familiar with the use of engineering instruments and with the usual problems of practice.

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. The field of civil engineering, nevertheless, still remains so large that no one can become expert in its whole extent. It covers topographical engineering, including the making of geodetic and geological surveys, and surveys for engineering construction; transportation engineering, consisting of the building of railroads, highways, canals, docks, harbors, and other works serving the purpose of commerce and transportation; municipal engineering, including the construction of sewers, waterworks, roads, and streets; structural engineering, consisting of the 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, and in these principles the students are trained by practice in the class-room, the drafting-room, the field and the testing laboratory.

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 in which more than usual attention is paid to railway and highway engineering, and an option in hydro-electric engineering in which special consideration is given to the subject of water power development. The special work of the hydro-electric option begins in the third year, and that of the other options in the fourth year.

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

I. CIVIL ENGINEERING

FIRST YEAR. See page 67

SECOND YEAR. All Options

First Term		*Second Term*	
Astronomy and Spher. Trig. 1·12	3 –4	Applied Mechanics 2·15	3 –6
Descriptive Geometry D31	4 –3	English & History E22	3 –5
English & History E21	3 –5	Graphic Statics 1·39	3 –1
Map Read. & Top. Draw. 1·18	2 –0	Mathematics M22	3 –6
Mathematics M21	3 –6	Mechanism 2·01	2 –4
Military Science MS21	3 –0	Military Science MS22	3 –0
Physics 8·03	4 –5	Physics 8·04	4 –5
Surveying and Plotting 1·00	2 –3	Surveying and Plotting 1·01	2 –0
Units of exercise and preparation:	24 –26	Units of exercise and preparation:	23 –27

Required during Summer. At Camp Technology

Geod. and Top. Surveying 1·06	7 –0
Hydrographic Surveying 1·60	5 –0
Plane Surveying 1·05	6 –1
Railway Fieldwork 1·20	5 –0

THIRD YEAR

Option 1. General

Option 2. Transportation Engineering

First Term		*Second Term*	
Applied Mechanics 2·20	3 –6	Electrical Eng. Lab. 6·89	2 –2
Electrical Eng., Elem. 6·40	4 –6	Geology 12·322	3 –3
Foundations 1·48	1 –1	Hydraulics 1·62	3 –5
Geodesy 1·13	2 –2	Materials 1·43	1 –2
Geology 12·321	2 –1	Political Economy Ec32	3 –3
Political Economy Ec31	3 –3	Railway and High. Eng. 1·22	2 –2
Railway and High. Eng. 1·21	2 –4	Railway Drafting 1·24	3 –0
Railway Drafting 1·23	4 –0	Structures 1·40	3 –5
General Study	2 –2	Testing Materials Lab. 2·37	2 –0
Units of exercise and preparation:	23 –25	General Study	2 –2
		Units of exercise and preparation:	24 –24

THIRD YEAR

Option 3. Hydro-Electric Engineering

First Term		*Second Term*	
Accounting Ec50	3 –3	Electrical Eng. Lab. 6·89	2 –2
Applied Mechanics 2·20	3 –6	Geology 12·322	3 –3
Electrical Eng., Elem. 6·40	4 –6	Hydraulics 1·62	3 –5
Foundations 1·48	1 –1	Materials 1·43	1 –2
Geodesy 1·13	2 –2	Political Economy Ec32	3 –3
Geology 12·321	2 –1	Railway and High. Eng. 1·22	2 –2
Political Economy Ec31	3 –3	Report Writing E33	2 –2
Railway and High. Eng. 1·211	1 –3	Structures 1·40	3 –5
General Study	2 –2	Testing Materials Lab. 2·37	2 –0
Units of exercise and preparation:	21 –27	General Study	2 –2
		Units of exercise and preparation:	23 –26

I. CIVIL ENGINEERING — *Continued*

FOURTH YEAR
Option 1. General

First Term		*Second Term*	
Bridge Design 1·501	7 – 0	Bridge Design 1·502	5 – 0
Field Geology 12·37	1 – 1	Eng. & Hyd. Lab. 2·63	2 – 2
Heat Engineering 2·46	4 – 7	Heat Engineering 2·47	2 – 3
Hydraulic & San. Eng. 1·75	4 – 5	Hydraulics & San. Design 1·79	2 – 0
Roads & Pavements 1·35	2 – 1	Hydraulic & San. Eng. 1·76	4 – 5
Structures 1·41	4 – 8	Structures 1·42	4 – 8
General Study	2 – 2	Thesis	7
Units of exercise and preparation:	24 – 24	General Study	2 – 2
		Units of exercise and preparation:	48

FOURTH YEAR
Option 2. (a and b). Transportation Engineering

First Term		*Second Term*	
Bridge Design 1·501	7 – 0	Bridge Design 1·502	5 – 0
Eng. Const. & Estim. 1·25	2 – 3	Eng. & Hyd. Lab. 2·63	2 – 2
Field Geology 12·37	1 – 1	Heat Engineering 2·47	2 – 3
Heat Engineering 2·46	4 – 7	Structures 1·42	4 – 8
Roads & Pavements 1·35	2 – 1	Thesis	7
Structures 1·41	4 – 8	(*a*) Railway Design 1·28	5 – 0
(*a*) Railway Main. & Sig. 1·26	2 – 2	(*a*) Railway Trans. 1·27	2 – 4
(*b*) Chem. of Road Mat. 5·37	4 – 0	(*b*) Highway Design 1·38	3 – 0
General Study	2 – 2	(*b*) Highway Trans. 1·37	2 – 4
Units of exercise and		(*b*) Testing Highway Mat. 1·36	1 – 1
preparation: (*a*)	24 – 24	General Study	2 – 2
(*b*)	26 – 22	Units of exercise and preparation:	48

FOURTH YEAR
Option 3. Hydro-Electric Engineering

First Term		*Second Term*	
Bridge Design 1·511	4 – 0	Bridge Design 1·512	6 – 0
Elec. Trans. Lines & Control 6·44	2 – 4	Eng. & Hyd. Lab. 2·631	3 – 3
Field Geology 12·37	1 – 1	Heat Engineering 2·47	2 – 3
Heat Engineering 2·46	4 – 7	Structures 1·42	4 – 8
Structures 1·41	4 – 8	Water Power Eng. 1·71	6 – 3
Water Power Eng. 1·70	5 – 3	Thesis	6
General Study	2 – 2	General Study	2 – 2
Units of exercise and preparation:	22 – 25	Units of exercise and preparation:	48

I-A. RAILROAD OPERATION

In Coöperation with the Boston and Maine Railroad

The Institute has established a five-year coöperative course in Railroad Operation, the purpose of which is to provide (1) fundamental training in engineering at the Institute and (2) practical experience in the operating department of the Boston and Maine Railroad. Competent young men, who wish to become railroad operating officers and who are accepted for this course, will receive a training which aims to develop them for responsible positions in the transportation, motive power, and engineering departments. Students successfully completing this course will receive both the Bachelor's and Master's degree.

The course consists of two years at the Institute followed by three years of coöperative work in which the student alternates between the Institute and the Railroad. The first year at the Institute is the same as for practically all the other courses. Several surveying subjects are taken at Camp during the summer following the first year. The fundamental subjects taken during the second year at the Institute are similar to those taken by other engineering students. Coöperative work periods start in the summer following the second year, the student thereafter spending half of his time at the Institute and half in actual work with the Railroad. The fifth year includes graduate study along the lines for which the individual student is best fitted.

The student receives practical experience as an employee of the Railroad for four terms of about seventeen weeks each, including work in the following departments: Maintenance of Way (including Signals), Maintenance of Equipment, Conducting Transportation, and General (including Accounting, Stores, etc.).

Students are subject to the usual requirements applying to the employees of the Railroad, including a reasonable physical examination. The compensation paid to students amounts to a total payment of about fifteen hundred dollars during the coöperative period. Forty-eight hours constitute the usual working week, but the time on some assignments differs somewhat in this respect. No employment contract is made between students and the Railroad, and graduates are free upon completion of the course to enter employment wherever offered and in accordance with their personal desires.

While working with the Railroad students are expected to carry on regular duties as employees in each of the various departments to which they are assigned. These duties are designed to give each student familiarity with the methods and activities of the various component departments.

Also on two afternoons or evenings each week after business hours the students attend classes dealing with the subjects of the Institute curriculum, the object being to make the residence of each group at the plant a period of definite educational activity and serviceableness.

The number of students who may be admitted to the coöperative course each year is limited. Candidates for admission are subject to the approval of both the Institute and the Railroad. On account of the limitation in numbers and the nature of the training, men who are admitted to the course with the approval of both parties are expected to carry the course through to completion unless prevented by exceptional circumstances.

Graduates of approved colleges who have emphasized mathematics and physics in their undergraduate work may enter the third year (*i.e.*, the first coöperative year) of this course on the credentials of their college work and the approval of the Railroad.

Students who have not been in residence at the Institute for the first and second years may be admitted to the first coöperative year of the course, provided that they have had engineering school training which is equivalent to the first two years' work at the Institute.

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

I-A. RAILROAD OPERATION. GROUP A

FIRST YEAR. See page 67

Required during Summer (Following First Year)

At Camp

Railway Drafting 1·231	5 – 0
Railway Fieldwork 1·20	5 – 0
Surveying 1·041	12 – 1

SECOND YEAR

First Term

Applied Mechanics 2·15	3 – 6
English & History E21	3 – 5
Mathematics M21	3 – 6
Mech. Eng. & Mach. Dr. 2·121	6 – 0
Mechanism 2·01	2 – 4
Military Science MS21	3 – 0
Physics 8·03	4 – 5
Units of exercise and preparation:	24 – 26

Second Term

Electrical Eng. Lab. 6·75	2 – 2
Electrical Eng. Prin. 6·00	5 – 6
English & History E22	3 – 5
Foundry 2·911	2 – 0
Machine Tool Lab. 2·96	4 – 0
Mathematics M22	3 – 6
Military Science MS22	3 – 0
Physics 8·04	4 – 5
Units of exercise and preparation:	26 – 24

THIRD YEAR

Summer Term

At M. I. T.

Applied Mechanics 2·20	3 – 6
Electrical Engineering Prin. 6·121	2 – 4
Materials of Engineering 2·30	2 – 2
Railway Accounts 1·29	2 – 3
Railway & High. Eng. 1·21	2 – 4

First Term

At Railroad

Committee Work E44	2 – 4
Electrical Eng. Prin. 6·122	2 – 4
Railroad Operation Prac. 1·901.	48 h.p.w.

Second Term

At M.I.T.

Electrical Eng. Lab. 6·84	2 – 3
Electrical Eng. Prin. 6·123	3 – 5
Heat Treatment 3·71	4 – 0
Hydraulics 1·64	3 – 6
Political Economy Ec31	3 – 3
Railway Design 1·281	3 – 0
Structures 1·40	3 – 5
Testing Materials Lab. 2·37	2 – 0
Units of exercise and preparation:	23 – 22

I-A. RAILROAD OPERATION. GROUP A — *Continued*

FOURTH YEAR

Summer Term

At Railroad

Business English E45	1 – 3
Railway & Highway Eng. 1·22	2 – 2
Railroad Operation Prac. 1·902	48 h.p.w.

First Term

At M.I.T.

Eng. Const. & Estim. 1·25	2 – 3
Eng. & Hyd. Lab. 2·63	2 – 2
Heat Engineering 2·46	4 – 7
Industrial Relations Ec45	2 – 2
Political Economy Ec32	3 – 3
Railway Maint. & Sig. 1·26	2 – 2
Structural Design 1·53	4 – 0
Structures 1·411	4 – 8
Units of exercise and preparation:	23 – 27

Second Term

At Railroad

Heat Engineering 2·47	2 – 3
Railway Transportation 1·27	2 – 4
Railroad Operation Prac. 1·903.	48 h.p.w.

GRADUATE YEAR (In Effect 1930-31)

Summer Term

At M. I. T.

Graduate Study & Research	28 h.p.w.
Locomotive Eng. 2·852	3 – 3

First Term

At Railroad

Graduate Study	14
Railroad Operation Prac. 1·904.	48 h.p.w.

Second Term

At M. I. T.

Business Law & Org. Ec63	3 – 5
Dev. of Transportation 1·30	2 – 2
Graduate Study and Research	36 h.p.w.

I-A. RAILROAD OPERATION. GROUP B

FIRST YEAR. See page 67

Required during Summer (Following First Year)

At Camp

Railway Drafting 1·231	5 – 0
Railway Fieldwork 1·20	5 – 0
Surveying 1·041	12 – 1

SECOND YEAR

First Term

Applied Mechanics 2·15	3 – 6
English & History E21	3 – 5
Mathematics M21	3 – 6
Mech. Eng. & Mach. Draw. 2·121	6 – 0
Mechanism 2·01	2 – 4
Military Science MS21	3 – 0
Physics 8·03	4 – 5
Units of exercise and preparation:	24 – 26

Second Term

Electrical Eng. Lab. 6·75	2 – 2
Electrical Eng. Prin. 6·00	5 – 6
English & History E22	3 – 5
Foundry 2·911	2 – 0
Machine Tool Lab. 2·96	4 – 0
Mathematics M22	3 – 6
Military Science MS22	3 – 0
Physics 8·04	4 – 5
Units of exercise and preparation:	26 – 24

I-A. RAILROAD OPERATION. GROUP B — *Continued*

THIRD YEAR

Summer Term

At Railroad

Business English E45	1 –3
Railway & Highway Eng. 1·22	2 –2
Railway Operation Prac. 1·901	48 h.p.w.

First Term

At M.I.T.

Applied Mechanics 2·20	3 –6
Eng. Const. & Estim. 1·25	2 –3
Heat Engineering 2·46	4 –7
Hydraulics 1·64	3 –6
Industrial Relations Ec45	2 –2
Railway & High. Eng. 1·21	2 –4
Railway Maint. & Signals 1·26	2 –2
Testing Materials Lab. 2·37	2 –0
Units of exercise and preparation:	20 –30

Second Term

At Railroad

Heat Engineering 2·47	2 –3
Political Economy Ec31	3 –3
Railroad Operation Prac. 1·902	48 h.p.w.

FOURTH YEAR (In Effect 1930-31)

Summer Term

At M. I. T.

Electrical Eng. Prin. 6·121	2 –4
Eng. & Hyd. Lab. 2·63	2 –2
Materials of Eng. 2·30	2 –2
Railway Accounts 1·29	2 –3
Railway Design 1·281	3 –0
Structures 1·40	3 –5

First Term

At Railroad

Electrical Eng. Prin. 6·122	2 –4
Committee Work E44	2 –4
Railroad Operation Prac. 1·903	48 h.p.w.

Second Term

At M.I.T.

Electrical Eng. Lab. 6·84	2 –3
Electrical Eng. Prin. 6·123	3 –5
Heat Treatment 2·856	4 –0
Political Economy Ec32	3 –3
Railway Transportation 1·27	2 –4
Structural Design 1·53	4 –0
Structures 1·411	4 –8
Units of exercise and preparation:	22 –23

GRADUATE YEAR (In Effect 1930-31)

Summer Term

At Railroad

Graduate Study	10
Railroad Operation Prac. 1·904	48 h.p.w.

First Term

At M.I.T.

Graduate Study & Research	42 h.p.w.
Locomotive Eng. 2·852	3 –3

Second Term

At M.I.T.

Business Law & Org. Ec63	3 –5
Dev. of Transportation 1·30	2 –2
Graduate Study & Research	36 h.p.w.

II. MECHANICAL ENGINEERING

Mechanical Engineering, next to the oldest and earliest developed branches of the engineering professions, is essentially the engineering of design and production in industry.

The course in Mechanical Engineering is so broadly fundamental as to prepare the student to enter successfully any of the various branches of this profession whether it be automotive design, engine design, locomotive construction, steam turbine engineering, power plant design, mill engineering, refrigeration, heating and ventilation, hydraulic engineering, factory design and construction, or production methods and industrial management.

Much time is spent during the first two years upon basic courses in chemistry, physics, mechanics, mechanism and drawing, and applied mechanics, a thorough knowledge of which is essential in all of the engineering professions.

The student is trained in the mechanic arts sufficiently to familiarize him with the use of modern machine tools, foundry practice, forging and pattern work, a practical knowledge of which is necessary for the successful designer of machinery. He is also given sufficient training in electrical engineering to enable him to handle the ordinary electrical problems which come to the mechanical engineer.

About one-seventh of the curriculum is devoted to the pursuit of general cultural subjects such as English and history, political economy, and general elective courses in this field.

The professional work of the third and fourth years includes lectures and laboratory work in heat engineering, thermodynamics, heat transmission, more advanced work in mechanics, theory of elasticity, machine design and power plant design and lectures and laboratory work dealing with the materials of engineering and the effect of heat treatment and other processes.

In the fourth year the student is offered the choice of one or more of several professional electives and one of the following options: Automotive Engineering, Engineering Design, Textile Engineering, Refrigeration, Ordnance Engineering.

This course leads to the degree of Bachelor of Science in Mechanical Engineering.

II. MECHANICAL ENGINEERING

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 – 5	Applied Mechanics 2·15	3 – 6
Foundry 2·91	3 – 0	English & History E22	3 – 5
Mathematics M21	3 – 6	Forging 2·90	3 – 0
Mech. Eng. Draw. 2·10	6 – 0	Machine Drawing 2·13	6 – 0
Mechanism 2·00	4 – 6	Mathematics M22	3 – 6
Military Science MS21	3 – 0	Mech. Eng. Equipment 2·04	1 – 0
Physics 8·03	4 – 5	Military Science MS22	3 – 0
Surveying 1·03	2 – 0	Pattern Making 2·92	2 – 0
Units of exercise and preparation:	28 – 22	Physics 8·04	4 – 5
		Units of exercise and preparation:	28 – 22

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3 – 6	Applied Mechanics 2·21	3 – 5
Boilers and Engines 2·41	2 – 2	Electrical Eng., Elem. 6·40	4 – 6
Eng. Thermodynamics 2·40	4 – 5	Eng. Thermodynamics 2·42	4 – 5
Machine Tool Lab. 2·951	6 – 0	Machine Design 2·70	4 – 0
Mechanism of Mach. 2·05	3 – 2	Machine Tool Lab. 2·952	4 – 0
Physical Chemistry 5·683	2 – 2	Materials of Eng. 2·30	2 – 2
Political Economy Ec31	3 – 3	Political Economy Ec32	3 – 3
General Study	2 – 2	General Study	2 – 2
Units of exercise and preparation:	25 – 22	Units of exercise and preparation:	26 – 23

FOURTH YEAR (General Course)

First Term		*Second Term*	
Dynamics of Machines 2·251	2 – 4	Engineering Lab. 2·602	4 – 4
Electrical Eng. Lab. 6·89	2 – 2	Industrial Plants 2·781	3 – 3
Engineering Lab. 2·601	4 – 4	Industrial Plants 2·782	4 – 0
Hydraulics 1·64	3 – 6	Mechanics of Eng. 2·26	3 – 6
Machine Design 2·71	6 – 0	Power Plant Design 2·58	4 – 0
Refrigeration 2·43	2 – 4	Production Methods 2·98	1 – 1
Testing Materials Lab. 2·35	4 – 2	Thesis	6
General Study	2 – 2	Elective	4
Units of exercise and preparation:	25 – 24	General Study	2 – 2
		Units of exercise and preparation:	47

Electives — Second Term

Aeronautics 16·76	2 – 2
App. of X-Ray & Photo-Elast. 8·44	4 – 0
Automatic Mach. 2·850	2 – 2
Engineering Chemistry 5·843	4 – 0
Fire Protection Eng. 2·851	2 – 2
Heat Treatment 3·71	4 – 0
Locomotive Eng. 2·853	2 – 2
Mech. Eq. of Bldgs. 2·854	2 – 2
Steam Turbine Eng. 2·855	2 – 2

II. MECHANICAL ENGINEERING — *Continued*

FOURTH YEAR
Option 1. Automotive

First Term		*Second Term*	
Dynamics of Machines 2·251	2 – 4	Automobile Laboratory 2·66	2 – 2
Electrical Eng. Lab. 6·89	2 – 2	Eng. Laboratory 2·603	2 – 2
Engineering Lab. 2·601	4 – 4	Gasoline Automobile 2·79	3 – 3
Heat Treatment 3·70	2 – 0	Industrial Plants 2·781	3 – 3
Hydraulics 1·64	3 – 6	Machine Design 2·712	2 – 0
Machine Design 2·711	4 – 0	Mechanics of Eng. 2·26	3 – 6
Refrigeration 2·43	2 – 4	Power Plant Design 2·58	4 – 0
Testing Materials Lab. 2·35	4 – 2	Production Methods 2·98	1 – 1
General Study	2 – 2	General Study	2 – 2
Units of exercise and preparation:	25 – 24	Thesis	6
		Units of exercise and preparation:	47

FOURTH YEAR
Option 2. Engine Design

First Term		*Second Term*	
Dynamics of Machines 2·251	2 – 4	Engine Design 2·77	6 – 2
Electrical Eng. Lab. 6·89	2 – 2	Engineering Lab. 2·602	4 – 4
Engineering Lab. 2·601	4 – 4	Industrial Plants 2·781	3 – 3
Heat Treatment 3·70	2 – 0	Mechanics of Eng. 2·26	3 – 6
Hydraulics 1·64	3 – 6	Power Plant Design 2·58	4 – 0
Machine Design 2·711	4 – 0	Production Methods 2·98	1 – 1
Refrigeration 2·43	2 – 4	General Study	2 – 2
Testing Materials Lab. 2·35	4 – 2	Thesis	6
General Study	2 – 2	Units of exercise and preparation:	47
Units of exercise and preparation:	25 – 24		

FOURTH YEAR
Option 3. Textile

First Term		*Second Term*	
Dynamics of Machines 2·251	2 – 4	Engineering Lab. 2·603	2 – 2
Electrical Eng. Lab. 6·89	2 – 2	Fire Protection Eng. 2·851	2 – 2
Engineering Lab. 2·601	4 – 4	Industrial Plants 2·781	3 – 3
Hydraulics 1·64	3 – 6	Mechanics of Eng. 2·26	3 – 6
Machine Design 2·71	6 – 0	Power Plant Design 2·58	4 – 0
Refrigeration 2·43	2 – 4	Production Methods 2·98	1 – 1
Testing Materials Lab. 2·35	4 – 2	Textile Engineering 2·87	6 – 2
General Study	2 – 2	General Study	2 – 2
Units of exercise and preparation:	25 – 24	Thesis	6
		Units of exercise and preparation:	47

II. MECHANICAL ENGINEERING — *Continued*

FOURTH YEAR
Option 1. Automotive

First Term		*Second Term*	
Dynamics of Machines 2·251	2 – 4	Automobile Laboratory 2·66	2 – 2
Electrical Eng. Lab. 6·89	2 – 2	Eng. Laboratory 2·603	2 – 2
Engineering Lab. 2·601	4 – 4	Gasoline Automobile 2·79	3 – 3
Heat Treatment 3·70	2 – 0	Industrial Plants 2·781	3 – 3
Hydraulics 1·64	3 – 6	Machine Design 2·712	2 – 0
Machine Design 2·711	4 – 0	Mechanics of Eng. 2·26	3 – 6
Refrigeration 2·43	2 – 4	Power Plant Design 2·58	4 – 0
Testing Materials Lab. 2·35	4 – 2	Production Methods 2·98	1 – 1
General Study	2 – 2	General Study	2 – 2
Units of exercise and preparation:	25 – 24	Thesis	6
		Units of exercise and preparation:	47

FOURTH YEAR
Option 2. Engine Design

First Term		*Second Term*	
Dynamics of Machines 2·251	2 – 4	Engine Design 2·77	6 – 2
Electrical Eng. Lab. 6·89	2 – 2	Engineering Lab. 2·602	4 – 4
Engineering Lab. 2·601	4 – 4	Industrial Plants 2·781	3 – 3
Heat Treatment 3·70	2 – 0	Mechanics of Eng. 2·26	3 – 6
Hydraulics 1·64	3 – 6	Power Plant Design 2·58	4 – 0
Machine Design 2·711	4 – 0	Production Methods 2·98	1 – 1
Refrigeration 2·43	2 – 4	General Study	2 – 2
Testing Materials Lab. 2·35	4 – 2	Thesis	6
General Study	2 – 2	Units of exercise and preparation:	47
Units of exercise and preparation:	25 – 24		

FOURTH YEAR
Option 3. Textile

First Term		*Second Term*	
Dynamics of Machines 2·251	2 – 4	Engineering Lab. 2·603	2 – 2
Electrical Eng. Lab. 6·89	2 – 2	Fire Protection Eng. 2·851	2 – 2
Engineering Lab. 2·601	4 – 4	Industrial Plants 2·781	3 – 3
Hydraulics 1·64	3 – 6	Mechanics of Eng. 2·26	3 – 6
Machine Design 2·71	6 – 0	Power Plant Design 2·58	4 – 0
Refrigeration 2·43	2 – 4	Production Methods 2·98	1 – 1
Testing Materials Lab. 2·35	4 – 2	Textile Engineering 2·87	6 – 2
General Study	2 – 2	General Study	2 – 2
Units of exercise and preparation:	25 – 24	Thesis	6
		Units of exercise and preparation:	47

II. MECHANICAL ENGINEERING — *Continued*

FOURTH YEAR
Option 3a. Textile

First Term		*Second Term*	
Dynamics of Machines 2·251...	2 –4	Automatic Machinery 2·850....	2 –2
Electrical Eng. Lab. 6·89......	2 –2	Engineering Lab. 2·603.......	2 –2
Engineering Lab. 2·601........	4 –4	Hydraulics 1·63.............	2 –3
Machine Design 2·71.........	6 –0	Industrial Plants 2·7811.......	1 –1
Mycology 7·07..............	3 –2	Industrial Plants 2·7812.......	2 –0
Optical Meas. 8·18...........	3 –2	Mech. Equip. of Bldgs. 2·854...	2 –2
Optics 8·172................	3 –6	Mechanics of Eng. 2·26.......	3 –6
Testing Materials Lab. 2·35....	4 –2	Power Plant Design 2·58......	4 –0
Units of exercise and preparation:	27 –22	Prec. of Measurements 8·07....	1 –1
		Textile Laboratory 2·871......	6 –0
		Thesis.....................	7
		Units of exercise and preparation:	49

FOURTH YEAR
Option 4. Refrigeration

First Term		*Second Term*	
Dynamics of Machines 2·251...	2 –4	Engineering Lab. 2·603.......	2 –2
Electrical Eng. Lab. 6·89......	2 –2	Industrial Plants 2·781.......	3 –3
Engineering Lab. 2·601.......	4 –4	Mechanics of Eng. 2·26.......	3 –6
Hydraulics 1·64.............	3 –6	Power Plant Design 2·58......	4 –0
Machine Design 2·71........	6 –0	Production Methods 2·98......	1 –1
Refrigeration 2·43...........	2 –4	Refrigeration 2·49...........	3 –5
Testing Materials Lab. 2·35....	4 –2	Refrigeration Lab. 2·64.......	2 –2
General Study..............	2 –2	General Study..............	2 –2
Units of exercise and preparation:	25 –24	Thesis.....................	6
		Units of exercise and preparation:	47

ARMY ORDNANCE

Summer before Fourth Year

Chemistry, Elementary 5·04....	3 –3
Differential Equations M72	13
Mechanics 2·891.............	13 –3

FOURTH YEAR

First Term		*Second Term*	
Electrical Eng., Elem. 6·42....	5 –5	Electrical Eng. Lab. 6·88......	4 –6
Heat Engineering 2·461.......	3 –6	Heat Engineering 2·471.......	3 –4
Mechanisms 2·03............	6 –2	Ordnance Problems 2·892......	8 –0
Organic Chemistry 5·41.......	4 –3	Organic Chemistry I 5·42......	4 –2
Organic Chem. Lab. 5·414.....	9 –0	Org. & Explosives Lab. 5·431...	7 –0
Theory of Elasticity 2·271.....	4 –8	Powder & Explosives 5·43.....	2 –2
Units of exercise and preparation:	31 –24	Power Laboratory 2·65........	2 –2
		Theory of Elasticity 2·272.....	2 –4
		Theory of Gyroscope M571....	1 –1
		Units of exercise and preparation:	33 –21

II. MECHANICAL ENGINEERING—*Continued*

TEXTILE ENGINEERING

In response to numerous requests for opportunities to study textile questions of advanced character the Institute has fully equipped a Textile Laboratory where the physical study of textile fibers, yarns and fabrics is carried out in extreme detail. This laboratory consists of a process room equipped with cotton working machinery from the gin to the loom, a testing laboratory with testing machines and moisture control, and a microscope room darkened and fully equipped with textile optical apparatus. For graduates of textile schools of approved character and for graduates of the Institute as well a course of study has been outlined leading to the degree of Master of Science in Mechanical Engineering. This is awarded at the end of one or two years of study, depending upon the candidate's preparation and aptitude. A special circular relating to this branch of study is available for those interested.

TEXTILE ENGINEERING — GRADUATE

First Term		*Second Term*	
Physical Metallurgy 3·653	10 – 2	Des. of Automatic Mach. 2·09	12 – 0
Design of Cotton Mach. 2·872	3 – 6	Micro. Th. & Photomicro. 8·191	3 – 2
Dynamics of Text. Mach. 2·874	2 – 2	Physical Instruments 8·99	5 – 4
Textile Tech. Analysis 2·875	2 – 3	Des. of Wool Work. Mach. 2·873	3 – 6
Prin. of Fabric Structure 2·876	2 – 4	Textile Research	15
Textile Research	14	Units of exercise and preparation:	50
Units of exercise and preparation:	50		

II. MECHANICAL ENGINEERING — *Continued*

AUTOMOTIVE ENGINEERING — GRADUATE

First Term		*Second Term*	
Automotive Design 2·811	8 –0	Automotive Design 2·812	10 –0
Automotive Eng. 2·801	3 –6	Automotive Eng. 2·802	3 –6
Automotive Fuels 10·93	3 –3	Heat Treat. & Metal. 3·72	4 –2
Dynamics of Engines 2·254	2 –4	Motor Vehicle Test. 2·672	5 –3
Engine Testing 2·671	4 –2	Research	19
Heat Treatment 3·702	3 –0	Units of exercise and preparation:	52
Maint.& Oper.of Auto.Eq.2.661	2 –2		
Mfg. Processes 2·981	3 –3		
Research	3		
Units of exercise and preparation:	51		

ORDNANCE DESIGN, UNITED STATES NAVY — GRADUATE

First Term		*Second Term*	
Adv. Mech., Th. of Elas. 2·281	3 –9	Adv. Mech., Th. of Elas. 2·282.	3 –9
Dynamics of Machines 2·251	2 –4	Aircraft Armament 16·48	3 –5
Electrical Eng. Lab. 6·89	2 –2	Ind. App. of Elec. Pr. 6·46	3 –2
Exterior Ballistics M75	2 –4	Interior Ballistics 2·29	2 –3
Heat Treatment 3·701	3 –2	Machine Design. Adv. 2·75	10 –0
Machine Design 2·71	6 –0	Physical Metallurgy 3·732	8 –2
Mechanism of Machines 2·06	2 –2	Structural Design 1·461	3 –0
Physical Metallurgy 3·731	1 –2	Theory of Gyroscope M57	1 –2
Structures 1·45	3 –6	Units of exercise and preparation:	33 –23
Units of exercise and preparation:	24 –31		

TORPEDO DESIGN, UNITED STATES NAVY — GRADUATE

First Term		*Second Term*	
Automatic Machinery 2·07	3 –3	Aero. Engine Lab. 2·691	2 –0
Dynamics of Mach. 2·251	2 –4	App. of X-Ray Photoelas. 8·44	4 –0
Eng. Thermodynamics 2·40	4 –5	Automatic Machinery 2·08	4 –4
Heat Treatment 3·701	3 –2	Eng. Thermodynamics 2·42	4 –5
Machine Design 2·761	6 –2	Machine Design 2·762	6 –2
Materials of Eng. 2·301	1 –2	Physical Metallurgy 3·732	8 –2
Mechanism of Machines 2·06	2 –2	Theory of Gyroscope M57	1 –2
Metallography 3·615	3 –2	Thermodynamics 5·75T	2 –2
Physical Chemistry 5·683	2 –2	Torpedoes 2·51	2 –4
Physical Metallurgy 3·731	1 –2	Units of exercise and preparation:	33 –21
Units of exercise and preparation:	27 –26		

III. MINING AND METALLURGY

Including Petroleum Production

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.

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.

Option 1. Mining Engineering. This covers the field of mining engineering and includes courses of 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. This option covers the field of 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. Emphasis is placed on statistics of importance in the study of petroleum economics from a world viewpoint.

Option 3. Metallurgy. This division is for those interested chiefly in 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 followed by conferences and reports are made to mills, foundries and shops in the vicinity.

Option 4. Physical Metallurgy. This option is 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.

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.

III. MINING AND METALLURGY

Option 1. Mining Engineering

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 – 5	English & History E22	3 – 5
Int. to Mining & Met. 3·00	2 – 0	Geology 12·30	3 – 3
Mathematics M21	3 – 6	Mathematics M22	3 – 6
Military Science MS21	3 – 0	Mechanism 2·01	2 – 4
Mineralogy 12·01	8 – 2	Military Science MS22	3 – 0
Physics 8·03	4 – 5	Physics 8·04	4 – 5
Qualitative Analysis 5·11	7 – 2	Quantitative Analysis 5·12	7 – 2
Units of exercise and preparation:	30 – 20	Units of exercise and preparation:	25 – 25

Required during Summer. At Summer Mining Camp

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

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·15	3 – 6	Applied Mechanics 2·20	3 – 6
Fire Assaying 3·31	6 – 2	Economic Geology 12·40	5 – 3
Geology 12·31	5 – 3	Mining Methods 3·02	4 – 3
Mining Methods 3·01	5 – 3	Ore Dressing 3·21	3 – 2
Political Economy Ec31	3 – 3	Ore Dressing Lab. 3·22	5 – 2
Qualitative Analysis 5·13	7 – 2	Political Economy Ec32	3 – 3
Units of exercise and preparation:	29 – 19	Testing Materials Lab. 2·37	2 – 0
		General Study	2 – 2
		Units of exercise and preparation:	27 – 21

FOURTH YEAR

First Term		*Second Term*	
Economics of Mining 3·03	4 – 3	Electrical Eng. Lab. 6·85	2 – 3
Electrical Eng., Elem. 6·40	4 – 6	Metallurgy 3·421	3 – 1
Field Geology 12·33	3 – 1	Principles of Mining 3·04	3 – 4
Geophysical Prospect., Elem. 3·13	3 – 1	Stationary Structures 1·44	2 – 3
Hydraulics 1·63	2 – 3	Thesis	10
Metallurgy 3·412	5 – 3	General Study	4 – 4
Metallurgy 3·432	2 – 1	Electives	9
Microstruct. of Ores & Met. 3·68	3 – 0	Units of exercise and preparation:	48
Electives	4		
Units of exercise and preparation:	48		

III. MINING AND METALLURGY — *Continued*

Option 2. Petroleum Production

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 – 5	English & History E22	3 – 5
Int. to Mining & Met. 3·00	2 – 0	Geology 12·30	3 – 3
Mathematics M21	3 – 6	Mathematics M22	3 – 6
Military Science MS21	3 – 0	Mechanism 2·01	2 – 4
Mineralogy 12·01	8 – 2	Military Science MS22	3 – 0
Physics 8·03	4 – 5	Physics 8·04	4 – 5
Qualitative Analysis 5·11	7 – 2	Quantitative Analysis 5·12	7 – 2
Units of exercise and preparation:	30 – 20	Units of exercise and preparation:	25 – 25

Required during Summer. At Summer Mining Camp

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

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·15	3 – 6	Applied Mechanics 2·20	3 – 6
Geology 12·31	5 – 3	Economic Geology 12·40	5 – 3
Metal. of Iron & Steel 3·432	2 – 1	Metallography 3·611	4 – 1
Mining, Elements of 3·05	2 – 2	Ore Dressing 3·23	3 – 2
Oil Test. & Petrol. Refin. 5·381	5 – 2	Petroleum Eng., Elem. 3·82	5 – 3
Petroleum Eng., Elem. 3·81	5 – 3	Political Economy Ec32	3 – 3
Political Economy Ec31	3 – 3	Testing Materials Lab. 2·37	2 – 0
General Study	2 – 2	General Study	2 – 2
Units of exercise and preparation:	27 – 22	Units of exercise and preparation:	27 – 20

FOURTH YEAR

First Term		*Second Term*	
Economics of Mining 3·03	4 – 3	Electrical Eng. Lab. 6·85	2 – 3
Electrical Eng., Elem. 6·40	4 – 6	Mining, Principles of 3·04	3 – 4
Field Geology 12·33	3 – 1	Petroleum Prod. & Util. 3·86	5 – 3
Geol. Coal & Petroleum 12·80	4 – 3	Stationary Structures 1·44	2 – 3
Geophysical Prospect. Elem. 3·13	3 – 1	Thesis	10
Hydraulics 1·63	2 – 3	Electives	9
Microstruct. of Ores & Met. 3·68	3 – 0	General Study	2 – 2
Petroleum Prod. & Util. 3·85	2 – 1	Units of exercise and preparation:	48
Electives	5		
Units of exercise and preparation:	48		

III. MINING AND METALLURGY — *Continued*

Option 3. Metallurgy

FIRST YEAR. See page 67

SECOND YEAR

First Term	
English & History E21	3 – 5
Int. to Mining & Met. 3·00	2 – 0
Mathematics M21	3 – 6
Military Science MS21	3 – 0
Mineralogy 12·01	8 – 2
Physics 8·03	4 – 5
Qualitative Analysis 5·11	7 – 2
Units of exercise and preparation:	30 – 20

Second Term	
English and History E22	3 – 5
Forging 2·902	2 – 0
Foundry 2·911	2 – 0
Gas Analysis 5·31	2 – 0
Mathematics M22	3 – 6
Mechanism 2·01	2 – 4
Military Science MS22	3 – 0
Physics 8·04	4 – 5
Quantitative Analysis 5·12	7 – 2
Units of exercise and preparation:	28 – 22

Required during Summer

Machine Drawing 2·14	4 – 0
Surveying & Plotting 1·02	5 – 0

THIRD YEAR

First Term	
Applied Mechanics 2·15	3 – 6
Mining, Elements of 3·05	2 – 2
Engin. Thermodynamics 2·40	4 – 5
Fire Assaying 3·31	6 – 2
Heat Measurements 8·12	3 – 1
Political Economy Ec31	3 – 3
Quantitative Analysis 5·13	7 – 2
Units of exercise and preparation:	28 – 21

Second Term	
Accounting Ec50	3 – 3
Applied Mechanics 2·20	3 – 6
Engineering Lab. 2·611	2 – 1
Metallography 3·61	5 – 1
Ore Dressing 3·23	3 – 2
Political Economy Ec32	3 – 3
Testing Materials Lab. 2·37	2 – 0
General Study	2 – 2
Electives	3 – 3
Units of exercise and preparation:	26 – 21

Required during Summer

Metallurgical Plant Visits 3·60	3 – 1

FOURTH YEAR

First Term	
Electrical Eng., Elem. 6·40	4 – 6
Hydraulics 1·63	2 – 3
(*a*) Metallurgy 3·43	7 – 3
(*a*) Metallurgy 3·411	6 – 3
(*b*) Metallurgy 3·431	3 – 3
(*b*) Metallurgy 3·41	10 – 3
Physical Chemistry, Elem. 5·681	2 – 4
General Study	4 – 4
Units of exercise and preparation: (*a*)	25 – 23
(*b*)	25 – 23

Second Term	
Electrical Eng. Lab. 6·85	2 – 3
Electrochemistry, Elem. 8·90	4 – 2
Metallurgy 3·42	5 – 2
Metallurgy 3·44	4 – 3
Met. & Heat Tr. of Steel 3·45	2 – 1
Thesis	12
General Study	2 – 2
Elective	4
Units of exercise and preparation:	48

III. MINING AND METALLURGY — *Continued*

Option 4. Physical Metallurgy

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 – 5	English & History E22	3 – 5
Int. to Mining & Metal. 3·00	2 – 0	Forging 2·90	3 – 0
Mathematics M21	3 – 6	Mathematics M22	3 – 6
Military Science MS21	3 – 0	Military Science MS22	3 – 0
Physics 8·03	4 – 5	Physics 8·04	4 – 5
Qualitative Analysis 5·11	7 – 2	Quantitative Analysis 5·12	7 – 2
Language	3 – 5	Language	3 – 5
Units of exercise and preparation:	25 – 23	Units of exercise and preparation:	26 – 23

Required during Summer

Mechanical & Machine Drawing 2·021 10

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·16	2 – 4	Applied Mechanics 2·20	3 – 6
Chem. Anal. Alloys 5·133	7 – 2	Heat Treatment 3·71	4 – 0
Foundry 2·91	3 – 0	Industrial Radiology 8·46	3 – 1
Heat Measurements 8·12	3 – 1	Machine Tool Lab. 2·96	4 – 0
Metallography 3·621	5 – 2	Metallography 3·622	5 – 2
Mining, Elements of 3·05	2 – 2	Mineralogy 12·03	3 – 1
Optics 8·172	3 – 6	Opt. Ident. Crys. Comp. 12·20	3 – 1
Political Economy Ec31	3 – 3	Political Economy Ec32	3 – 3
Units of exercise and preparation:	28 – 20	Testing Materials Lab. 2·37	2 – 0
		General Study	2 – 2
		Units of exercise and preparation:	32 – 16

Required during Summer

Metallurgical Plant Visits 3·60 . . 3 – 1

FOURTH YEAR

First Term		*Second Term*	
Electrical Eng., Elem. 6·40	4 – 6	Electrical Measurements 6·79	2 – 3
(*a*) Metallurgy 3·43	7 – 3	Electrochemistry, Elem. 8·90	4 – 2
(*a*) Metallurgy 3·411	6 – 3	Metallurgy 3·44	4 – 3
(*b*) Metallurgy 3·431	3 – 3	Physical Metallurgy 3·642	5 – 2
(*b*) Metallurgy 3·41	10 – 3	Physics of Metals 3·67	4 – 2
Physical Crystallog. 12·25	4 – 2	Thesis	13
Physical Metallurgy 3·641	7 – 2	Elective	4
General Study	2 – 2	Units of exercise and preparation:	48
Units of exercise and preparation: (*a*)	30 – 18		
(*b*)	30 – 18		

IV. ARCHITECTURE

The architect of today requires training in the creative, the constructive, and the executive aspects of his profession. Rarely is an individual so endowed that he may achieve a mastery of all three fields, though an understanding of each in its relation to the other is essential to a thorough realization of the opportunities that lie before the architectural student. At the present time the Department offers courses covering two aspects of the general field, the creative and the constructive. A description of the latter (Course IV-A, Architectural Engineering) will be found on page 91; a description of the former (Course IV, Architecture) follows herewith.

The Department of Architecture of the Massachusetts Institute of Technology is the oldest school of architecture in the country. Its record of distinguished performance in the field of architectural education is unexcelled. That this enviable accomplishment may be perpetuated and that the graduates of the Department may have the best possible preparation for their years of practice, a five-year course has been established, leading to the degree of Bachelor in Architecture.

This new course affords the high school graduate the opportunity to acquire the essentials of a general education while pursuing his technical studies. For students with a college background, and likewise for those whose training has been largely in offices, this course offers an opportunity to supplement the deficiencies in their educational preparation to the best possible advantage. The former will receive credit for satisfactory work equivalent to the requirements of our schedule that has been performed elsewhere. The latter will correspondingly find that as a rule their experience as draughtsmen will qualify them to take the more advanced professional courses in design, freehand drawing and color (see requirements for special students on page 63). Thus in both instances as much time as possible will be gained toward the completion of the required schedule.

The method of teaching followed in the Department is founded upon personal criticism. Instructors in all professional subjects devote their efforts toward the development of individual initiative. This applies particularly to the courses in design, modeling, color and freehand drawing where individual criticism at the draughting board is accompanied by careful direction in the use of our exceptional library material.

Lest constant criticism should tend to make the student depend upon his instructors for ideas, and thus defeat the whole purpose of our teaching, students in the advanced grades are thrown increasingly upon their own resources, only receiving criticism when satisfactory progress has been made since the instructor's last visit. This policy, together with the custom of advancing students in design by points rather than by years, ensures to the capable performer such rapid advancement as his qualities justify.

Frequent opportunities for the comparison of our student work with that of students from other institutions are provided by the conjunctive problems shared with the Harvard School of Architecture and the Boston Architectural Club. These opportunities are further supplemented by sending selected drawings from all grades to the judgments of the Beaux Arts Institute of Design in New York City.

That deserving students in need of financial aid may not have to forego the opportunities that we offer, scholarship aid is available for both men and women. This assistance is supplemented by many cash prizes given throughout the year, and conspicuous ability is rewarded by Fontainebleau Scholarships and a Traveling Fellowship entitling the student to a year's travel in Europe.

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

The course leads to the degree of Bachelor of Science in Architecture through 1931. Beginning in 1932, it leads to the degree of Bachelor in Architecture.

IV. ARCHITECTURE

FIRST YEAR

First Term		*Second Term*	
Architectural History 4·411	3–3	Architectural History 4·412	3–3
English & History E11	3–5	Design 1·4712	12–0
French L63	3–6	English & History E12	3–5
Graphics 4·06	6–0	French L64	3–6
Mathematics M11	3–6	Mathematics M12	3–6
Military Science MS11	3–0	Military Science MS12	3–0
Perspective 4·12	3–0	Physical Training PT2	1–0
Physical Training PT1	1–0	Theory of Architecture 4·312	1–0
Shades & Shadows 4·11	3–0	Units of exercise and preparation:	29–20
Theory of Architecture 4·311	1–0		
Units of exercise and preparation:	29–20		

Required during Summer

Office Practice 4·20 7

SECOND YEAR

First Term		*Second Term*	
Architectural History 4·421	2–1	Architectural History 4·422	2–1
Design II 4·721	11–0	Design II 4·722	11–0
English and History E21	3–5	English and History E22	3–5
Freehand Drawing 4·021	4–0	Freehand Drawing 4·022	4–0
French L65	2–3	French L66	2–3
Mechanics 2·231	3–6	Mechanics 2·232	3–6
Military Science MS21	3–0	Military Science MS22	3–0
Office Practice 4·211	3–0	Office Practice 4·212	3–0
Theory of Architecture 4·321	1–1	Theory of Architecture 4·322	1–1
Units of exercise and preparation:	32–16	Units of exercise and preparation:	32–16

THIRD YEAR

First Term		*Second Term*	
Building Construction 4·80	1–1	Constructive Design 4·812	7–0
Constructive Design 4·811	7–0	Design III 4·732	15–0
Design III 4·731	13–0	European Civ. & Art G57	3–4
European Civ. & Art G56	3–4	Freehand Drawing 4·032	4–0
Freehand Drawing 4·031	4–0	Modeling 4·072	3–0
Modeling 4·071	3–0	Political Economy Ec32	3–3
Political Economy Ec31	3–3	Problem Analysis E42	2–2
Problem Analysis E41	2–2	Theory of Architecture 4·332	2–0
Theory of Architecture 4·331	2–0	Units of exercise and preparation:	39–9
Units of exercise and preparation:	38–10		

IV. ARCHITECTURE—*Continued*

FOURTH YEAR (Discontinued after June, 1930)

First Term		*Second Term*	
Color, Design & App. 4·091	1–4	Color, Design & App. 4·092	1–4
Design IV 4·741	23–0	Design IV 4·742	25–0
European Civ. & Art 4·471	3–4	European Civ. & Art 4·472	3–4
Freehand Drawing 4·041	6–0	Freehand Drawing 4·042	6–0
Town Planning 4·61	2–3	History of Ren. Art 4·49	1–1
Professional Relations 4·241	1–1	Philosophy of Arch. 4·52	1–0
Units of exercise and preparation:	36–12	Professional Relations 4·242	1–1
		Units of exercise and preparation:	38–10

FOURTH YEAR (In effect 1930–31)

First Term		*Second Term*	
Color. Theory & Exercises 4·081	1–3	Color. Theory & Exercises 4·082	1–3
Design IV 4·741	23–0	Design IV 4·742	22–0
European Civ. & Art 4·471	3–4	European Civ. & Art 4·472	3–4
Freehand Drawing 4·041	4–0	Freehand Drawing 4·042	4–0
Theory of Architecture 4·341	2–0	Mech. Equipment of Bldgs.	4–3
General Study	4–4	Professional Relations	1–1
Units of exercise and preparation:	37–11	Theory of Architecture 4·342	2–0
		Units of exercise and preparation:	37–11

FIFTH YEAR (In effect 1931–32)

First Term		*Second Term*	
Architectural Humanities 4·51	1–1	Color. Design & App. 4·092	2–4
Color. Design & App. 4·091	1–4	Design V 4·752	12–0
Design V 4·751	25–0	European Civ. & Art 4·482	2–3
European Civ. & Art 4·481	2–3	Figure Composition 4·052	6–0
Freehand Drawing 4·051	6–0	Philosophy of Arch. 4·52	1–1
Town Planning	2–3	Thesis	18–0
Units of exercise and preparation:	37–11	Units of exercise and preparation:	41–8

IV-A. ARCHITECTURAL ENGINEERING*

The course in Architectural Engineering was first developed as an option in Architecture and graduated its first class in 1900. 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 reïnforced 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 the new profession of 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 on a particular piece of work.

It is the aim of Course IV-A to offer training leading to a professional career in engineering applied to architecture. In addition to the preparatory training given to the other engineering students those of IV-A are required to take courses in history of civilization, of art, and of architecture, and in principles of planning.

In accord with the general policy of the Institute much stress is laid upon the acquisition by the student of the basic principles of engineering and upon his ability to adapt these principles to special cases. Parallel with the theory of structures long periods of structural analysis and design develop the student's initiative and imagination, and expand his power to use his equipment in the solution of the infinite variety of problems with which the structural engineer has to cope. The instruction in this work is largely individual in character and is planned to develop the ability to think independently. This work is carried on in the atmosphere of the architectural department where the student is constantly in touch with the men working in Course IV.

*Definition adopted by the Association of Collegiate Schools of Architecture, May, 1921. Architectural Engineering: "Essentially an engineering course, giving fundamental and comprehensive training in engineering and including sufficient preparation in Architecture to put the student in full sympathy with the ideals of the architect, but with no attempt to give him facility in Architectural Design."

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 an essential element in his equipment if he is to be a success as an engineer practicing in Architecture and will form a most useful bond of understanding between himself and the architect.

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

IV-A. ARCHITECTURAL ENGINEERING

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
Applied Mechanics 2·15	3 –6	Applied Mechanics 2·20	3 –6
Architectural History 4·413	2 –2	Architectural History 4·414	2 –2
Building Construction 4·80	1 –1	English & History E22	3 –5
English & History E21	3 –5	Foundry 2·911	2 –0
Mathematics M21	3 –6	Geology of Materials 12·49	1 –2
Military Science MS21	3 –0	Mathematics M22	3 –6
Perspective 4·13	1 –3	Military Science MS22	3 –0
Physics 8·03	4 –5	Physics 8·04	4 –5
Surveying 1·03	2 –0	Structural Drawing 4·90	3 –0
Units of exercise and preparation:	22 –28	Units of exercise and preparation:	24 –26

THIRD YEAR

First Term		*Second Term*	
Acoustics, Illum. & Color 8·06	1 –2	Architectural History 4·424	1 –1
Applied Mechanics 2·211	3 –6	European Civ. & Art G57	3 –4
Architectural History 4·423	1 –1	Planning Principles 4·78	4 –7
European Civ. & Art G56	3 –4	Political Economy Ec32	3 –3
Foundations 1·48	1 –1	Report Writing E33	2 –
Geology of Materials 12·49	1 –2	Structural Analysis 4·912	8 –0
Materials of Eng. 2·304	2 –2	Structures 1·40	3 –5
Office Practice 4·22	6 –0	Surveying 1·03	2 –0
Political Economy Ec31	3 –3	Units of exercise and preparation:	26 –22
Structural Analysis 4·911	6 –0		
Units of exercise and preparation:	27 –21		

FOURTH YEAR

First Term		*Second Term*	
Estimating 4·25	1 –2	Hydraulics 1·62	3 –5
Foundations 1·48	1 –1	Mech. Equip. of Bldgs. 2·59	4 –3
Professional Relations 4·241	1 –1	Professional Relations 4·242	1 –1
Rein. Concrete Design 2·391	7 –0	Rein. Concrete Design 2·392	6 –0
Structural Design 4·921	7 –0	Structural Design 4·922	5 –0
Structures 1·41	4 –8	Structures 1·422	2 –4
Testing Materials Lab. 2·36	2 –1	Thesis	10
Test. Mat. Lab. (Concrete) 2·362	3 –2	General Study	2 –2
General Study	2 –2	Units of exercise and preparation:	48
Units of exercise and preparation:	28 –17		

V. CHEMISTRY

The curriculum in Chemistry includes a large number of individual courses in Chemistry, most of which are general and fundamental in character. The aim of the course is first to give the student thorough instruction by means of lectures, recitations and laboratory practice, in the fundamental principles of inorganic, analytical, organic, physical and industrial chemistry. Instruction in mathematics, physics and German is included in the course. This fundamental instruction is the same for all students for the first three years.

A second aim is to stimulate and develop the research attitude in the student. In any scientific career, the highest success is attained by those who possess an ability to surmount difficulties as they appear, to attack untried problems systematically, and to use knowledge already acquired to advance the boundaries of the science. This is particularly true of chemical science. The "Thesis" coming in the fourth year is intended to develop ability in research. In this subject each student is assigned a problem of not great difficulty which he is expected to plan and execute, with reasonable aid from an instructor. He is required to present the results of the investigation in a careful and concise report. The extensive equipment of the various laboratories is fully utilized for this work.

Specialized courses, optional in the fourth year, are given in such subjects as the examination of water supplies, foods, oils, gases, sugars and starches, and the methods of proximate technical analysis.

For those students who show special aptitude for investigation, opportunity for pursuing graduate courses and research is offered in the Research Laboratories of Physical Chemistry, Organic Chemistry and Inorganic Chemistry.

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

A special Chemistry Department circular gives in detail the aims and courses of the Department.

V. CHEMISTRY

FIRST YEAR. See page 67

Required during Summer (Following First Year)

Qualitative Analysis 5·10..... 14 – 4

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 – 5	English & History E22	3 – 5
Geology G60	2 – 2	Mathematics M22	3 – 6
Mathematics M21	3 – 6	Military Science MS22	3 – 0
Military Science MS21	3 – 0	Physics 8·04	4 – 5
Physics 8·03	4 – 5	Quantitative Analysis 5·13	7 – 2
Quantitative Analysis 5·12	7 – 2	Language	3 – 5
Language	3 – 5	General Study	2 – 2
Units of exercise and preparation:	25 – 25	Units of exercise and preparation:	25 – 25

THIRD YEAR

First Term		*Second Term*	
Analytical Chem. 5·141	3 – 2	Analytical Chem. 5·142	3 – 2
Biology & Bact. 7·28	3 – 1	Chemical Literature 5·82T	1 – 1
Chemical Literature 5·81T	3 – 2	Industrial Chemistry 10·201	4 – 4
Organic Chemistry I 5·41	4 – 3	Organic Chemistry I 5·42	4 – 2
Organic Chem. Lab. 5·414	9 – 0	Organic Chem. Lab. 5·424	13 – 0
Physical Chemistry I 5·61T	5 – 5	Physical Chemistry II 5·62T	5 – 5
Political Economy Ec31	3 – 3	Political Economy Ec32	3 – 3
Units of exercise and preparation:	30 – 16	Units of exercise and preparation:	33 – 17

FOURTH YEAR

First Term		*Second Term*	
Industrial Chemistry 10·211	3 – 3	History of Chemistry 5·83T	2 – 2
Inorganic Chemistry 5·061	2 – 3	Inorganic Chemistry 5·062	2 – 3
Metallography 3·611	4 – 1	Opt. Ident. of Crys. Comp. 12·20	3 – 1
Physical Chemistry III 5·63	4 – 4	Physical Chemistry IV 5·64T	3 – 4
Thesis 5·961	15	Thesis 5·962	15
Elective	5	Thesis Conference 5·96	1 – 1
General Study	2 – 2	General Study	2 – 2
Units of exercise and preparation:	48	Elective	7
		Units of exercise and preparation:	48

Elective subjects in the Fourth Year must be approved by the Fourth Year Registration Officer.

Students credited with Elementary and Intermediate French upon entrance 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.

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. Along with these are associated the essential principles of heat power engineering, hydraulic power engineering, the designing of structures and machines and of political economy. The electrical engineering instruction of the third and fourth years take 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, power transmission and distribution, lighting, telephony, 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 electrical testing 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 laboratory work is carried on with the purpose of developing in the student habits of accurate observation and reflection, besides bringing to his consideration the methods and tests of fundamental importance and questions of economy of time and precision of results. It culminates in a thesis requiring originality and the application of acquired technique.

The importance of work of the nature of scientific research is emphasized. Research laboratories are provided, and seminar meetings are held weekly at which the progress of research work being carried on is reported and discussed. The historical development of the electrical sciences and arts is discussed in the same meetings. These meetings, established particularly for graduate students, are open to all students.

Under present regulations no students are assured admittance to Course VI 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.

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

VI. ELECTRICAL ENGINEERING

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 –5	Applied Mechanics 2·16	2 –4
Foundry 2·911	2 –0	Electrical Eng. Prin. 6·00	5 –6
Machine Tool Lab. 2·941	2 –0	English & History E22	3 –5
Mathematics M21	3 –6	Machine Tool Lab. 2·942	4 –0
Mech. Eng. & Mach. Draw. 2·12	7 –0	Mathematics M22	3 –6
Mechanism 2·00	4 –6	Military Science MS22	3 –0
Military Science MS21	3 –0	Physics 8·04	4 –5
Physics 8·03	4 –5	Units of exercise and preparation:	24 –26
Units of exercise and preparation:	28 –22		

Required during Summer

Surveying and Plotting 1·02 .... 5 –0

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3 –6	Applied Mechanics 2·22	3 –5
Electrical Eng. Lab. 6·70	7 –4	Electrical Eng. Lab. 6·71	5 –5
Electrical Eng. Prin. 6·01	3 –4	Electrical Eng. Prin. 6·02	5 –6
Eng. Thermodynamics 2·40	4 –5	Eng. Thermodynamics 2·42	4 –5
Mathematics M31	2 –4	Political Economy Ec32	3 –3
Political Economy Ec31	3 –3	General Study	2 –2
Units of exercise and preparation:	22 –26	Units of exercise and preparation:	22 –26

FOURTH YEAR

First Term		*Second Term*	
Electrical Eng. Lab. 6·72	4 –4	Biography in Science G51	3 –5
Electrical Eng. Prin. 6·03	6 –8	Electrical Eng. Prin. 6·04	6 –9
Engineering Lab. 2·621	3 –2	Thesis	15
Hydraulics 1·64	3 –6	Professional Elective	3 –6
General Study	2 –2	Units of exercise and preparation:	47
Professional Elective	3 –6		
Units of exercise and preparation:	21 –28		

Professional Electives

First Term		*Second Term*	
Central Stations 6·221	3 –6	Central Sta. Des. 6·222	3 –6
Electrical Eng. Lab. 6·80	Time arr.	Electrical Equip. Bldgs. 6·23	1 –2
Electric Mach. Des. 6·251	3 –6	Electrical Eng. Lab. 6·80	Time arr.
Electric Railways 6·241	3 –6	Electric Mach. Des. 6·252	3 –6
Illumination 6·27	3 –6	Electric Railways 6·242	3 –6
Prin. Wire Com. 6·281	3 –6	Ind. App. of Elec. Pr. 6·21	3 –6
		Power Trans. Equip. 6·20	3 –6
		Prin. Radio Com. 6·282	3 –6
		Storage Batteries 6·29	1 –1

VI-C. ELECTRICAL ENGINEERING

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 scientific work covering wire telephony, carrier telephony and radio telephony, also wire telegraphy, carrier telegraphy and radio telegraphy. The properties and engineering applications of electron tubes are also included.

The course 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 Term		*Second Term*	
Applied Mechanics 2·20	3 – 6	Electrical Com. Prin. 6·302	3 – 6
Electrical Com. Prin. 6·301	3 – 6	Electrical Eng. Lab. 6·71	5 – 5
Electrical Eng. Lab. 6·70	7 – 4	Electrical Eng. Prin. 6·02	5 – 6
Electrical Eng., Prin. 6·01	3 – 4	Political Economy Ec32	3 – 3
Mathematics M31	2 – 4	Vector Analysis M77	3 – 5
Political Economy Ec31	3 – 3	General Study	2 – 2
Units of exercise and preparation:	21 – 27	Units of exercise and preparation:	21 – 27

FOURTH YEAR

First Term		*Second Term*	
Electrical Com. Prin. 6·311	3 – 5	Biography in Science G51	3 – 5
Electrical Com. Lab. 6·331	5 – 6	Electrical Com. Prin. 6·312	3 – 5
Electrical Eng. Prin. 6·03	6 – 8	Electrical Com. Lab. 6·332	3 – 4
Electrical Eng. Lab. 6·72	4 – 4	Electromag. Wave Prop. 8·242	2 – 3
Electromag. Theory 8·241	2 – 2	Sound, Speech & Aud. 8·05	3 – 6
General Study	2 – 2	Thesis	10
Units of exercise and preparation:	22 – 27	Units of exercise and preparation:	47

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.**
- **(c) Power Systems — Construction and Operation. In coöperation with Stone & Webster, Inc.**

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. All of the manufacturing practice is taken at the General Electric Company's plants 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 Company. Where similar experience is desired in the planning and construction of power systems, it may be obtained with Stone & Webster. 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 similar to 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 Boston Edison Company, Boston Elevated Railway, Stone & Webster 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 an advanced nature. For Option 1 the emphasis during this year is on problems of administration of large 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 administration of public utilities together with research on technical, scientific and administrative problems incident to the conduct of affairs of such enterprises. In Option 3 the development and research work in Communications is carried on in the Bell Telephone Laboratories in New York City.

The training at the plants is laid out and conducted with a view to the maximum 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 with a view to utilizing and developing individual aptitudes.

The number of men who may be admitted to the coöperative training each year is at present limited to fifty-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 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 considerably exceeds 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 intimately discussed. While at the shops students also devote three hours a week to classroom work in electrical theory and general studies, for which six hours' preparation per week is required. 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.

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. GROUP A

FIRST YEAR. See page 67

Required during Summer (Following First Year)

Options 2 and 3. Surveying & Plotting 1·02.... 5 –0

SECOND YEAR

First Term		*Second Term*	
Applied Mechanics 2·16	2 –4	Electrical Eng. Prin. 6·00	5 –6
English & History E21	3 –5	Electrical Eng. Lab. 6·75	2 –2
Mathematics M21	3 –6	English & History E22	3 –5
Mech. Eng.& Mach. Draw. 2·122	5 –0	Mathematics M22	3 –6
Mechanism 2·00	4 –6	Military Science MS22	3 –0
Military Science MS21	3 –0	Physics 8·04	4 –5
Physics 8·03	4 –5	Political Economy Ec31	3 –3
Units of exercise and preparation:	24 –26	Units of exercise and preparation:	23 –27

THIRD YEAR

Summer Term

At M. I. T.

Applied Mechanics 2·20	3 –6
Electrical Engineering Lab. 6·76.	4 –3
Electrical Engineering, Prin. 6·01	3 –4
EngineeringThermodynamics2·40	4 –5
Units of exercise and preparation:	14 –18

First Term		*Second Term*	
At Works		**At M. I. T.**	
Committee Work E44	2 –4	Applied Mechanics 2·22	3 –5
Electrical Eng. Prin. 6·021	2 –4	Electrical Eng. Lab. 6·77	3 –2
(1) Manufacturing Practice	48 h.p.w.	Electrical Eng. Prin. 6·023	5 –6
General Electric Co. 6·901		Eng. Thermodynamics 2·42	4 –5
(2) Public Utility Practice	48 h.p.w.	Mathematics M31	2 –4
Edison Elec. Ill. Co. 6·911		Political Economy Ec32	3 –3
Boston Elevated Ry. 6·921		Testing Materials Lab. 2·36	2 –1
Stone & Webster 6·931		Units of exercise and preparation:	22 –26
(3) Communications Practice	48 h.p.w.		
Western Electric Co. 6·941			

VI-A. ELECTRICAL ENGINEERING. GROUP A — *Continued*

FOURTH YEAR

Summer Term

At Works

Business English E45	1 – 3
Electrical Engineering, Prin. 6·032	2 – 5
(1) Manufacturing Practice	48 h.p.w.
General Electric Co. 6·902	
(2) Public Utility Practice	48 h.p.w.
Edison Elec. Ill. Co. 6·912	
Boston Elevated Railway 6·922	
Stone & Webster 6·932	
(3) Communications Practice	48 h.p.w.
N. Y. Telephone Co. 6·942	

First Term

At M. I. T.

Biography in Science G51	3 – 5
Hydraulics 1·64	3 – 6
(3) Elec. Com. Lab. 6·330	4 – 4
(3) Electrical Com. Prin. 6·311	3 – 5
(1,2) Electrical Eng. Lab. 6·78	6 – 4
(3) Elec. Eng. Lab. 6·781	4 – 3
(1,2) Electrical Eng. Prin. 6·041	3 – 5
(1,2) Electron Th. & App. 8·21	4 – 4
(1,2) Engineering Lab. 2·621	3 – 2
(3) Vector Analysis M77	3 – 5
Units of exercise and preparation:	
(1, 2)	22 – 26
(3)	20 – 28

Second Term

At Works

Modern Forms of Lit. E46	2 – 4
(3) Electrical Com. Prin. 6·312	2 – 6
(1,2) Electrical Eng., Prin. 6·042	2 – 6
(1) Manufacturing Practice	48 h.p.w.
General Electric Co. 6·903	
(2) Public Utility Practice	48 h.p.w.
Edison Elec. Ill. Co. 6·913	
Boston Elevated Ry. 6·923	
Stone & Webster 6·933	
(3) Communications Practice	48 h.p.w.
Bell Telephone Laboratories 6·943	

GRADUATE YEAR

Summer Term

At M. I. T.

Graduate Study & Research	34

First Term

At Works

Graduate Study	14
(1) Manufacturing Practice	48 h.p.w.
General Electric Co. 6·904	
(2) Public Utility Practice	48 h.p.w.
Edison Elec. Ill. Co. 6·914	
Boston Elevated Ry. 6·924	
Stone & Webster 6·934	
(3) Communications Practice	48 h.p.w.
Bell Telephone System 6·944	

Second Term

At M. I. T.

Business Law & Org. Ec63	3 – 5
Graduate Study & Research	40
Units of exercise and preparation:	48

VI-A. ELECTRICAL ENGINEERING. GROUP B

FIRST YEAR. See page 67

Required during Summer (Following First Year)

Options 2 and 3.

Surveying & Plotting 1·02 .... 5 –0

SECOND YEAR

First Term		*Second Term*	
Applied Mechanics 2·16	2 –4	Electrical Eng. Prin. 6·00	5 –6
English & History E21	3 –5	Electrical Eng. Lab. 6·75	2 –2
Mathematics M21	3 –6	English & History E22	3 –5
Mech. Eng. & Mach. Dr. 2.122	5 –0	Mathematics M22	3 –6
Mechanism 2·00	4 –6	Military Science MS22	3 –0
Military Science MS21	3 –0	Physics 8·04	4 –5
Physics 8·03	4 –5	Political Economy Ec31	3 –3
Units of exercise and preparation:	24 –26	Units of exercise and preparation:	23 –27

THIRD YEAR

Summer Term

At Works

Business English E45 .... 1 –3
Electrical Engineering, Prin. 6·01 2 –5
(1) Manufacturing Practice ....48 h.p.w.
General Electric Co. 6·901
(2) Public Utility Practice .....48 h.p.w.
Edison Elec. Ill. Co. 6·911
Boston Elevated Railway 6·921
Stone & Webster 6·931
(3) Communications Practice ...48 h.p.w.
Western Electric Co. 6·941

First Term		*Second Term*	
At M. I. T.		**At Works**	
Applied Mechanics 2·20	3 –6	Modern Forms of Lit. E46	2 –4
Electrical Eng. Prin. 6·02	5 –6	Elec. Eng. Prin. 6·031	2 –5
Electrical Eng. Lab. 6·76	4 –3	(1) Manufacturing Practice	48 h.p.w.
Eng. Thermodynamics 2·40	4 –5	General Electric Co. 6·902	
Mathematics M31	2 –4	(2) Public Utility Practice	48 h.p.w.
Political Economy Ec32	3 –3	Edison Elec. Ill. Co. 6·912	
Units of exercise and preparation:	21 –27	Boston Elevated Ry. 6·922	
		Stone & Webster 6·932	
		(3) Communications Practice	48 h.p.w.
		N. Y. Telephone Co. 6·942	

VI-A. ELECTRICAL ENGINEERING. GROUP B — *Continued*

FOURTH YEAR

Summer Term

At M. I. T.

Applied Mechanics 2·22	3 – 5
Electrical Eng. Lab. 6·77	3 – 2
(3) Electrical Com. Prin. 6·311	3 – 5
(1,2) Electrical Eng. Prin. 6·032	3 – 4
Eng. Thermodynamics 2·42	4 – 5
Testing Materials Lab. 2·36	2 – 1

First Term

At Works

Committee Work E44	2 – 4
(1,2) Electrical Eng. Prin. 6·041	2 – 6
(3) Electrical Eng. Prin. 6·032	2 – 5
(1) Manufacturing Practice	48 h.p.w.
General Electric Co. 6·903	
(2) Public Utility Practice	48 h.p.w.
Edison Elec. Ill. Co. 6·913	
Boston Elevated Ry. 6·923	
Stone & Webster 6·933	
(3) Communications Practice	48 h.p.w.
Bell Telephone Laboratories 6·943	

Second Term

At M. I. T.

Biography in Science G51	3 – 5
Hydraulics 1·64	3 – 6
(3) Electrical Com. Lab. 6·330	4 – 4
(3) Electrical Com. Prin. 6·312	3 – 5
(1,2) Electrical Eng. Lab. 6·78	6 – 4
(3) Electrical Eng. Lab. 6·781	4 – 3
(1,2) Elec. Eng. Prin. 6·042	3 – 5
(1,2) Electron Th. and App. 8·21	4 – 4
(1,2) Engineering Lab. 2·621	3 – 2
(3) Vector Analysis M77	3 – 5
Units of exercise and preparation:	
(1, 2)	22 – 26
(3)	20 – 28

GRADUATE YEAR

Summer Term

At Works

Graduate Study	10
(1) Manufacturing Practice	48 h.p.w.
General Electric Co. 6·904	
(2) Public Utility Practice	48 h.p.w.
Edison Elec. Ill. Co. 6·914	
Boston Elevated Ry. 6·924	
Stone & Webster 6·934	
(3) Communications Practice	48 h.p.w.
Bell Telephone System 6·944	

First Term

At M. I. T.

Graduate Study & Research	48
Units of exercise and preparation:	48

Second Term

At M. I. T.

Business Law & Org. Ec63	3 – 5
Graduate Study & Research	40
Units of exercise and preparation:	48

VII. BIOLOGY AND PUBLIC HEALTH

The applications of modern biological sciences have opened up new fields of usefulness for those with broad and properly coördinated training, in public health, research and industry.

To provide the equipment necessary for these positions three groups of related studies, covering four years, have been arranged. The first deals primarily with biological sciences in general and with public health administration; the second with the industrial or technical applications of biology, and the third with engineering aspects of health work.

In the public health field useful and inviting careers in the service of the government, states and cities, or with public service or private corporations, health organizations or individuals are now open to ambitious students well trained in general and sanitary biology, bacteriology, industrial hygiene, municipal sanitation, public health administration and the diagnostic procedures used in identification and control of infectious diseases. The new option in Public Health Engineering offers excellent training for those who wish to take up public health work on the engineering side.

For persons proficient in these subjects the demand has of late years generally exceeded the supply, and graduates have readily obtained positions as bacteriologists, health officers, sanitary inspectors or engineers in states and cities, or in connection with health work in industrial plants, or in research.

The work in this Department also affords preparation for entrance to medical schools of the highest grade.

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 fisheries or food conservation and manufacture, industrial fermentations and the control of biochemical processes. The two options here described are in Fisheries Technology, and Food Technology. Fisheries industries have especially requested training of this type in order to be able to secure men properly equipped to become superintendents of plants, managers and administrators. This basic industry, comparable in significance to Forestry or Animal Husbandry, has had but slight attention from the standpoint of technical training, so that a course in Fisheries Technology should lead to positions of industrial importance and great technical interest. The corresponding work in Food Technology has been so developed that it trains especially for the other great food conservation industries and provides a thorough grounding in the chemistry and bacteriology of foods, in biochemistry and fermentation and in the essentials, statistics, business management and other economic subjects desirable for important professional or commercial positions.

Any of the subdivisions of the course in Biology and Public Health thus furnishes certain essential elements for well-rounded education with professional training for special occupations.

VII. BIOLOGY AND PUBLIC HEALTH

Option 1. Biology and Public Health

FIRST YEAR. See page 67

Required during Summer (Following First Year)

Qualitative Analysis 5·11	7 –2
Quantitative Analysis 5·12	7 –2

SECOND YEAR

First Term		*Second Term*	
Biology, General 7·01	5 –2	Botany 7·06	5 –2
English & History E21	3 –5	English & History E22	3 –5
Mathematics M21	3 –6	Military Science MS22	3 –0
Military Science MS21	3 –0	Organic Chem. Lab. 5·428	7 –1
Organic Chemistry 5·412	3 –2	Physics 8·04	4 –5
Physics 8·03	4 –5	Political Economy Ec32	3 –3
Political Economy Ec31	3 –3	Zoology 7·10	5 –2
Units of exercise and preparation:	24 –23	Units of exercise and preparation:	30 –18

THIRD YEAR

First Term		*Second Term*	
Anatomy & Histology 7·11	8 –5	Anatomy & Histology 7·12	8 –4
Bacteriology 7·301	6 –4	Bacteriology 7·302	6 –3
Biological Literature 7·90	1 –3	Chem. of Water & Sew. 5·20	4 –1
Chemistry of Foods 5·25	5 –1	Municipal Sanitation 7·57	4 –4
Personal Hyg. & Nut. 7·22	2 –3	Physiology 7·20	6 –5
Physical Chem. Elem. 5·684	3 –3	General Study	2 –2
General Study	2 –2	Units of exercise and preparation:	30 –19
Units of exercise and preparation:	27 –21		

FOURTH YEAR

First Term		*Second Term*	
Biochemistry 7·80	8 –5	Biological Colloquium 7·92	1 –1
Biological Colloquium 7·91	1 –1	Industrial Hygiene 7·52	4 –4
Infection & Immunity 7·50	3 –5	Parisitology 7·08	2 –4
Public Health Admin. 7·541	2 –2	Public Health Admin. 7·542	2 –3
Public Health Lab. Meth. 7·551	6 –2	Pub. Health Lab. Meth. 7·552	3 –1
Theoretical Biology 7·03	2 –3	Public Health Surveys 7·56	1 –2
Vital Statistics 7·58	2 –3	School Health Admin. 7·604	1 –1
General Study	2 –2	Thesis and Elective	18
Units of exercise and preparation:	26 –23	Units of exercise and preparation:	48

VII. BIOLOGY AND PUBLIC HEALTH — *Continued*

Option 2. Industrial Biology
(a) Fisheries Technology. (b) Food Technology

FIRST YEAR. See page 67

Required during Summer (Following First Year)

Qualitative Analysis 5·11	7 – 2
Quantitative Analysis 5·12	7 – 2

SECOND YEAR

First Term		*Second Term*	
Biology, General 7·01	5 – 2	Botany 7·06	5 – 2
English & History E21	3 – 5	English & History E22	3 – 5
Mathematics M21	3 – 6	Military Science MS22	3 – 0
Military Science MS21	3 – 0	Organic Chem. Lab. 5·428	7 – 1
Organic Chemistry 5·412	3 – 2	Physics 8·04	4 – 5
Physics 8·03	4 – 5	Political Economy Ec32	3 – 3
Political Economy Ec31	3 – 3	Zoology 7·10	5 – 2
Units of exercise and preparation:	24 – 23	Units of exercise and preparation:	30 – 18

THIRD YEAR

First Term		*Second Term*	
Bacteriology 7·301	6 – 4	Bacteriology 7·302	6 – 3
Chemistry of Foods 5·25	5 – 1	Chem. of Water and Sew. 5·20	4 – 1
Mycology 7·07	3 – 2	Municipal Sanitation 7·57	4 – 4
Personal Hyg. and Nut. 7·22	2 – 3	Physiology 7·20	6 – 5
Physical Chem. Elem. 5·684	3 – 3	(*a*) Food Fishes 7·422	6 – 2
(*a*) Food Fishes 7·421	8 – 5	(*a*) Fish Culture 7·43	2 – 2
(*b*) Essentials of Anat. 7·15	3 – 3	(*b*) Plant Diseases 7·33	1 – 2
(*b*) Tech. Food Sup. 7·701	4 – 2	(*b*) Tech. Food Sup. 7·702	5 – 4
General Study	2 – 2	General Study	2 – 2
Units of exercise and preparation: (*a*)	29 – 20	Units of exercise and preparation: (*a*)	30 – 19
(*b*)	28 – 20	(*b*)	28 – 21

FOURTH YEAR

First Term		*Second Term*	
Biochemistry 7·80	8 – 5	Biological Colloquium 7·92	1 – 1
Biological Colloquium 7·91	1 – 1	Business Law & Org. Ec63	3 – 5
Indust. Microbiology 7·361	5 – 2	Industrial Hygiene 7·52	4 – 4
Refrigeration 2·491	1 – 2	Indust. Microbiology 7·362	4 – 2
Theoretical Biology 7·03	2 – 3	(*a*) Tech. Fish Prod. 7·442	5 – 4
(*a*) Tech. Fish. Prod. 7·441	4 – 4	(*b*) Tech. Food Prod. 7·712	5 – 4
(*b*) Tech. Food Prod. 7·711	4 – 4	Thesis & Elective	15
Thesis & Elective	10	Units of exercise and preparation: (*a*)	48
Units of exercise and preparation: (*a*)	48	(*b*)	48
(*b*)	48		

VII. BIOLOGY AND PUBLIC HEALTH — *Continued*

Option 3. Public Health Engineering

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
Biology, General 7·01	5 – 2	Applied Mechanics 2·16	2 – 4
English & History E21	3 – 5	English & History E22	3 – 5
Mathematics M21	3 – 6	Mathematics M22	3 – 6
Machine Drawing 2·131	5 – 0	Military Science MS22	3 – 0
Military Science MS21	3 – 0	Physics 8·04	4 – 5
Physics 8·03	4 – 5	Quantitative Analysis 5·122	10 – 3
Qualitative Analysis 5·11	7 – 2	Units of exercise and preparation:	25 – 23
Units of exercise and preparation:	30 – 20		

Required during Summer. At Camp Technology

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

THIRD YEAR (In effect 1930–31)

First Term		*Second Term*	
Applied Mechanics 2·20	3 – 6	Bacteriology 7·302	6 – 3
Bacteriology 7·301	6 – 4	Chem. of Water & Sew. 5·20	4 – 1
Geology 12·321	2 – 1	Hydraulics 1·62	3 – 5
Organic Chemistry 5·412	3 – 2	Municipal Sanitation 7·57	4 – 4
Personal Hyg. & Nut. 7·22	2 – 3	Political Economy Ec32	3 – 3
Political Economy Ec31	3 – 3	Railway & High. Eng. 1·22	2 – 2
Railway & High. Eng. 1·211	1 – 3	Structures 1·40	3 – 5
General Study	4 – 4	Units of exercise and preparation:	25 – 23
Units of exercise and preparation:	24 – 26		

FOURTH YEAR (In effect 1931–32)

Engineering and Public Health

Engineering	Public Health
Eng. Const. & Estimates 1·25	Public Health Problems
Heat Engineering 2·46, 2·47	Industrial Hygiene 7·52
Sanitary Engineering 1·77, 1·78	Infection and Immunity 7·50
Sanitary Design	Public Health Admin. 7·541
Structures	Vital Statistics 7·58
Testing Materials Lab.	
Eng. & Hydraulic Lab. 2·63	
General Study	
Thesis	

VIII. PHYSICS

The course in Physics is intended to be sufficiently broad to provide for the needs of those men who desire to prepare for graduate work in theoretical physics and for research in pure physics as well as for those students who intend to prepare themselves for work in industrial physics. Experience has shown that for graduate work or for later research and investigation work either of a theoretical or of a practical nature, sound fundamental training in theoretical physics is necessary, and this work is therefore carried through to the end of the fourth year. Ample laboratory courses are provided in order to furnish opportunity for the students to become familiar with physical manipulation and with the methods and processes involved in the design and study of physical apparatus for special problems. Considerable instruction in the fourth year as well as in the graduate year is given by prominent physicists, not members of the regular staff, who give from time to time extensive courses upon the newer developments in physics.

The Department reserves the right to limit admission to Course VIII above the second year to that number of students (at present about twelve or fifteen in each class) who may be properly trained with the professional equipment available. The limitation if necessary will be effected by the selection of the applicants of highest grade.

VIII. PHYSICS

FIRST YEAR. See page 67

Required during Summer (Following First Year)

Qualitative Analysis 5·11 . . . . . . 7 –2

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 –5	English & History E22	3 –5
Higher Alg. & Geom. M23	2 –4	Higher Alg. & Geom. M24	2 –4
Mathematics M21	3 –6	Introd. to Phys. Science 8·22	2 –3
Military Science MS21	3 –0	Mathematics M22	3 –6
Organic Chemistry 5·412	3 –2	Military Science MS22	3 –0
Physics 8·03	4 –5	Physics 8·04	4 –5
Phys. Meas. & Precis. 8·071	1 –1	Language	3 –5
Language	3 –5	Units of exercise and preparation:	20 –28
Units of exercise and preparation:	22 –28		

THIRD YEAR

First Term		*Second Term*	
Elem. of Analysis M32	3 –6	Acoustics 8·09	2 –3
Higher Alg. & Geom. M23	2 –4	Electricity 8·20	3 –6
Mech. & Hydrodynamics 8·221	4 –8	Electricity Lab. 8·203	3 –3
Optics 8·172	3 –6	Heat & Kinetic Th. 8·222	4 –6
Optical Meas. 8·18	3 –2	Higher Alg. & Geom. M24	2 –4
Political Economy Ec31	3 –3	Political Economy Ec32	3 –3
Units of exercise and preparation:	18 –29	Vector Analysis M77	3 –5
		Units of exercise and preparation:	20 –30

FOURTH YEAR

First Term		*Second Term*	
Physics II 8·231	4 –8	Physics II 8·232	4 –8
Precision of Measure. 8·07	1 –1	Sound, Speech & Aud. 8·05	3 –6
Thesis	6	Thesis	10
General Study	2 –2	General Study	2 –2
Elective	21	Elective	13
Units of exercise and preparation:	45	Units of exercise and preparation:	48

IX-A. GENERAL SCIENCE

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 such humanistic studies as English, modern language, history, economics and social science.

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.

IX-A. GENERAL SCIENCE

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
Biology & Bacteriology 7·28	3 –1	Biology & Bacteriology 7·291	3 –1
English & History E21	3 –5	English & History E22	3 –5
Mathematics M21	3 –6	Mathematics M22	3 –6
Military Science MS21	3 –0	Military Science MS22	3 –0
Physics 8·03	4 –5	Physics 8·04	4 –5
Qualitative Analysis 5·11	7 –2	Quantitative Analysis 5·12	7 –2
Language	3 –5	Language	3 –5
Units of exercise and preparation:	26 –24	Units of exercise and preparation:	26 –24

THIRD YEAR

First Term		*Second Term*	
Heat Measurements 8·11	2 –1	Geology 12·30	3 –3
Organic Chemistry 5·413	2 –2	Mineralogy 12·03	3 –1
Political Economy Ec31	3 –3	Organic Chem. Lab. 5·429	5 –0
Electives	31	Organic Evolution G64	2 –2
General Study	2 –2	Political Economy Ec32	3 –3
Units of exercise and preparation:	48	Professional Elective	23
		Units of exercise and preparation:	48

FOURTH YEAR

First Term		*Second Term*	
Geology 12·31	5 –3	Descriptive Astronomy G66	2 –2
General Study	2 –2	Major Professional Elective	9
Major Prof. Elective	9	Professional Elective & Thesis	35
Professional Elective & Thesis	27	Units of exercise and preparation:	48
Units of exercise and preparation:	48		

IX-B. GENERAL ENGINEERING

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 to the extent demanded by one of the regular courses, 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. In all cases 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.

IX-B. GENERAL ENGINEERING

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 – 5	Applied Mechanics 2·15	3 – 6
Mathematics M21	3 – 6	English & History E22	3 – 5
Mech. Eng.& Mach. Draw. 2·121	6 – 0	Machine Tool Lab. 2·96	4 – 0
Mechanism 2·01	2 – 4	Mathematics M22	3 – 6
Military Science MS21	3 – 0	Military Science MS22	3 – 0
Physics 8·03	4 – 5	Physics 8·04	4 – 5
Elective	9	Surveying 1·03	2 – 0
Units of exercise and preparation:	50	Elective	6
		Units of exercise and preparation:	50

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3 – 6	Electrical Eng. Elem. 6·40	4 – 6
Eng. Thermodynamics 2·40	4 – 5	Eng. Thermodynamics 2·42	4 – 5
Political Economy Ec31	3 – 3	Hydraulics 1·62	3 – 5
General Study	2 – 2	Political Economy Ec32	3 – 3
Electives	20	Structures 1·40	3 – 5
Units of exercise and preparation:	48	Electives	3
		General Study	2 – 2
		Units of exercise and preparation:	48

FOURTH YEAR

First Term		*Second Term*	
Electrical Eng. Lab. 6·85	2 – 3	Elective & Thesis	44
Engineering Lab. 2·62	4 – 2	General Study	2 – 2
Elective & Thesis	33	Units of exercise and preparation:	48
General Study	2 – 2		
Units of exercise and preparation:	48		

IX-C. MATHEMATICS

The Institute offers exceptional opportunities for the study of mathematics, particularly as applied to scientific and engineering work.

The course outlined is for men who desire to specialize in Applied Mathematics. It is well adapted to serve as a preparation for specialization in pure mathematics, in mathematical physics, or along lines of experimental physics or engineering requiring proficiency in mathematics.

Considerable latitude in the choice of subjects is provided for in the third and fourth years in order that the student shall be able to take, in addition to his purely mathematical courses, a considerable amount of work in general studies, or in scientific and engineering subjects in which mathematics plays an important part. For example, he may elect courses in thermodynamics, mechanics, electricity or in physical chemistry.

While a definite schedule for the second year is offered, any student who has completed satisfactorily the work of the first two years in any of the professional courses of 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 option.

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

IX-C. MATHEMATICS

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3–5	English & History E22	3–5
Mathematics M21	3–6	Mathematics M22	3–6
Military Science MS21	3–0	Military Science MS22	3–0
Physics 8·03	4–5	Physics 8·04	4–5
Elective	13	Elective	13
Language	3–5	Language	3–5
Units of exercise and preparation:	50	Units of exercise and preparation:	50

THIRD YEAR

First Term		*Second Term*	
Elements of Analysis M32	3–6	Heat & Kinetic Th. 8·222	4–6
Mathematical Elective	3–6	Mathematical Elective	3–6
Mech. & Hydrodynamics 8·221	4–8	Political Economy Ec32	3–3
Political Economy Ec31	3–3	Vector Analysis M77	3–5
Elective	8	Elective	11
General Study	2–2	General Study	2–2
Units of exercise and preparation:	48	Units of exercise and preparation:	48

FOURTH YEAR

First Term		*Second Term*	
Least Squares & Prob. M26	2–2	Mathematical Lab. M54	3–5
Physics II (Advanced) 8·231	4–8	Physics II (Advanced) 8·232	4–8
Elective and Thesis	28	Elective & Thesis	28
General Study	2–2	Units of exercise and preparation:	48
Units of exercise and preparation:	48		

X. CHEMICAL ENGINEERING

The efficiency of any industrial chemical process depends not only upon a knowledge of the chemical reactions forming the basis of the process, but also upon a knowledge of the mechanical principles on which depend the design, construction and maintenance of plant for carrying on these reactions. To prepare students capable of filling the demand for men competent to build and operate manufacturing industries based upon chemical principles is the purpose of this course in Chemical Engineering.

The professional work of the course falls naturally into three groups: first, courses which provide a thorough knowledge of the fundamental principles of chemistry. Second, those courses which furnish a sound knowledge of mechanical engineering subjects, both in theory and in practice. Third, courses which deal with chemical engineering as a separate entity.

The course therefore includes a training in inorganic, analytical, organic, physical and industrial chemistry, which is the same as that given to students in the course in Chemistry except in the case of some of the laboratory courses. The training in mechanism, applied mechanics, and testing materials laboratory is given in the Department of Mechanical Engineering, with special reference to the particular needs of this course. This is true also of the work of the course which is given in the Electrical Engineering Department. The instruction in Chemical Engineering and Industrial Chemistry is of a distinctly professional nature.

A graduate year of the course is provided in which opportunity for the development and correlation of these fundamental subjects in the field of chemical engineering is presented.

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

X-B. CHEMICAL ENGINEERING PRACTICE

The privileges of the School of Chemical Engineering Practice are available for a selected group of Institute undergraduates the last part of the senior year. Students desiring this course should apply the second term of the third year and those accepted will be given special courses in the first term of the fourth year to prepare them for the work of the Practice School.

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

X. CHEMICAL ENGINEERING

FIRST YEAR. See page 67

Required during Summer (Following First Year)

Qualitative Analysis 5·10 ...... 14 –4

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 –5	Applied Mechanics 2·15	3 –6
Mathematics M21	3 –6	English & History E22	3 –5
Military Science MS21	3 –0	Mechanism 2·01	2 –4
Physics 8·03	4 –5	Military Science MS22	3 –0
Prob. of the Chem. Eng. 10·11	1 –0	Physics 8·04	4 –5
Quantitative Analysis 5·121	9 –3	Quantitative Analysis 5·131	6 –1
Language	3 –5	Language	3 –5
Units of exercise and preparation:	26 –24	Units of exercise and preparation:	24 –26

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 both Elementary French and Elementary German will take Chemical Engineering Literature 10·191, two General Studies and four units Elective.

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3 –6	Chemical Eng. 10·29	3 –6
Chemical Eng. 10·28	3 –6	Industrial Chemistry 10·20	5 –5
Organic Chemistry I 5·41	4 –3	Organic Chemistry I 5·42	4 –2
Organic Chem. Lab. 5·416	7 –0	Organic Chem. Lab. 5·426	3 –0
Physical Chemistry 5·61T	5 –5	Physical Chemistry 5·62T	5 –5
Political Economy Ec31	3 –3	Political Economy Ec32	3 –3
Units of exercise and preparation:	25 –23	General Study	2 –2
		Units of exercise and preparation:	25 –23

FOURTH YEAR

First Term		*Second Term*	
Calculus, Applications M41	3 –6	Chemical Engineering 10·32	4 –4
Chemical Engineering 10·31	5 –5	Electrical Eng. Lab. 6·85	2 –3
Electrical Eng. Elem. 6·40	4 –6	Testing Materials Lab. 2·37	2 –0
Engineering Lab. 2·62	4 –2	Thesis Rep. & Mem. 10·15	2 –2
Industrial Chem. Lab. 10·26	5 –1	Prof. Electives and Thesis	28
Industrial Chemistry 10·21	2 –2	Units of exercise and preparation:	47
General Study	2 –2		
Units of exercise and preparation:	25 –24		

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 optional subject in the second term of the fourth year.

X-B. CHEMICAL ENGINEERING PRACTICE

Students desiring to take the work of the School of Chemical Engineering Practice as undergraduates may apply for admission at the end of the third year of Course X. If accepted, they will substitute for the fourth year the program shown below:

FOURTH YEAR

First Term		*Second Term*	
Calculus, Applications M41....	3 –6	Chemical Engineering 10·34....	3 –6
Chemical Engineering 10·33....	7 –9	School of Chem. Eng. Practice	
Electrical Eng. Elem. 6·41.....	3 –5	Bangor 10·84..............	11
Industrial Chemistry 10·22....	2 –2	Boston 10·85..............	11
General Study...............	2 –2	Buffalo 10·86..............	11
Units of exercise and preparation:	41	Thesis....................	20
		Units of exercise and preparation:	62

XI. SANITARY ENGINEERING

The course in Sanitary Engineering is an offshoot of the Civil Engineering course intended to fill the needs of students wishing to give particular attention to problems affecting the health and convenience of the public. The course resembles the general option in Civil Engineering except for a reduction in the time devoted to structural engineering and an entire omission of the courses in astronomy, geodesy and foundations. The time thus gained is devoted principally to courses in organic chemistry; in bacteriology, biology and allied subjects; and in the special fields of water supplies and the disposal of sewage and other municipal wastes. In these courses it is intended to give the students such training as shall fit them to interpret properly the results of researches in sanitary chemistry and in bacteriology, to design and supervise the operation of modern filtration and sewage disposal plants and to deal intelligently with the problems arising in the construction, maintenance and care of city streets.

Special attention is given to the problems arising in water supply engineering and sewerage engineering and to the principles involved in the purification of water supplies and the disposition of sewage. The relation between drinking waters and disease is also thoroughly investigated.

Considerable practice in the chemical and biological laboratories is required and the student is instructed in the methods of water analyses and is taught to observe and identify the more important animal and vegetable organisms present in water and sewage.

Graduates of this course should be especially qualified to enter the service of private and public engineering organizations dealing with the increasingly numerous and difficult problems of water supply and sewage disposal confronting our larger cities, or to join the engineering staff of a municipality, or to enter the service of national, state or municipal boards of health.

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

XI. SANITARY ENGINEERING

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3–5	Applied Mechanics 2·15	3–6
Map Read. & Top. Draw. 1·18	2–0	English & History E22	3–5
Mathematics M21	3–6	Mathematics M22	3–6
Machine Drawing 2·131	5–0	Military Science MS22	3–0
Military Science MS21	3–0	Physics 8·04	4–5
Physics 8·03	4–5	Quantitative Analysis 5·12	7–2
Qualitative Analysis 5·11	7–2	Surveying & Plotting 1·01	2–0
Surveying & Plotting 1·00	2–3	Units of exercise and preparation:	25–24
Units of exercise and preparation:	29–21		

Required during Summer. At Camp Technology

Geod. & Topographic Survey. 1·06	7–0
Hydrographic Surveying 1·60	5–0
Plane Surveying 1·05	6–1
Railway Fieldwork 1·20	5–0

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3–6	Biology & Bacteriology 7·29	5–2
Electrical Eng. Elem. 6·40	4–6	Electrical Eng. Lab. 6·86	1–2
Political Economy Ec31	3–3	Hydraulics 1·62	3–5
Railway & High. Eng. 1·211	1–3	Political Economy Ec32	3–3
Roads & Pavements 1·35	2–1	Railway & High. Eng. 1·22	2–2
Sanitary Biology 7·281	7–3	Sanitary Chemistry 5·23	7–1
Testing Materials Lab. 2·37	2–0	Structures 1·40	3–5
General Study	2–2	General Study	2–2
Units of exercise and preparation:	24–24	Units of exercise and preparation:	26–22

FOURTH YEAR

First Term		*Second Term*	
Eng. Const. & Estim. 1·25	2–3	Eng. & Hyd. Lab. 2·63	2–2
Geology 12·321	2–1	Heat Engineering 2·47	2–3
Heat Engineering 2·46	4–7	Sanitary Design 1·80	6–0
Microscopy of Waters 7·34T	1–1	Sanitary Engineering 1·78	3–4
Sanitary Engineering 1·77	4–5	Structures 1·421	2–4
Structures 1·41	4–8	Structural Design 1·52	6–0
Water Sup. & Wastes Dis. 5·22	2–1	Testing Materials Lab. 2·37	2–0
General Study	2–2	Thesis	8
Units of exercise and preparation:	21–28	General Study	2–2
		Units of exercise and preparation:	48

XII. GEOLOGY

The geologist and the geological engineer have lately won for themselves a place in many technical enterprises related to mining, civil engineering and water supply. Course XII is planned with this fact in view, though it is also adapted for those who desire to follow geology in its more theoretical aspects.

The course prescribes during the first two years the usual subjects taken by all the engineering and science courses. It also requires summer work in surveying and, throughout the upper years, a carefully arranged list of geologic subjects fundamental to one specializing in geology. A considerable amount of time is left for electives which may be chosen from either engineering subjects closely related to geology, such as mining engineering, or from more advanced geological subjects. The course is thus given considerable flexibility and can be adapted to the needs of students desiring to specialize in one of the larger divisions of geologic science; the same flexibility makes it possible to adapt the course to the needs of students from other colleges who may have in part anticipated the prescribed studies of the course.

The course leads to the degree of Bachelor of Science in Geology.

XII. GEOLOGY

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 –5	English & History E22	3 –5
Mathematics M21	3 –6	Geology 12·30	3 –3
Military Science MS21	3 –0	Mathematics M22	3 –6
Mineralogy 12·01	8 –2	Military Science MS22	3 –0
Physics 8·03	4 –5	Mineralogy 12·02	5 –1
Qualitative Analysis 5·11	7 –2	Physics 8·04	4 –5
Units of exercise and preparation:	28 –20	Quantitative Analysis 5·12	7 –2
		Units of exercise and preparation:	28 –22

THIRD YEAR

First Term		*Second Term*	
Geology 12·31	5 –3	Geology, Economic 12·40	5 –3
Opt. Crystallography 12·211	4 –1	Historical Geology 12·50	3 –2
Paleontology 12·511	3 –2	Organic Evolution G64	2 –2
Political Economy Ec31	3 –3	Paleontology 12·512	1 –1
Quantitative Analysis 5·13	7 –2	Petrography 12·15	8 –2
(*a*) Mining, Elem. of 3·05	2 –2	Political Economy Ec32	3 –3
(*a*) Professional Elective	4 –0	(*a*) Ore Dressing 3·23	3 –2
(*b*) General Biology 7·01	5 –2	(*b*) Zoology 7·10	4 –2
Language	3 –5	Language	3 –5
Units of exercise and (*a*)	31 –18	Units of exercise and (*a*)	28 –20
preparation: (*b*)	30 –18	preparation: (*b*)	29 –20

Required during Summer. At Summer Mining Camp

Surveying 1·10	23 –1
Field Geology 12·36	8

FOURTH YEAR

First Term		*Second Term*	
Econ. Geology Lab. 12·41	6 –2	App. Econ. Geology 12·42	2 –1
Ec. Geol. Non-Met. Dep. 12·46	3 –3	Diastro. & Vulcan. 12·61	2 –3
Field Geology 12·33	3 –2	Eng. Geol. & Hyd. 12·48	3 –2
Geol. Coal & Pet. 12·80	4 –3	Met. of Common Metals 3·46	3 –3
Physiography 12·38	3 –1	Thesis	13
Structural Geology 12·60	2 –3	(*a*) Electrochemistry 8·802	3 –6
(*a*) Electrochemistry 8·801	4 –6	(*a*) Professional Elective	7
(*a*) General Study	2 –2	(*b*) Language	3 –5
(*b*) Physical Chem. Elem. 5·681	2 –4	(*b*) General Study	2 –2
(*b*) Language	3 –5	(*b*) Professional Elective	4
Units of exercise and (*a*)	27 –22	Units of exercise and (*a*)	48
preparation: (*b*)	26 –23	preparation: (*b*)	48

Professional Electives may be chosen in Metallurgy, Mining, Paleontology and Advanced Mineralogy or Petrography.

XIII. NAVAL ARCHITECTURE AND MARINE ENGINEERING

Option 1. General

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 mechanism, thermodynamics, applied mechanics, hydraulics, heat engineering, 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 manoeuvring, 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. The student makes a model, lays out plating and draws up specifications. 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.

Lectures are also given on the Organization and Management of Shipyards, including buildings, plant personnel, wages, trades unions, etc.

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

Option 2. Ship Operation

The Option in Ship Operation is intended for students who wish to enter the fields of ship operation and management or to engage in other maritime pursuits such as marine insurance, admiralty law, and the various branches of marine transportation.

The Course is a combination of science, engineering, economics, business studies, naval architecture and marine engineering, especially prepared to train men for the activities of this field. In many respects it parallels the courses in Engineering Administration given at the Institute.

Men with a knowledge of economics, business methods and a training in the fundamentals of the exact sciences and engineering should be particularly well qualified to visualize and analyze the problems of ship operation, after they have had the necessary practical experience and training in subordinate positions with a ship-owning organization.

The instruction in naval architecture, ship construction and design takes up the technical and economic aspects of these subjects, but the treatment is more from the point of view of the ship owner and operator than from that of designer and builder.

As a thorough knowledge of a ship's power plant is essential to the ship operator who must have a large share in the selection and economic operation of the propelling machinery, marine engineering, covering all types of steam and Diesel machinery, is given a prominent place in the course.

Special features in the schedule of studies are the courses in Shipping Administration, Terminal Facilities and the Economics of Ship Operation.

Nearly twenty per cent of the student's time is devoted to economics and business administration subjects.

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

XIII. NAVAL ARCHITECTURE AND MARINE ENGINEERING
Option 1

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 – 5	Applied Mechanics 2·16	2 – 4
Forging 2·901	2 – 0	English & History E22	3 – 5
Marine Engineering 13·50	2 – 1	Forging 2·902	2 – 0
Mathematics M21	3 – 6	Foundry 2·911	2 – 0
Mech. Eng. & Mach. Draw. 2·121	6 – 0	Mathematics M22	3 – 6
Mechanism 2·01	2 – 4	Military Science MS22	3 – 0
Military Science MS21	3 – 0	Physics 8·04	4 – 5
Physics 8·03	4 – 5	Ship Construction 13·32	2 – 2
Ship Construction 13·31	2 – 2	Ship Drawing 13·41	7 – 0
Units of exercise and preparation:	27 – 23	Units of exercise and preparation:	28 – 22

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3 – 6	Applied Mechanics 2·221	3 – 6
Eng. Thermodynamics 2·40	4 – 5	Engineering Lab. 2·611	2 – 1
Machine Tool Lab. 2·951	6 – 0	Eng. Thermodynamics 2·42	4 – 5
Naval Architecture 13·01	2 – 2	Machine Tool Lab. 2·952	4 – 0
Political Economy Ec31	3 – 3	Marine Engineering 13·51	2 – 2
Ship Construction 13·33	2 – 2	Materials of Engineering 2·30	2 – 2
Ship Design 13·42	4 – 0	Naval Architecture 13·02	2 – 2
General Study	2 – 2	Political Economy Ec32	3 – 3
Units of exercise and preparation:	26 – 20	Ship Design 13·43	3 – 0
		General Study	2 – 2
		Units of exercise and preparation:	27 – 23

FOURTH YEAR

First Term		*Second Term*	
Electrical Eng. Elem. 6·40	4 – 6	Accounting Ec50	3 – 3
Engineering Laboratory 2·612	2 – 2	Applied Chemistry 5·35	1 – 2
Hydraulics 1·63	2 – 3	Electrical Eng. Lab. 6·89	2 – 2
Marine Engine Design 13·61	4 – 0	Engineering Lab. 2·615	2 – 2
Marine Engineering 13·54	3 – 3	Mar. Diesel Eng. 13·72	2 – 3
Naval Architecture 13·03	3 – 3	Marine Engine Design 13·62	5 – 0
Ship Design 13·45	7 – 0	Ship Design 13·46	3 – 0
Testing Materials Lab. 2·36	2 – 1	Shipyard Organization 13·38	2 – 1
General Study	2 – 2	Steam Turbines 13·70	2 – 3
Units of exercise and preparation:	29 – 20	Thesis	7
		General Study	2 – 2
		Units of exercise and preparation:	49

Option 2. Ship Operation

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 –5	Accounting Ec50	3 –3
Marine Engineering 13·50	2 –1	Applied Mechanics 2·16	2 –4
Mathematics M21	3 –6	English & History E22	3 –5
Mech. Eng. Drawing 2·101	4 –0	Mathematics M22	3 –6
Mechanism 2·01	2 –4	Military Science MS22	3 –0
Military Science MS21	3 –0	Physics 8·04	4 –5
Physics 8·03	4 –5	Ship Construction 13·32	2 –2
Political Economy Ec21	3 –5	Ship Drawing 13·411	5 –0
Units of exercise and preparation:	24 –26	Units of exercise and preparation:	25 –25

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3 –6	Banking Ec37	3 –4
Corporate Organization Ec56	3 –6	Corp. Finance & Invest. Ec57	3 –6
Eng. Thermodynamics 2·40	4 –5	Engineering Laboratory 2·611	2 –1
Forging 2·901	2 –0	Eng. Thermodynamics 2·42	4 –5
Naval Architecture 13·011	2 –2	Foundry 2·911	2 –0
Report Writing E33	2 –2	Marine Diesel Engines 13·72	2 –3
Ship Construction 13·33	2 –2	Marine Engineering 13·51	2 –2
Terminal Facilities 13·83	3 –2	Naval Architecture 13·021	2 –2
Units of exercise and preparation:	21 –25	Ship Administration Ec80	2 –4
		Units of exercise and preparation:	22 –27

FOURTH YEAR

First Term		*Second Term*	
Business Law Ec61	2 –4	Applied Chemistry 5·35	1 –2
Cost Accounting Ec51	4 –4	Business Law Ec62	2 –4
Electrical Eng. Elem. 6·40	4 –6	Foundry 2·911	2 –0
Engineering Lab. 2·612	2 –2	Industrial Relations G21	3 –5
Marine Engineering 13·52	1 –1	Machine Tool Lab. 2·961	2 –0
Materials of Eng. 2·31	1 –2	Mar. Diesel Engines 13·72	2 –3
Ship Design 13·47	6 –0	Marine Eng. Design 13·66	3 –0
Ship Operation 13·81	3 –4	Ship Operation 13·82	2 –2
Testing Materials Lab. 2·37	2 –0	Steam Turbines 13·70	2 –3
Units of exercise and preparation:	25 –23	Thesis	7
		General Study	2 –2
		Units of exercise and preparation:	49

XIII-A. NAVAL CONSTRUCTION

Course for Naval Constructors

SENIOR YEAR

First Term

Alt. Cur., Alt. Cur. Mach. 6·451	2 –4
Business Law Ec61	2 –4
Electrical Eng. Lab. 6·871	2 –1
Marine Engine Des. 13·63	3 –0
Marine Engineering 13·58	2 –2
Naval Architecture 13·01	2 –2
Political Economy Ec35	3 –5
Th. of Warship Des. 13·11	4 –6
Warship Design 13·21	8 –0
Units of exercise and preparation:	28 –24

Second Term

Alt. Cur., Alt. Cur. Mach. 6·452	2 –4
Electrical Eng. Lab. 6·872	2 –2
Internal Comb. Eng. 2·48	1 –2
Marine Engine Design 13·64	4 –0
Merchant Shipbuilding 13·37	2 –2
Model Making 13·48	2 –0
Naval Architecture 13·02	2 –2
Shipyard Practice 13·39	2 –2
Steam Turbines 13·70	2 –3
Th. of Warship Des. 13·12	4 –4
Warship Design 13·22	8 –0
Units of exercise and preparation:	31 –21

GRADUATE YEAR

First Term

Aeronautics 16·76	2 –4
Naval Architecture 13·03	3 –3
Rigid Dynamics M731	3 –6
Structures 1·45	3 –6
Th. of Warship Des. 13·13	5 –8
Precision of Measure. 8·07	1 –1
Warship Design 13·23	10 –0
Units of exercise and preparation:	27 –28

Second Term

Aeronautics 16·78	3 –5
Rigid Dynamics M732	3 –6
Structural Design 1·46	2 –0
Th. of Warship Des. 13·14	5 –6
Warship Design 13·24	10 –0
Thesis	13
Units of exercise and preparation:	53

XIV. ELECTROCHEMICAL ENGINEERING

The course in Electrochemical Engineering 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 undertake various lines of purely electrical or chemical as well as electrochemical work, if they so desire. The course also offers a very satisfactory foundation in Science for the subsequent study of Patent Law.

The main features of the curriculum are a very thorough training in electrical engineering and chemical subjects, which extend throughout the whole course, upon which is based the distinctly professional work in electrochemistry, which runs through the third and fourth years. The electrical studies are similar to those taken by students in electrical engineering, and include courses in the theory of direct and alternating currents, courses in direct and alternating current generators and motors and power transmission, with practice in the laboratories of electrical engineering and electrical testing. The instruction in chemistry is devoted chiefly to courses in analytical, organic and industrial chemistry. In addition to these subjects are included courses in mechanism, applied mechanics and the examination of materials by the methods of metallography and X-rays.

In the third year the underlying principles of electrochemical and chemical phenomena are discussed both from the kinetic and thermodynamic points of view. This course is completed in the first term of the fourth year, when it is accompanied by extended laboratory practice in electrochemical measurements. In the second term the instruction is continued by a course in applied electrochemistry, including electro-deposition, accumulators, electric furnaces and their products, electrolytic processes and electrometallurgy, and by work in the laboratory of applied electrochemistry. Current periodical literature is reviewed in a weekly colloquium. The latter part of the course is devoted principally to the preparation of a thesis on some electrochemical topic.

A wide range of elective studies is allowed in the fourth year to meet the needs of students who desire to specialize along certain lines of work.

Admission to the laboratory courses in electrochemistry is necessarily restricted to the capacity of the special laboratories equipped for this work.

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

XIV. ELECTROCHEMICAL ENGINEERING

FIRST YEAR. See page 67

Required during Summer (Following First Year)

Mechanism 2·01	2 – 4
Qualitative Analysis 5·101	12 – 2

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 – 5	Electrical Eng., Prin. 6·06	3 – 5
Machine Tool Lab. 2·96	4 – 0	English & History E22	3 – 5
Mathematics M21	3 – 6	Mathematics M22	3 – 6
Military Science MS21	3 – 0	Military Science MS22	3 – 0
Physics 8·03	4 – 5	Physics 8·04	4 – 5
Quantitative Analysis 5·12	7 – 2	Quantitative Analysis 5·132	4 – 1
Language	3 – 5	Language	3 – 5
Units of exercise and preparation:	27 – 23	Units of exercise and preparation:	23 – 27

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·16	2 – 4	Applied Mechanics 2·20	3 – 6
Electrochemistry Prin. 8·801	4 – 6	Electrochemistry Prin. 8·802	3 – 6
Electrical Eng. Prin. 6·07	4 – 6	Electrical Eng. Prin. 6·08	4 – 6
Electrical Eng. Lab. 6·81	3 – 2	Electrical Eng. Lab. 6·82	3 – 2
Heat Measurements 8·11	2 – 1	Organic Chemical Lab. 5·429	5 – 0
Organic Chemistry 5·413	2 – 2	Political Economy Ec32	3 – 3
Political Economy Ec31	3 – 3	General Study	2 – 2
General Study	2 – 2	Units of exercise and preparation:	23 – 25
Units of exercise and preparation:	22 – 26		

FOURTH YEAR

First Term		*Second Term*	
App. Electrochem. Lab. 8·871	2 – 1	App. Electrochem. Lab. 8·872	2 – 1
App. Electrochemistry 8·851	1 – 1	App. Electrochemistry 8·852	2 – 4
Electrical Eng. Prin. 6·09	4 – 6	Colloquium 8·93	1 – 1
Electrical Eng. Lab. 6·83	3 – 2	Industrial Chemistry 10·201	4 – 4
Electrochemical Lab. 8·86	5 – 1	Metallography 3·611	4 – 1
Electrochemistry 8·82	2 – 3	Thesis	12
Precision of Measure. 8·07	1 – 1	Elective	8
X-Rays & Crystal Physics 8·33	3 – 1	General Study	2 – 2
Thesis	1	Units of exercise and preparation:	48
Elective	6		
General Study	2 – 2		
Units of exercise and preparation:	48		

Students credited with Elementary and Intermediate French on entrance will take Elementary German or if they have had preparation Intermediate German. Students credited with Elementary and Intermediate German on entrance will take Elementary French or if they have had preparation Intermediate French. Students credited with Elementary French and Elementary German on entrance will take Intermediate German.

XV. ENGINEERING ADMINISTRATION

The course in Engineering Administration provides a training for men who expect to enter positions concerned with the management or administration of manufacturing, construction and transportation enterprises which demand a knowledge of scientific and engineering principles. Studies in the methods, economics and law of business are combined with instruction in general engineering. The course includes (1) the instruction common to all courses, in literature, language and history, and in chemistry, physics and mathematics; (2) a choice of engineering studies, classified under three options: Civil Engineering, Mechanical and Electrical Engineering, Chemical Engineering; and (3) a selected group of subjects in business and economics. While the amount of time assigned to engineering subjects is less than that prescribed in the other courses of the Institute, the fundamental subjects have been retained which will enable graduates to fill many of the positions open to engineers.

Approximately one-fourth of the total time is given to business subjects which are primarily chosen to train students to analyze commercial and industrial problems. In this group special emphasis is placed upon accounting, business law, the corporate organization of society and business management. The course in Accounting is designed to be of service to administrative officers in the analysis of accounts and financial reports, rather than to make bookkeepers, auditors or accountants in a technical sense. Business Law treats of contracts, agency, negotiable instruments, sales and patents. The two extended subjects of Corporate Organization and Business Management deal with the financial operations of corporations and the conduct of business from the standpoint of the individual employer. Among other subjects included in the group of business studies are banking, statistics, report writing, industrial relations and securities and investments.

Civil Engineering Option. The Civil Engineering Option is intended to meet the needs of students expecting to enter upon administrative positions in organizations engaged in transportation or the construction of works pertaining thereto, or in the development and distribution of hydraulic power. The course differs from the regular Civil Engineering Course by the substitution of business subjects for some of the specialized optional subjects of the fourth year and for the following subjects of earlier years: astronomy, geodesy, geology, railway drafting and topographical drawing. The graduates of this option are, however, trained in the fundamental principles and professional subjects upon which the practice of civil engineering depends.

Mechanical and Electrical Engineering Option. The Option in Mechanical and Electrical Engineering is planned to give a training in a sufficient number of the fundamental engineering subjects to make its graduates competent to deal with engineering affairs other than the direct design and construction of plants. It includes many of the important subjects given in the regular course in Mechanical Engineering, omitting, however, certain of the more specialized subjects. The option differs from the course in Electrical Engineering in that less attention is given to design and to the more theoretical parts of electrical engineering, the aim being to give the students a general knowledge, which, together with the laboratory practice, should make them capable of employment in electrical industries.

Chemical Engineering Option. The Chemical Engineering Option affords instruction in the more important branches of chemistry and in the fundamental principles of mechanical engineering. The time devoted in this option to organic chemistry is much less, and that devoted to the other branches of chemistry is somewhat less than in the Chemical Engineering Course. The training is, however, adequate to fit capable students to take business positions in establishments concerned with industrial chemistry. The instruction in mechanical and electrical engineering is also less extended than that in the Chemical Engineering Course. The primary purpose of the option is to give the information and training necessary to prepare men to deal with the economic administration rather than with the scientific development and control of the processes involved in the industries devoted to the manufacture of materials, such as textiles, paper, leather, rubber, fertilizers, iron and steel, foods and chemicals.

All options of the course lead to the degree of Bachelor of Science in Engineering Administration.

XV. ENGINEERING ADMINISTRATION

Option 1. Civil Engineering

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 –5	Accounting Ec50	3 –3
Mathematics M21	3 –6	Applied Mechanics 2·16	2 –4
Mechanism 2·01	2 –4	Banking Ec37	3 –4
Military Science MS21	3 –0	English & History E22	3 –5
Physics 8·03	4 –5	Mathematics M22	3 –6
Political Economy Ec21	3 –5	Military Science MS22	3 –0
Statistics Ec65	3 –1	Physics 8·04	4 –5
Surveying 1·001	2 –1	Surveying & Plotting 1·01	2 –0
Units of exercise and preparation:	23 –27	Units of exercise and preparation:	23 –27

Required during Summer. At Camp Technology

Geod. & Topographic Survey. 1·06	7 –0
Hydrographic Surveying 1·60	5 –0
Plane Surveying 1·05	6 –1
Railway Fieldwork 1·20	5 –0

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3 –6	Business Management Ec70	3 –3
Corporate Organization Ec56	3 –6	Corp. Finance & Invest. Ec57	3 –6
Electrical Eng. Elem. 6·40	4 –6	Elec. Eng. Lab. 6·89	2 –2
Eng. Thermodynamics 2·40	4 –5	Eng. Thermodynamics 2·42	4 –5
Railway & High. Eng. 1·211	1 –3	Materials 1·43	1 –2
General Study	8	Railway & High. Eng. 1·22	2 –2
Units of exercise and preparation:	49	Report Writing E33	2 –2
		Structures 1·40	3 –5
		Testing Materials Lab. 2·37	2 –0
		Units of exercise and preparation:	22 –27

FOURTH YEAR

First Term		*Second Term*	
Business Law Ec61	2 –4	Business Law Ec62	2 –4
Business Management Ec71	4 –6	Business Management Ec72	4 –5
Cost Accounting Ec51	4 –4	Eng. & Hyd. Lab. 2·63	2 –2
Eng. Const. & Estim. 1·25	2 –3	Industrial Relations G21	3 –5
Foundations 1·48	1 –1	Structural Design 1·54	6 –0
Hydraulics 1·63	2 –3	Structures 1·421	2 –4
Structures 1·41	4 –8	Thesis	7
Units of exercise and preparation:	19 –29	Units of exercise and preparation:	46

XV. ENGINEERING ADMINISTRATION

Option 2. Mechanical and Electrical Engineering

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 –5	Accounting Ec50	3 –3
Machine Tool Lab. 2·971	3 –0	Applied Mechanics 2·16	2 –4
Mathematics M21	3 –6	Banking Ec37	3 –4
Mechanism 2·01	2 –4	English & History E22	3 –5
Military Science MS21	3 –0	Mathematics M22	3 –6
Physics 8·03	4 –5	Military Science MS22	3 –0
Political Economy Ec21	3 –5	Physics 8·04	4 –5
Statistics Ec65	3 –1	Surveying 1·03	2 –0
Units of exercise and preparation:	24 –26	Units of exercise and preparation:	23 –27

Required during Summer

Foundry 2·911	2 –0
Machine Tool Lab. 2·972	3 –0
Mech. Eng. Drawing 2·11	5 –0

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3 –6	Applied Mechanics 2·221	3 –6
Boilers & Engines 2·41	2 –2	Business Management Ec70	3 –3
Corporate Organization Ec56	3 –6	Corp. Finance & Invest. Ec57	3 –6
Eng. Thermodynamics 2·40	4 –5	Electrical Eng. Elem. 6·40	4 –6
Machine Drawing 2·14	4 –0	Eng. Thermodynamics 2·42	4 –5
Report Writing E33	2 –2	Materials of Eng. 2·31	1 –2
General Study	8	Testing Materials Lab. 2·36	2 –1
Units of exercise and preparation:	47	Units of exercise and preparation:	20 –29

FOURTH YEAR

First Term		*Second Term*	
Business Law Ec61	2 –4	Business Law Ec62	2 –4
Business Management Ec71	4 –6	Business Management Ec72	4 –5
Cost Accounting Ec51	4 –4	Engineering Lab. 2·615	2 –2
Elec. Eng. Lab. 6·89	2 –2	Gen. & Dis. of Elec. En. 6·43	4 –6
Engineering Lab. 2·614	4 –3	Industrial Relations G21	3 –5
Hydraulics 1·64	3 –6	Thesis	7
Machine Design 2·721	4 –0	Elective	4 –0
Units of exercise and preparation:	23 –25	Units of exercise and preparation:	48

XV. ENGINEERING ADMINISTRATION

Option 3. Chemical Engineering

Required during Summer (Following First Year)

Mechanism 2·01	2 –4
Qualitative Analysis 5·101	12 –2

SECOND YEAR

First Term		*Second Term*	
English & History E21	3 –5	Accounting Ec50	3 –3
Mathematics M21	3 –6	Applied Mechanics 2·16	2 –4
Military Science MS21	3 –0	Banking Ec37	3 –4
Physics 8·03	4 –5	English & History E22	3 –5
Political Economy Ec21	3 –5	Military Science MS22	3 –0
Quantitative Analysis 5·12	7 –2	Physics 8·04	4 –5
Statistics Ec65	3 –1	Quantitative Analysis 5·13	7 –2
Units of exercise and preparation:	26 –24	Units of exercise and preparation:	25 –23

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3 –6	Business Management Ec70	3 –3
Corporate Organization Ec56	3 –6	Chemical Engineering 10·35	3 –4
Eng. Thermodynamics 2·40	4 –5	Corp. Finance & Invest. Ec57	3 –6
Organic Chemistry 5·412	3 –2	Eng. Thermodynamics 2·42	4 –5
Physical Chemistry, Elem. 5·681	2 –4	Industrial Chemistry 10·201	4 –4
General Study	8	Organic Chem. Lab. 5·418	6 –0
Units of exercise and preparation:	46	Report Writing E33	2 –2
		Units of exercise and preparation:	25 –24

FOURTH YEAR

First Term		*Second Term*	
Business Law Ec61	2 –4	Business Law Ec62	2 –4
Business Management Ec71	4 –6	Business Management Ec72	4 –5
Chemical Engineering 10·361	2 –2	Chemical Engineering 10·362	3 –4
Cost Accounting Ec51	4 –4	Elec. Eng. Lab. 6·85	2 –3
Electrical Eng. Elem. 6·40	4 –6	Engineering Lab. 2·62	4 –2
Industrial Chem. Lab. 10·27	5 –1	Industrial Relations G21	3 –5
Industrial Chemistry 10·212	2 –1	Thesis	7
Testing Materials Lab. 2·37	2 –0	Units of exercise and preparation:	48
Units of exercise and preparation:	25 –24		

XVI. AERONAUTICAL ENGINEERING

The Course in Aeronautical Engineering is designed 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. Following the usual preliminary work in the subjects fundamental to all engineering, part of the time in the third year and most of that in the fourth is devoted to professional subjects, lectures being supplemented by drafting room practice and by laboratory work both in the methods of aeronautical research and in the operations and maintenance of airplanes in the field.

While a graduate in Aeronautical Engineering is especially prepared for work in the engineering department of a company manufacturing airplanes, the subjects taught are not so specialized as to go beyond the proper and necessary interest of any man entering any part of the aeronautical field. In particular, it furnishes a sound basic training for those desirous of associating themselves with enterprises engaged in the operation of aircraft, whether their primary concern is with the selection of equipment or with its maintenance.

The number of students in the first-year class admitted to the second year of Course XVI is limited for the present to thirty, to be chosen, if the number of candidates shall exceed that figure, by the head of the Aeronautical Engineering Course.

Students may be admitted to Course XVI by transfer from other courses at the Institute only when their general records compare favorably with those of the students already in the course. Students who wish to enter Course XVI 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 when they have shown themselves capable of doing work of the required standard. Students not enrolled in Course XVI are admitted to aeronautical subjects when facilities permit, if their general records are good.

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

XVI. AERONAUTICAL ENGINEERING

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
English & History E21	3–5	Applied Mechanics 2·15	3–6
Mathematics M21	3–6	English & History E22	3–5
Mech. Eng. & Mach. Draw. 2·12	7–0	Mathematics M22	3–6
Mechanism 2·01	2–4	Mech. Eng. Drawing 2·102	4–0
Military Science MS21	3–0	Military Science MS22	3–0
Physics 8·03	4–5	Physics 8·04	4–5
Language	3–5	Language	3–5
Units of exercise and preparation:	25–25	Units of exercise and preparation:	23–27

Required during Summer

Forging 2·90	3–0
Foundry 2·911	2–0
Machine Tool Laboratory 2·951	6–0
Pattern Making 2·923	3–0
Airplane Laboratory 16·51	3–1

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3–6	Aerodyn. Airplane Des. 16·00	2–3
Eng. Thermodynamics 2·40	4–5	Eng. Thermodynamics 2·42	4–5
Materials of Eng. 2·30	2–2	Machine Drawing 2·14T	3–0
Political Economy Ec31	3–3	Political Economy Ec32	3–3
Theoret. Aeronautics M43	3–6	Structures 1·401	3–5
General Study	2–2	Theoret. Aeronautics M44	3–6
Language	2–4	Language	2–4
Units of exercise and preparation:	19–28	General Study	2–2
		Units of exercise and preparation:	22–28

FOURTH YEAR

First Term		*Second Term*	
Airplane Design 16·03	4–4	Aeronautical Eng. Lab. 16·88	2–1
Airplane Des. Prac. 16·11	2–0	Aeronautical Lab. 16·62	4–2
Dynamics of Machines 2·251	2–4	Aeronaut. Power Plants 16·82	2–2
Electrical Eng. Elem. 6·40	4–6	Airplane Construction 16·54	2–1
Engineering Lab. 2·611	2–1	Airplane Des. Prac. 16·12	4–0
Machine Design 2·731	2–4	Electrical Eng. Lab. 6·85	2–3
Physical Chemistry 5·683	2–2	Machine Design 2·732	2–4
Testing Materials Lab. 2·35	4–2	Propellers & Airships 16·72	2–2
General Study	2–2	General Study	2–2
Units of exercise and preparation:	24–25	Thesis	9
		Units of exercise and preparation:	48

XVII. BUILDING CONSTRUCTION

This Course is planned to prepare students to enter the business of building and allied industries.

It is based on the Course in Civil Engineering with the mathematics and scientific training generally associated with that profession. Subjects in building finance, and management, cost accounting and professional and industrial relations are also included. Finally a broad course, extending over three years, is given in the analysis, details and assembly of the materials of building, whereby the student is given a thorough understanding of construction methods and procedure, covering dwellings and industrial and commercial structures.

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

XVII. BUILDING CONSTRUCTION

FIRST YEAR. See page 67

SECOND YEAR

First Term		*Second Term*	
Arch. Forms & Det. 17·11	3 –2	Applied Mechanics 2·15	3 –6
Building Construction 17·21	14 –0	Arch. Forms & Det. 17·12	3 –0
English & History E21	3 –5	Building Construction 17·22	9 –0
Mathematics M21	3 –6	English & History E22	3 –5
Military Science MS21	3 –0	Mathematics M22	3 –6
Physics 8·03	4 –5	Military Science MS22	3 –0
Surveying 1·03	2 –0	Physics 8·04	4 –5
Units of exercise and preparation:	32 –18	Units of exercise and preparation:	28 –22

THIRD YEAR

First Term		*Second Term*	
Applied Mechanics 2·20	3 –6	Accounting Ec50	3 –3
Building Construction 17·31	12 –0	Building Const. & Mat. 17·32	9 –0
Carpentry 2·921	2 –0	Contract Management Ec74	3 –6
Electrical Eng. Elem. 6·40	4 –6	Electrical Eng. Lab. 6·89	2 –2
Geology 12·321	2 –1	Hydraulics 1·63	2 –3
Graphic Statics 1·391	3 –1	Structural Th. & Des. 1·471	5 –6
Political Economy Ec21	3 –5	General Study	2 –2
Units of exercise and preparation:	29 –19	Units of exercise and preparation:	26 –22

FOURTH YEAR

First Term		*Second Term*	
Building Construction 17·41	11 –0	Building Construction 17·42	10 –0
Building Finance Ec53	3 –6	Elec. Equip. of Bldgs. 6·23	1 –2
Found. & Soil Mech. 1·481	4 –4	Found. & Soil Mech. 1·482	3 –5
Reinf. Concrete Design and Lab. 2·390	7 –0	Job Management 17·50	1 –1
Structures 1·41	4 –8	Mech. Equip. of Bldgs. 2·59	4 –3
Testing Materials Lab. 2·36	2 –1	Structures 1·422	2 –4
Units of exercise and preparation:	29 –19	Thesis	7
		General Study	2 –2
		Units of exercise and preparation:	47

MILITARY ENGINEERING

Open to regular officers of the United States Army or the United States Navy.

Graduates of the United States Military Academy at West Point or the United States Naval Academy at Annapolis will be admitted on their credentials; Army Officers or Navy Officers of the United States of America not graduates of either of the government schools, who are graduates of a technical school, will be admitted on showing that they have had the necessary preliminary training.

MILITARY ENGINEERING

Required during Summer Preceding the Academic Year

Applied Mechanics 2·20	3 – 6
Applied Mechanics 2·21	3 – 5
Heat Engineering 2·46	4 – 7
Heat Engineering 2·47	2 – 3
Structures 1·40	3 – 5
Units of exercise and preparation:	15 – 26

FOURTH YEAR

First Term		*Second Term*	
Bacteriology 7·31	2 – 2	Con. Bldg., Des. & Spec. 2·395	2 – 4
Elec. Eng., Elem. 6·40	4 – 6	Eng. & Hyd. Lab. 2·631	3 – 3
Eng. Const. & Estim. 1·25	2 – 3	Elec. Eng. Lab. 6·85	2 – 3
Materials of Eng. 2·30	2 – 2	Heat Treatment 3·711	2 – 0
Physical Chemistry 5·683	2 – 2	Ind. App. Elec. Power 6·46	3 – 2
Reinf. Concrete Des. 1·581	6 – 2	Municipal Sanitation 7·57	4 – 3
Structures 1·41	4 – 8	Structures 1·42	4 – 8
Testing Mat. Lab. (Con.) 2·363	2 – 0	Testing Materials Lab. 2·36	2 – 1
Thesis	3	Thesis	6
Units of exercise and preparation:	52	Units of exercise and preparation:	52

UNDERGRADUATE SCHEDULES FOR RESERVE OFFICERS' TRAINING CORPS

The Reserve Officers' Training Corps 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

For instruction in the first year of the basic course, the students are organized as a five-company infantry battalion. The cadet corporals are selected for appointment from the members of the first-year class who demonstrate especial aptitude for military instruction. Cadet sergeants are selected for appointment from such members of the second-year class as are especially qualified and who volunteer to attend drill.

Cadet officers are selected for appointment from members of the advanced course of the R. O. T. C. who volunteer to attend drill.

An R. O. T. C. band consisting of forty pieces is organized from qualified members of the basic and advanced courses.

The completion of this course is a prerequisite for graduation.

First Year. Required of all able-bodied male citizen students registered in the Freshman Class except where suitable evidence of equivalent work already performed is presented to the professor of military science and tactics before the first term begins.

Second Year. Required of all able-bodied male citizen students registered in the Sophomore Class except where suitable evidence of equivalent work already performed is presented to the professor of military science and tactics before the first term begins.

Opportunity is given the student to choose the unit in which he prefers to continue his instruction during the second term.

First Year

First Term			*Second Term*		
MS11.	Infantry drill, elementary subjects of military training, infantry weapons and rifle marksmanship	3–0	MS12.	Infantry drill	3–0

Second Year

MS21.	Topography and map reading, field fortifications, signal communications	3–0	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: Ordnance material	3–0
			MS225.	Air Corps Unit: Tactics and communications	3–0
			MS226.	Chemical Warfare Unit: Theoretical and tactical..	3–0

ADVANCED COURSE

The advanced course is open to students who have completed the basic course at this Institute or in some other R. O. T. C. unit, who are acceptable to the professor of military science and tactics and who receive the approval of the professor in charge of the course in which they are registered.

Students enrolling in the advanced course will receive commutation of rations at the rate of thirty cents per day from date of enrollment until the end of the second Institute year thereafter, 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. In very exceptional cases attendance at camp may be postponed until after the senior year, but only upon the express agreement that the student's diploma will be withheld until after the completion of his R. O. T. C. course.

Students in the advanced course are required to select G98, Military History and Policy of the United States (second term) 2–2, and G3, International Law and American Foreign Policy (first term) 2–2, as two of their General Studies. (Students in Course XV are excused from the requirement in G3.)

"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."

From among the R. O. T. C. graduates each year there may be designated as "Honor Graduates R. O. T. C." not to exceed three per cent of the total number of students who on March 1 of that year were enrolled in the second year of the advanced course of the R. O. T. C.

COAST ARTILLERY UNIT No. 1

Open to students in all courses except V. Students whose Institute courses do not include Surveying, or who are unable to demonstrate proficiency in this subject, will be required to take one of the Institute Surveying subjects.

Students in the Coast Artillery Unit are required to take Military Science MS311, MS321, MS411 and MS421, as well as General Studies G98 and G3.

If other changes in the course schedules are necessary they are noted under the number of the course.

Third Year

First Term			*Second Term*		
MS311.	Fire control instruments, computation of firing data for heavy mobile artillery.	3 –3	MS321.	Dispersion and probability of fire observation and adjustment of fire.......	3 –3

Fourth Year

MS411.	Coast artillery material, organization and administration of Coast Artillery Corps, camp sanitation and military hygiene, gunnery for anti-aircraft artillery..............	2 –2	MS421.	Tactical employment of artillery, fixed anti-aircraft and heavy mobile artillery and military law.	2 –2

Course II. General Course

Advised to take Machine Tool Laboratory in summer following second year.

Fourth Year, First Term.	Omit:	Testing Materials Laboratory 2'35......	4 –2
	Add:	Testing Materials Laboratory 2'36......	4 –0
Second Term.	Omit:	Industrial Plants 2'782................	4 –0

Course II. Options 1, 2, 3, 4

Applicants must have their schedules approved by the Military Department and the head of the Mechanical Engineering Department.

Course III. Option 1

Fourth Year, Second Term. Change Thesis from 10 units to 8 units.

Course III. Option 3

Fourth Year, Second Term. Change Thesis from 11 units to 10 units.

Course VI

Third Year, First Term.	Omit:	Political Economy Ec31...............	3 –3
Second Term.	Omit:	Political Economy Ec32...............	3 –3
Fourth Year, First Term.	Omit:	General Study.......................	2 –2
		Professional Elective.................	3 –6
	Add:	Political Economy Ec31...............	3 –3
Fourth Year, Second Term.	Omit:	Professional Elective.................	3 –6
	Add:	Political Economy Ec32...............	3 –3
		Change Thesis from 15 units to 14 units.	

COAST ARTILLERY UNIT—*Continued*

Course XIV

Fourth Year, First Term.	Change Optional Studies from 9 units to 3 units.
Second Term.	Change Optional Studies from 12 units to 6 units.

Course XV. Option 2

Third Year, First Term.	Omit: Report Writing E33	2–2
Second Term.	Add: Report Writing E33	2–2
	Omit: Machine Tool Laboratory 2·972	3–0
Fourth Year, Second Term.	Omit: Machine Design 2·722	4–0

ENGINEER UNIT NO. 2

Open to students in all courses except V. All instruction for this unit throughout the fourth year is given by Institute personnel.

Students in the Engineer Unit are required to take Military Science MS312 and MS322, as well as General Studies G98 and G3.

If other changes in the course schedules are necessary, they are noted under the number of the course.

Third Year

First Term		*Second Term*	
MS312. Organization and duties of engineers, administration, supply equipment, musketry and combat principles	3–3	MS322. General construction in war, field and permanent fortifications	3–3

Course VI

Third Year, First Term.	Omit: Political Economy Ec31	3–3
Second Term.	Omit: Political Economy Ec32	3–3
Fourth Year, First Term.	Add: Political Economy Ec31	3–3
	Omit: Professional Elective	3–6
Fourth Year, Second Term.	Add: Political Economy Ec32	3–3
	Omit: Professional Elective	3–6
	Change Thesis from 15 units to 19 units.	

SIGNAL UNIT No. 3

Open only to students in Courses VI, VI-A, VI-C, VIII, IX-B and XIV.

Students in the Signal Corps Unit are required to take Military Science MS313 and MS323, as well as General Studies, G98 and G3.

All instruction throughout the fourth year is given by Institute personnel.

If other changes in the course schedules are necessary, they are noted under the number of the course.

Third Year

First Term		*Second Term*	
MS313. Local and common battery telephony, military telegraphy, signal tactics, infantry division	3–3	MS323. Message center, codes and ciphers, international Morse code, Signal Corps radio sets	3–3

SIGNAL UNIT — *Continued*

Course VI

Third Year, First Term.	Omit:	Political Economy Ec31	3 – 3
Second Term.	Omit:	Political Economy Ec32	3 – 3
Fourth Year, First Term.	Omit:	Hydraulics 1·64	3 – 6
	Add:	Political Economy Ec31	3 – 3
		Thesis	2 – 0
Fourth Year, Second Term.	Add:	Political Economy Ec32	3 – 3
		Change Thesis from 15 units to 12 units.	

Courses VIII and IX-B

Fourth Year. Students will elect as a part of their optional studies:

First Term.	Electrical Communications 6·301	3 – 6
Second Term.	Electrical Communications 6·302	3 – 6

or other approved electives acceptable to the Military Science Department.

ORDNANCE UNIT No. 4

Open only to students in Courses II, III_3, VI-A, X, X-B, XV_2 and XV_3.

Students in the Ordnance Unit are required to take Military Science MS314 and MS324, as well as General Studies G98 and G3.

All instruction for this unit throughout the fourth year is given by Institute personnel.

If other changes in the course schedules are necessary, they are noted under the number of the course.

Third Year

First Term			*Second Term*		
MS314.	Organization and duties of Ordnance Department.	1 – 1	MS324.	Organization and duties of Ordnance Department.	1 – 1

Course II. General Course

Fourth Year, Second Term.	Omit:	Engineering Laboratory 2·602	4 – 4
		Industrial Plants 2·781	4 – 0
		Electives	4 – 0
		General Study	2 – 2
	Add:	Engineering Laboratory 2·603	2 – 2
		Heat Treatment 3·71	6 – 0
		Ordnance Engineering 2·88	5 – 3
	Change Thesis from 6 units to 7 units.		

Course II. Options 1, 2, 3, 4

Applicants must have their schedules approved by the Military Science Department, and the head of the Mechanical Engineering Department.

Course X

Fourth Year, First Term.	Omit:	Chemical Engineering 10·31	5 – 5
		Industrial Chemistry 10·21	2 – 2
	Add:	Chemical Engineering 10·311	5 – 5
		Industrial Chemistry 10·214	2 – 2
Fourth Year, Second Term.	Omit:	Chemical Engineering 10·32	4 – 4
		Professional Elective*	10
	Add:	Chemical Engineering 10·321	4 – 4
		Professional Elective*	6
		Powder and Explosives 5·43	2 – 2

*Professional electives may not be less than 4 or more than 8 units, time adjustment being made in hours assigned to Thesis.

ORDNANCE UNIT — *Continued*

Course X-A

Students admitted to Course X-A must take Analytical Chemistry 5·16 (4–1) in the second term of the fourth year as an elective.

Course X-B

Fourth Year, First Term.	Omit:	Chemical Engineering 10·33	7 – 9
		Industrial Chemistry 10·22	2 – 2
	Add:	Chemical Engineering 10·331	7 – 9
		Industrial Chemistry 10·224	2 – 2
Fourth Year, Second Term.	Omit:	Chemical Engineering 10·34	3 – 6
	Add:	Chemical Engineering 10·341	3 – 6

Course XV. Option 2

Fourth Year, Second Term.	Omit:	Machine Design 2·722	4 – 0
	Add:	Ordnance Engineering 2·88	6 – 2
	Change Thesis from 7 units to 6 units.		

Course XV. Option 3

Fourth Year, Second Term.	Add:	Powder and Explosives 5·43	2 – 2

AIR CORPS UNIT No. 5

Open only to students in Courses II, VI and XVI.

Students in the Air Corps Unit are required to take Military Science MS325 and MS415, as well as General Studies G98 and G3.

If other changes in the course schedules are necessary, they are noted under the number of the course.

Third Year

Second Term

MS325. Lectures and problems on airplane instruments, aerial navigation, bomb racks and sites, meteorology, duties of squadron officers and property accountability .... 3 – 3

Fourth Year

First Term

MS415. Lectures and problems on military law, administration and supply, essentials of pursuit, attack, bombardment, and observation and flying operations .... 3 – 3

Courses II (All Options) and VI

Third Year, First Term.	Add:	Rigging and Maintenance of Aircraft 16·51	3 – 1
Fourth Year, Second Term.	Add:	Aeronautical Power Plants 16·82	2 – 2

CHEMICAL WARFARE UNIT No. 6

Open only to students in Courses V, X, XIV and XV_3.

Students in the Chemical Warfare Unit are required to take Military Science MS326, as well as General Studies G98 and G3.

If other changes in the course schedules are necessary, they are noted under the number of the course.

Third Year

Second Term

MS326. Organization and duties of C. W. S. personnel and material 3–3

Course V

Third Year, First Term.	Omit:	Organic Chemistry 5·41	4–3
		Organic Chemical Laboratory 5·414	9–0
	Add:	Organic Chemistry 5·411	4–3
		Organic Chemical Laboratory 5·415	9–0
Third Year, Second Term.	Omit:	Industrial Chemistry 10·201	4–4
		Organic Chemistry 5·42	4–2
		Organic Chemical Laboratory 5·424	13–0
	Add:	Industrial Chemistry 10·202	5–5
		Organic Chemistry 5·421	4–2
		Organic Chemical Laboratory 5·425	9–0
		Study of War Gases 5·33	1–1
Fourth Year, First Term.	Omit:	Industrial Chemistry 10·211	2–2
	Add:	Industrial Chemistry 10·214	2–2
Fourth Year, Second Term.	Omit:	Electives	2
	Add:	Powder and Explosives 5·43	2–2

Course X

Third Year, First Term.	Omit:	Organic Chemistry 5·41	4–3
		Organic Chemical Laboratory 5·416	7–0
	Add:	Organic Chemistry 5·411	4–3
		Organic Chemical Laboratory 5·417	7–0
Third Year, Second Term.	Omit:	Industrial Chemistry 10·20	5–5
		Organic Chemistry 5·42	4–2
		Organic Chemical Laboratory 5·426	3–0
	Add:	Industrial Chemistry 10·202	5–5
		Organic Chemistry 5·421	4–2
		Organic Chemistry Laboratory 5·427	3–0
Fourth Year, First Term.	Omit:	Chemical Engineering 10·31	5–5
		Industrial Chemistry 10·21	2–2
	Add:	Chemical Engineering 10·311	5–5
		Industrial Chemistry 10·214	2–2
Fourth Year, Second Term.	Omit:	Chemical Engineering 10·32	4–4
		Professional Electives*	10
	Add:	Chemical Engineering 10·321	4–4
		Powder and Explosives 5·43	2–2
		Professional Elective*	6

*Professional electives may not be less than 4 nor more than 8 units, time adjustment being made in hours assigned to thesis.

Course X-A

Students planning to enter Course X-A will take Analytical Chemistry 5·16 (4–1) in the second term of the fourth year as an elective.

CHEMICAL WARFARE UNIT — *Continued*

Course X-B

Fourth Year, First Term.	Omit:	Chemical Engineering 10·33	7–9
		Industrial Chemistry 10·22	2–2
	Add:	Chemical Engineering 10·331	7–9
		Industrial Chemistry 10·224	2–2
Fourth Year, Second Term.	Omit:	Chemical Engineering 10·34	3–6
	Add:	Chemical Engineering 10·341	3–6

Course XIV

Fourth Year, Second Term. Students will take

Study of War Gases 5·33	1–1
Powder and Explosives 5·43	2–2

as part of their optional studies.

Course XV. Option 3

Third Year, First Term.	*Omit:*	*Engineering Thermodynamics 2·40*	4–5
	Add:	Heat Engineering 2·46	4–7
Third Year, Second Term.	Omit:	Engineering Thermodynamics 2·45	4–5
	Add:	Heat Engineering 2·47	2–3
Fourth Year, Second Term.	Add:	Powder and Explosives 5·43	2–2
		Change Thesis from 7 units to 6 units.	

NAVAL RESERVE AVIATION UNIT

Opportunity is offered for students at the Institute to enter special classes conducted by naval officers for the study of fundamental naval and aviation subjects in preparation for enrollment in the United States Naval Reserve for Aviation after graduation. Men so enrolled are given flight training by the Navy, and may be eligible for a period of active duty in the Naval Air Service at the end of the training period.

DESCRIPTION OF SUBJECTS

CIVIL AND SANITARY ENGINEERING

The instruction in Civil and Sanitary Engineering is given by means of lectures and recitations, and by practice in the field, the drafting-room and the laboratory. The strictly professional work begins in the second year and includes a thorough classroom course in surveying, followed by field practice in the use of surveying instruments and by drafting-room work consisting of computations and the preparation and interpretation of maps and profiles. This work is preliminary to an extensive summer course in which thorough training is given in surveying and in railroad fieldwork. Students in civil engineering also take astronomy and a brief course in graphic statics during this year, while the sanitary engineers have extended courses in qualitative and quantitative analysis; students in both courses also begin applied mechanics during this year.

In the third year the chief professional subjects for the civil engineers are railway and highway engineering and the theory of structures; students in both courses also complete during this year their formal instruction in applied mechanics and in materials. The sanitary engineers continue chemistry and begin subjects of biology and bacteriology, while both the civil engineers and the sanitary engineers are given a course of considerable length in electrical engineering. Students taking the hydro-electric option take a slightly different course in the third year from the other civil engineering students. In the fourth year the work is almost entirely professional and leads the student into various branches of engineering. The work of this year is divided into three distinct options: (1) general; (2) transportation engineering; (3) hydro-electric engineering. Option 1 gives special attention to the application of the principles of hydraulics to branches of engineering which have to do with public water supplies, irrigation, sewage and its disposal, and the development of water power. Option 2 is divided into two parts, permitting the student to give special attention to either railway transportation or highway transportation. Option 3 deals in considerable detail with the problems that arise in hydro-electric developments.

In all this work the object is to enable the student to apply intelligently to practical problems the principles that he has studied; to give power, to avoid rule-of-thumb methods, and to train the students to have courage and self-reliance in solving the problems that the engineer has to meet.

In Course I-A, the Coöperative Course in Railroad Operation, the fundamental training in engineering at the Institute is supplemented by practical operating experience received by the student during the coöperative work periods with the Boston and Maine Railroad.

Subjects 1·00 to 1·99 (see page 66)

1·00, 1·01. Surveying and Plotting. A thorough classroom drill in the principles of surveying accompanied by fieldwork, computations, and the making of scale drawings, profiles, and contour maps, followed by a study of their application to the solution of engineering problems. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

1·001. Surveying. Covers the main features of 1·00 but with fewer details of application. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

1·02. Surveying and Plotting. Given in the summer between the second and third years, covers the same ground as 1·00 and 1·01 somewhat more briefly. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

1·03. Surveying. The methods of using the compass, transit, tape and level, in making plane surveys, are explained by lectures and by field exercises. In the drafting room the computations and drawings necessary to interpret and plot surveying field notes are made.

1·04. Surveying. At Camp Technology. Consists of 355 hours, lectures, recitations, fieldwork and drafting. The fieldwork consists of plane, topographic, hydrographic and elementary railway surveying. Plans and maps will be made in the drafting room from notes taken in the field.

This course satisfies the requirements in surveying for students in Courses II, IV-A, VI, IX-B, XV_2 and XVII. It will not be accepted in place of the work in surveying for students in Courses I, XI and XV_1.

It will not be given unless eight or more students apply, and is open to all students having the necessary preparation. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vols. I and II.*

1·041. Surveying. At Camp Technology. Given in the summer following the first year for Course I-A. It consists of lectures, fieldwork, computations and drafting. 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 in the drafting room from the notes taken in the field. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vols. I and II* (not accepted in place of 1·05 and 1·06 for students in Courses I, XI, and XV_1).

1·05. Plane Surveying. At Camp Technology. Given in the summer; it consists of lectures, fieldwork and drafting. The fieldwork consists in making surveys with the transit and tape, the running of profiles and cross-sectioning with the level, and in the astronomical determination of a meridian, time and latitude. The work in the drafting room consists of making computations which arise in surveying operations and of making scale drawings, profiles and contour maps from field notes. Textbooks: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I; Hosmer's Practical Astronomy.*

1·06. Geodetic and Topographic Surveying. At Camp Technology. Given in the summer; it consists of lectures, fieldwork, computations and drafting. The fieldwork consists of the making of topographic surveys with the transit including triangulation and stadia surveying; the making of large and small scale maps with the plane table; the use of the sextant in hydrographic surveys; the use of the traverse plane table in making road traverses for small scale maps. It also includes trigonometric and barometric leveling. The work in the drafting room consists of making the computations and drawings necessary to interpret the results of the field observations. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. II.*

1·07. Geodetic Surveying. At Camp Technology. Given in the summer between third and fourth years; it covers three weeks of field and office work and consists of 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.)

1·10. Surveying. At Summer Mining Camp, Dover, New Jersey. Given during the summer. It consists of 360 hours, lectures, recitations, fieldwork and drafting.

The fieldwork consists of plane, topographic, magnetic dip-needle, magnetometer and mine surveying. In the drafting room, plans and maps, both surface and underground, are made from the notes taken in the field. The class work consists of discussions of surveying methods and is supplemented by numerous problems. Textbook: *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. The class work in 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. Textbook: *Hosmer's Practical Astronomy.*

1·13. Geodesy. The methods of conducting a geodetic survey are discussed in detail, and the theory of the figure of the earth and the methods of determining it, both by arc measurements and by gravity observations, are briefly considered. Textbook: *Hosmer's Geodesy.*

1·14. Advanced Geodesy. Includes methods of developing the higher formulas computing geodetic positions; the theories of potential and of the earth's figure; the application of least squares to geodetic surveys; and the theories of astronomical, magnetic and gravity observations. Textbook: *Jordan's Handbuch der Vermessungkunde* and *Clark's Geodesy.*

1·15. Navigation. Such theory and practice of navigation as is required for examination for officers' licenses, and includes (1) use of compass, log and chart, (2) piloting, (3) dead-reckoning, (4) Mercator and Great-circle sailing, (5) observations for latitude, longitude and azimuth, and (6) Sumner's Method. Practice is given in adjusting the compass for error of deviation and in making the sextant observations. Textbook: *Bowditch's Navigator.*

1·16. Aerial Surveying. Includes a study of the various methods of constructing photographic maps for engineering and commercial 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.

1·17. Sea and Aerial Navigation. Consists of a study of maps and charts, the compass and sextant, laying out of courses both graphically and mathematically, the location of position by the methods of dead reckoning, astronomy and radio. Students will be required to adjust the compass for deviation, to use the sextant in observing a celestial body for latitude or longitude, and to use the charts for working problems.

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.

1·20. Railway Fieldwork. A complete survey (reconnaissance, preliminary and final location) for a railroad about two miles in length; together with a systematic drill in laying out curves by various methods, and in setting slope stakes for earthwork. Sufficient class work of an elementary character is given to supplement the fieldwork. Textbooks: *Allen's Railroad Curves and Earthwork; Allen's Field and Office Tables.*

1·21, 1·211, 1·22. Railway and Highway Engineering. A thorough study of curves and earthwork. The first term is devoted to the mathematics of curves with applications to the location of railways and highways, and to the layout of tracks and pavements. The second term is devoted principally to the methods of staking out and computing earthwork and masonry. Recitation work predominates, particularly in the first term, and many problems are assigned for solution outside and in the classroom. The applications of this subject are further developed by subjects 1·23, 1·24. As much of this subject as relates specifically to railways is omitted by students in Courses I_3 and XI. Textbooks: *Allen's Railroad Curves and Earthwork; Allen's Field and Office Tables.*

1·23, 1·24. Railway Drafting. Consists of two parts: (*a*) The making of a plan and a profile from the notes of a railway location survey made at Camp Technology; (*b*) the application of the theory of curves and earthwork developed in 1·21 and 1·22 to the solution of problems in hydraulic, railway or highway construction.

1·231. Railway Drafting. Includes the drawing of a map and profile based on a railway location survey made at Camp Technology, together with office studies of railway location based on topographic maps.

1·25. Engineering Construction and Estimates. Deals primarily with the construction of railways, highways, dams and similar projects. The subjects covered are engineering organization and duties, construction methods, estimates of quantities and costs, contracts and specifications. Some consideration is given to the methods of financing engineering projects. Some of the details considered are the acquisition of land, clearing the site, earth and rock handling, culverts, abutments and retaining walls. The methods of laying out and carrying on construction work and of making preliminary and pay estimates are illustrated by studies of typical projects.

1·26. Railway Maintenance and Signals. Includes maintenance of way and structures; interlocking and block signals, and automatic train control. Textbooks: *Tratman's Railway Track and Maintenance; Manual of the American Railway Engineering Association; Notes on Railway Signaling.*

1·27. Railway Transportation. Includes an analysis of the elements affecting the cost of transportation of passengers and freight; attention is devoted to locomotives and cars, train resistance and tonnage rating; the influence of grade and alignment upon operating expenses; I. C. C. accounting, valuation, relations of railway and public, Transportation Act; and interrelations of railway and highway transportation. Textbook: *Notes on Economics of Railway Engineering.*

1·28. Railway Design. Drafting room course, including problems in railway location on topographic maps; the proportioning of culverts and waterways and the detailed design of a division yard, including a locomotive terminal.

1·281. Railway Design. An abbreviation of 1·28, with most of the time devoted to the detailed design of a railway division yard, including a locomotive terminal.

1·29. Railway Accounts. Railway accounting conforming to Interstate Commerce Commission requirements. Emphasis is placed upon the underlying reasons for accounting; it treats of the distinction between capital investments and operating expenses, betterments, retirements, depreciation, and such matters, rather than of accounting details. Rates, classifications, and traffic will be considered briefly in order to enable the student to understand the sources of revenue. Also includes an analysis of those railway statistics which are of importance to the operating officials. Reports by the I C. C., Bureau of Railway Economics, Railway Accounting Officers Association, and annual reports of railway companies will be studied.

1·30. Development of Transportation. A series of thirty lectures on the history and development of transportation from the beginning down to the present day. 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 course. The interrelation and the governmental regulation of these different agencies are emphasized. Not offered in 1929-30.

1·301, 1·302. Advanced Railway Transportation. A continuation of the undergraduate courses in railway engineering and transportation. Attention is given to the design and operation of freight and passenger yards and terminals; locomotive terminals; coal handling plants; electrification; electric railways; inter-relation of highway and railway transportation; use of motor transport by railways. The principles of railway accounting, rates and public regulation and control are thoroughly discussed. Students make individual investigations and reports upon problems involving railway operation and economics. Given only if a sufficient number of adequately prepared students apply. Textbooks: *Droege's Passenger Terminals and Trains, Droege's Freight Terminals and Trains, Reports of the American Railway Engineering Association, and various other reports and periodicals.*

1·311, 1·312. Advanced Railway Design. A continuation of 1·28 and closely correlated with 1·301 and 1·302. Includes the design of freight, passenger and locomotive terminals; a study of problems arising in grade crossing eliminations, and in the handling of traffic during construction, and a consideration of the methods of making cost estimates. Given only if a sufficient number of adequately prepared students apply.

1·35. Roads and Pavements. An outline of the principles governing the location, construction and maintenance of roads, and the construction and maintenance of pavements for city streets. Textbook: *Agg's Construction of Roads and Pavements.*

1·36. Testing Highway Materials. Physical tests of various kinds of road materials and discussion of their value in highway construction.

1·37. Highway Transportation. A comprehensive study of state highways, Federal Aid, traffic studies, methods of financing highways, highway legislation, results of recent research, design of pavements, construction and organization methods, motor vehicle types and operating costs, economics of highway location, snow removal, highway safety, city traffic problems. Textbook: *Notes on Highway Transportation.*

1·38. Highway Design. A design for the improvement of an existing highway by substitution of improved alignment, grades and new pavement suitable for assumed traffic.

1·39. Graphic Statics. Graphic methods of solution of problems dealing with forces and reactions, curves of bending moment and shear and stresses in simple trussed structures. Textbook: *Hudson and Squires, Elements of Graphic Statics.*

1·391. Graphic Statics. Similar to 1·39 but adapted to the needs of students in Course XVII. Textbook: *Hudson and Squires, Elements of Graphic Statics.*

1·40. Theory of Structures. An introductory course 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 of plate girders. Textbook: *Spofford's Theory of Structures.*

1·401. Structures. A course 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 and the analysis of trusses by algebraic and graphical methods. This course is adapted to the needs of students in aeronautical engineering. Textbook: *Niles and Newell's Airplane Structures.*

1·41, 1·42. Theory of Structures. An extended course, in continuation of 1·40. It treats of the computation and design of structures of wood, steel and masonry, by analytical and by graphic methods. The subjects considered in the first term are roof and bridge trusses of various forms. In the second term the subjects treated are earth pressure; retaining walls; masonry dams; arches of metal, stone and concrete; and the theory of reinforced concrete design. The object is to train the student thoroughly in the application of the principles of mechanics to the design of the more common engineering structures. Textbook: *Spofford's Theory of Structures.*

1·411. Theory of Structures. Intended for students in Course I-A and covers some of the more important features of 1·41 and 1·42. Textbook: *Spofford's Theory of Structures.*

1·421. Theory of Structures. A continuation of 1·41 intended for students in the hydro-electric option of Course I, and also for students in Courses XI and XV_1. The subjects included are: the theory of reinforced concrete, earth pressures, deflection of trusses and theory of least work. Textbook: *Spofford's Theory of Structures.*

1·422. Theory of Structures. A continuation of 1·41 intended for students in architectural engineering and building construction. The subjects covered are deflection of trusses, the method of least work as applied to the determination of stresses in statically indeterminate structures, and stresses in space frameworks and high building frameworks. Textbook: *Spofford's Theory of Structures.*

1·43. Materials. Designed to acquaint the student with the properties of the various structural materials used by the engineer, such as stone, brick, cement, concrete, wood, iron and steel. Textbook: *Mills' Materials of Construction.*

1·44. Stationary Structures. A short course for students in mining engineering, designed to give them a knowledge of the fundamentals of the theory of structures. Textbook: *Spofford's Theory of Structures.*

1·45. 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 computing and designing structures. The subject matter includes the use of influence lines and the computation of stresses in simple trusses, portals, rigid frames, trusses with redundant members, and space frameworks, continuous beams, and the computation of deflection of beams and trusses. Textbook: *Spofford's Theory of Structures.*

1·46, 1·461. Structural Design. Designing and partial detailing of simple structures such as columns, roof trusses, footings, etc. Intended to illustrate and amplify the work of 1·45 by practical design problems.

1·471. Structural Theory and Design. An introductory course covering stresses in simple trusses and the design of wood structural members. Textbooks: *Spofford's Theory of Structures; Voss and Varney's Wood Construction.*

1·472. Structural Theory and Design. A course in continuation of 1·471, giving consideration to plate girders, steel structural members, steel truss design and the wind bracing of high building frames. Textbooks: *Spofford's Theory of Structures; Voss and Varney, Steel Construction.* (Not offered in 1929–30.)

1·473. Structural Theory and Design. A course in continuation of 1·472, giving a thorough grounding in the theory of reinforced concrete with the design of a portion of a typical mill building. Attention is given to modern methods of determining stresses in continuous structures and to the design codes now in use. Textbook: *Sutherland and Clifford's Reinforced Concrete Design.* (Not offered in 1929–30.)

1·48. Foundations. A study of the methods of constructing foundations for bridges, buildings and other structures. Textbook: *Hool and Kinne's Foundations, Abutments and Footings.*

1·481. Foundations and Soil Mechanics. Covers in condensed form the subject matter of Foundations 1·48 and Soil Mechanics 1·491. Students registering for 1·481 will attend lectures in 1·48 and 1·491.

1·482. Foundations and Soil Mechanics. Covers in slightly condensed form the subject matter of Soil Mechanics 1·491.

1·491, 1·492. Soil Mechanics. Covers the whole field of recent scientific investigations relating to earthwork engineering. Divided into two parts, the first dealing with the physical factors involved in earth pressure phenomena, which includes a study of all those physical properties of the soils which are of practical importance in connection with engineering operations, such as fluidity, plasticity, cohesion, internal friction, nature and effect of the colloidal content, permeability, movement of capillary water, hydro-static stress phenomena and elasticity, including a discussion of the physical causes of these properties. The second portion (second term) will be devoted to a thorough and critical study of the various soil phenomena which are known to occur in connection with earthwork operations and foundation work. This study is based on the results of modern soil research and includes the following topics: mechanics of landslides, earth pressure against retaining walls, theory of bearing capacity, the relation between settlement and the bearing area of buildings, the interpretation of loading tests, a consideration of floating foundations extending over both uniformly compressible and unequally compressible ground, dynamic and static pile driving resistance, the effect of time on pile driving resistance, settlement of pile groups, stress conditions in hydraulic fill dams and weir foundations on permeable ground with particular attention to the piping effect of the seepage water. Mimeographed text, covering the first term of the course.

1·493. Soil Mechanics. Includes a study of the physical properties and classification of soils; sampling and testing; mechanics of internal friction, cohesion, compressibility and consolidation; the quicksand phenomenon; earth and masonry dams, with special reference to stability, seepage and piping effect; bearing capacity of footings and raft foundations; pile foundations; the stability of slopes and retaining walls; tunnel construction; highway subgrades; cofferdams, caissons and special types of foundations.

1·501, 1·502. Bridge Design. Shows the relations of the theory of structures to engineering practice through the preparation of designs and drawings for a plate girder railway bridge, a wooden roof truss, several reinforced concrete structures and a riveted steel truss highway bridge. Emphasis is laid on the development of careful, systematic and practical habits of computation.

1·511, 1·512. Bridge Design. Abridged from 1·501, 1·502 and especially adapted to the needs of students in I_3.

1·52. Structural Design. A drafting room subject similar in character to 1·501, 1·502, giving only an outline of the subject.

1·53. Structural Design. A drafting room subject similar in character to 1.501, 1.502, giving only an outline of the subject.

1·54. Structural Design. A drafting room subject similar in character to 1·501, 1·502, giving only an outline of the subject.

1·55. Advanced Structural Design. Supplements Advanced Structures and illustrates the applications of the principles there studied. Much of the allotted time is devoted to the determination of stresses in suspension bridges and in arch bridges of both the hinged and no hinged type.

1·561, 1·562. Advanced Structures. Includes an exhaustive treatment of the fundamental principles applying to the design of complicated structures of statically indeterminate types, such as suspension bridges, arches, continuous trusses, framed domes and frameworks of high buildings. The methods of least work, slope deflection and deflections are all given thorough consideration. Several mechanical methods are also demonstrated. Textbooks: *Spofford's Theory of Structures; Mimeographed Notes prepared by Professor Spofford; Textbooks by various American and German authors; Monographs and Professional Papers.*

1·57. Secondary Stresses. Within the last ten years the importance of secondary stresses in bridges and similar structures resulting from distortion has become widely recognized and during this period engineering periodicals have contained descriptions of a large number of modern bridges in which the secondary stresses have been computed. In this subject, the student investigates the various sources of secondary stresses, computes the secondary stresses in a number of trusses, and studies various methods of design for controlling secondary stresses and preventing their becoming of large magnitude. Textbook: *Johnson, Bryan and Turnneaure's Modern Framed Structures, Part II.*

1·581, 1·582. Reinforced Concrete Design. A consideration of the theoretical and practical principles involved in the design of structures of reinforced concrete. In the first term a study is made of the rules and methods of design commonly used in this country together with the reasons for their adoption. Parallel with this work, a complete design is made of an interior bay of a typical factory building. In the second term the following topics are taken as: (*a*) an investigation of bending moments in reinforced concrete structures by exact methods, such as those of least work, slope deflections, etc.; (*b*) the design of chimneys, tanks, tunnels and similar structures. Textbook: *Sutherland and Clifford's Reinforced Concrete Design.*

1·60. Hydrographic Surveying. Given at Camp Technology in the summer between the second and third years; it consists of lectures, fieldwork, computations and drafting. (*a*) Stream gagings. Designed to instruct the student in the principles underlying the art of measuring the flow of water in open channels. The equipment of the Camp includes a complete gaging station on a nearby stream where each student is instructed in the use of various types of current meters, and the rate of flow of the stream computed. In the drafting room a portion of the data thus secured is plotted. (*b*) Soundings. On Gardner's Lake, the student is instructed in the method of making soundings and practices the use of the sectant and the transit in locating them. Textbook: *Liddell's Stream Gaging.*

1·62. Hydraulics. A thorough study of the elementary principles of Hydrostatics and Hydrokinetics, 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. All portions of the subject covered in 1·63 are included. Textbook: *Russell's Hydraulics.*

1·63. Hydraulics. Comprises the essentials of 1·62 but the subject of flow in open channels is abbreviated. Textbook: *Russell's Hydraulics.*

1·64. Hydraulics. Comprises the elements of hydraulics followed by a study of the theory and practical selection of hydraulic turbines, and certain of the more important problems relating to hydro-electric development. Textbooks: *Russell's Hydraulics* and *Daugherty's Turbines.*

1·66. Advanced Hydraulics. Offered for students in the graduate year who are desirous of pursuing further their studies in theoretical and applied hydraulics. The subjects treated relate in a general way to problems arising in water-supply and water-power engineering, and subjects which are only fundamentally treated in 1·62 are further elaborated and discussed. An important feature of the subject is the study of the relations existing between the performances of models and their originals, involving the discussion of the laws of hydraulic similitude. The outside preparation includes a certain amount of reference study in addition to the usual problems and the writing of reports.

1·70. Water Power Engineering. This subject and 1·71 is intended to acquaint the student with the various general problems involved in the location, design and construction of hydro-electric developments and to provide a suitable foundation for practice in this field or for the more detailed and advanced studies of the graduate year. The subjects studied follow the order of investigations as usually made for water power projects. They include a thorough study of hydrology — precipitation, run-off, water losses and their relations; methods of analyzing, and using stream flow data as a basis for estimates of water power; flood flow and spillway capacity and the effect of storage and pondage, followed by a study of the theory and practice applicable to the selection of hydraulic turbines for the plant, as well as general plant arrangement. Textbook: *Barrows' Water Power Engineering.*

1·71. Water Power Engineering. Continuing from 1·70 the elements of design of the main features of a hydro-electric development — the dam, waterway and power house are studied. The work of this term is also accompanied by drafting room exercises, consisting of computations, reports and problems of design. Textbook: *Barrows' Water Power Engineering.*

1·731, 1·732. Advanced Water Power Engineering. This and Water Power Design 1·851, 1·852 are based upon the undergraduate courses in Water Power Engineering 1·70, 1·71. These two graduate courses, which are supplementary to each other, have for their special object the study of some water power site and the design of its principal features. An actual power site is used for which survey data and other necessary information are available. The following representative topics illustrate the scope of these courses: (*a*) hydrograph (or mass curve) study of the storage effect; (*b*) plant capacity and output; (*c*) plant layout, including canal penstock and power house location and arrangement; (*d*) power house design; (*e*) surge tank and penstock design; (*f*) head gatehouse and gate design; (*g*) valuation of water power privilege. In the classroom attention is also given to other general problems of power development and the theory and practice upon which their solution is based. Numerous references and reports upon special features of plants and their accessories are also considered. A field trip of several days duration is taken early in the course during which several modern and representative power developments are examined in detail. A test of a hydraulic turbine is usually made at the Holyoke testing flume at this time. Reports based upon the information thus gathered are required and form a basis for discussion and assistance in the problems of design given later in the year. Textbook: *Barrows' Water Power Engineering.* Reference Book: *Creager and Justin's Hydro-electric Handbook.*

1·75. Hydraulic and Sanitary Engineering. Includes investigations of problems of sewerage and sewage disposal, storm water drains, theories of sewage treatment and design of disposal plants and other sewage works, plumbing systems, etc., together with the relationship of sanitation to the public health. The latter part of the course deals with the engineering problems of irrigation and land drainage. Textbooks: *Metcalf and Eddy's Sewage and Sewage Disposal, a Textbook; Etcheverry's Irrigation Practice and Engineering, Vol. I.*

1·76. Hydraulic and Sanitary Engineering. Deals with the principles and practice for securing adequate public water supplies and with the purification of same. Includes hydrographic studies of rainfall and run-off, evaporation, methods of determining required storage for given demands, and the principles of design of earth and masonry dams, distributing systems and purification plants. The principles of design and testing of hydraulic turbines are also given during the last four weeks of the course. Textbooks: *Turneaure and Russell's Public Water Supplies; Daugherty's Hydraulic Turbines.*

1·77. Sanitary Engineering. Deals with (*a*) the relationship of bacteriology to sanitation; (*b*) the theory and design of sewer systems, sewage disposal plants and storm water drains; (*c*) methods of disposal of garbage and of industrial wastes; (*d*) the design of plumbing systems for buildings; (*e*) the relationship of sanitation and drainage to the public health. Textbook: *Metcalf and Eddy's Sewerage and Sewage Disposal, a Textbook.*

1·78. Sanitary Engineering. Deals with the problems of securing adequate public water supplies together with the theories and design of water purification works. Includes rainfall and run-off studies, evaporation, stream yield, computation of required storage, design of distributing systems, earth and masonry dams, filtration plants, and the making of sanitary surveys, and studies of vital statistics. Textbook: *Turneaure and Russell's Public Water Supplies.*

1·79. Hydraulic and Sanitary Design. Deals with the design and preparation of plans, maps and profiles for a system of sanitary sewers for a selected area and given conditions and of a storm water drainage system for a similar area.

1·80. Sanitary Design. Includes the layout and design of a system of sanitary sewers for a given area, a system of storm sewers for a similar area and the design of special structures used by the sanitary engineer.

1·811. Advanced Sanitary Engineering. Deals with the most recent developments in the methods of disposal of sewage and municipal refuse. No textbook is used but the student is required to consult monographs, reports and engineering periodicals and prepare abstracts covering library research in connection with (*a*) the activated sludge method of sewage disposal; (*b*) colloidal chemistry and sewage treatment; (*c*) sludge — its nature, treatment and uses; (*d*) filtration and special problems connected with operation of sewage filters; (*e*) hydrogen-ion adjustment and its effect upon sewage treatment; (*f*) disinfection of sewage; (*g*) treatment of special trade wastes; (*h*) methods of garbage disposal; (*i*) elimination of odors; (*j*) other phases of sanitary engineering which are more complex than can be included in a general course for undergraduates.

1·812. Advanced Sanitary Engineering. A study of recent progress in problems connected with water supplies and their purification including (*a*) principles of des[illegible]n of dams of previous materials; (*b*) hydraulic fill dams; (*c*) special spillway co[illegible]derations; (*d*) recent flood flow studies; (*e*) operating experience of purification plants; (*f*) studies of factors influencing coagulation; (*g*) hydrogen-ion adjustment; (*h*) problems in treating water for industrial uses; (*i*) treatment of soft, colored waters; (*j*) friction losses in sand; (*k*) flow of underground waters; (*l*) design of lay-out as affecting fire insurance rates, etc.

1·851, 1·852. Advanced Water Power Design. For description see Advanced Water Power Engineering 1·731, 1·732.

1·881, 1·882. Advanced Sanitary Design. Carried on in parallel with Advanced Sanitary Engineering 1·811 and 1·812 and affords an opportunity of applying the theoretical factors studied in these subjects to special problems in connection with the design of plants for the disposal of sewage and the purification of water. Inspection trips to plants in various parts of the state are made at frequent intervals and the effect of special design features upon efficiency and economy of operation are studied under actual operating conditions.

1·901 to 1·904. Railroad Operation Practice. These numbers cover the railroad operation subjects taken by the coöperative students with the Boston and Maine Railroad. During the four periods, which average seventeen weeks each, the student will receive practical training in the following departments of the railroad: Maintenance of Way, Maintenance of Equipment, Conducting Transportation, and General. The subdivision of the work in these departments will be substantially as shown below. The students will not necessarily take work in the different departments in the same order.

Maintenance of Way. (*a*) Office of Chief Engineer, Engineer Maintenance of Way, or Division Engineer; (*b*) Bridge Engineer's Office (or as Inspector of Construction); (*c*) Track Work; (*d*) Signal Engineer's Office.

Maintenance of Equipment. (*a*) Round House; (*b*) Locomotive Shops; (*c*) Car Shops; (*d*) Operation of Locomotives; (*e*) Mechanical Superintendent's Office.

Conducting Transportation. (*a*) Station Work; (*b*) Yard Work; (*c*) Freight Service; (*d*) Passenger Service; (*e*) Freight House Operation; (*f*) Car Service Office; (*g*) Division Superintendent's Office.

General. (*a*) Accounting; (*b*) Stores (including Inspection and Testing of Materials); Research and Special Investigations.

1·901. Railroad Operation Practice. First period of coöperative work with the Boston and Maine Railroad.

1·902. Railroad Operation Practice. Second period of coöperative work with the Boston and Maine Railroad.

1·903. Railroad Operation Practice. Third period of coöperative work with Boston and Maine Railroad.

1·904. Railroad Operation Practice. Fourth period of coöperative work with the Boston and Maine Railroad.

MECHANICAL ENGINEERING

Many of the subjects taught by the Mechanical Engineering Department are fundamentals in nearly all of the different branches of engineering; consequently instruction is given not only to students in Mechanical Engineering, but also to those taking other engineering courses.

The course in Mechanical Engineering aims first to give the student a thorough training in the fundamentals of physics, mathematics and applied mechanics; then, by means of lectures, laboratory work and drawing room work in his different professional subjects, to familiarize him with the various problems with which the mechanical engineer has to deal. He is also given training in the mechanic arts sufficient to make him familiar with the use of shop tools, foundry practice, pattern work and forging, such knowledge being essential to the successful designer of machinery.

A considerable portion of time is devoted to non-professional work in English, history, economics and allied subjects.

The work in mechanism, supplemented by a course in mechanical engineering drawing, includes the study of linkages, cams, gear teeth and valve gears of steam engines; followed by a more advanced course on the mechanisms of machine tools and automatic machinery.

The instruction in applied mechanics in the second and third years covers the fundamental principles of statics, kinetics, strength of materials and the theory of elasticity; particular attention being given to the solution of problems illustrating the application of these principles in engineering practice. A series of lectures on engineering materials makes the student familiar with the important physical properties of the materials used in engineering and with the effects on these properties of impurities and of manufacturing defects. Consideration is given the relationship existing between constitution and microstructure of metals and the effect of heat treatment, cold working, etc., upon the physical properties. This is followed by laboratory work where tests are made to determine the quality of materials and to obtain data for use in design.

The student is taught how to carry out the usual routine tests required for any material and to appreciate the significance of specifications. Modern methods for the examination of materials by photoelasticity, X-Ray and by microscopic analyses are taken up. In the heat treatment laboratory a study is made of the changes which the common properties of metals undergo when subjected to heat treatment and a student is taught how to determine the proper treatment to bring out any property desired.

The course in heat engineering covers thermodynamics, steam engines, turbines, boilers, gas engines, gas producers, heat transmission, refrigeration and power station accessories. A course in physical chemistry designed to familiarize a student with the subject of molecular structure is given simultaneously with the course in heat engineering.

A thorough course in theoretical hydraulics is followed by a course in hydraulic engineering in which both the estimation and utilization of hydraulic power are discussed. The courses in heat engineering and hydraulics are supplemented by engineering laboratory work extending through the latter half of the third year and through two terms of the fourth year. The work is planned to follow the classroom work and thereby assist the student in getting a better grasp of the subjects taught. The laboratories are equipped to provide for an extended series of experiments on steam and its properties, steam engines, turbines, compressed air, gas and oil engines, gas producers, refrigerating machinery, hydraulics, pumps, water wheels and turbines, devices for the mechanical transmission of power, transmission and absorption dynamometers. The main power plant of the Institute is available for complete power plant tests.

The instruction in mechanic arts aims to give a systematic training in the typical operations to be performed with the different tools and appliances used in the foundry, in the forge shop, in the machine shop and in wood working. The student is taught how to sharpen and to adjust all edge tools used, also the proper speeds, cutting angles and feeds for the various materials worked. In order to make a student familiar in as short a time as possible with the different operations and with the different methods used in any branch of the work, every problem given him is so chosen as to bring in each time one or more new operations.

The instruction is mainly by lecture, each new operation being described and discussed just before the work is to be undertaken; notes and textbooks are also used. Supplementary illustrated lectures are given in connection with many of the courses descriptive of industrial appliances and methods of production used in large establishments.

The professional work of the fourth year includes courses in machine design, power plant design, refrigeration, internal combustion engines; the design and equipment of a manufacturing plant including a study of structural details and heating and ventilating equipment and problems in financing and the management of such an establishment; courses in dynamics of machinery and mechanics of engineering which involve the application of the principles of mechanics in more advanced engineering problems.

At the beginning of the second term of the fourth year, a student has to decide whether to take the general course with choice of a professional elective, or to take one of the four options offered.

These options — Automotive, Engine Design, Textile Engineering, Refrigeration, Ordnance Engineering — differ from the general course in that the time allotted to electives has been definitely assigned to the main subject of the option. The time allotted in the second term to the design of an industrial plant has also been assigned to the main subject of the options.

M.I.T. ANNUAL CATALOGUES AND BULLETINS
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03
OF
05

Subjects 2·00 to 2·99 (see page 66)

2·00. Mechanism. A study of the forms and motions of various mechanisms occurring in machines, independently of their strength, such as rolling cylinders and cones, belting, screws, cams, linkages, wheel trains and the design of gear teeth. Includes lectures covering elementary valve gears. Textbooks: *Elements of Mechanism, Schwamb, Merrill and James; Power Plant Machinery, Vol. I, James and Dole.*

2·01. Mechanism. Abridgment of 2·00. Textbook: *Elements of Mechanism, Schwamb, Merrill and James.*

2·021. Mechanism and Machine Drawing. Consists of lectures and drafting room work dealing with the elementary principles of mechanism, solution of kinematic problems, machine sketching, etc.

2·03. Mechanisms. Combines the theory of mechanisms with their practical applications, including wrapping connectors, linkwork, gearing, cams, screws, etc. Suitable materials with their properties, forms and proportions of parts, efficiencies, friction, etc., are discussed. Complete calculations for the design of a punch and shear are made, together with sufficient drawing lay-out to show the design of the frame casting, and the relation of the parts.

2·04. Mechanical Engineering Equipment. A description of different types of steam engines, condensers, pumps, cooling towers and other power station accessories. Textbook: *Power Plant Machinery, Vol. II, James and Dole or Elementary Steam Power Engineering, MacNaughton.*

2·05. Mechanism of Machines. Supplements the work in pure mechanism. The discussion is intended to familiarize the student with the practical applications of mechanical movements to various classes of machinery, such as machine tools, textile machinery, shoe machinery, etc. The practical advantages and disadvantages of the different mechanisms are taken up, together with such details as methods of reducing friction, providing for wear, etc. Several lectures on the principles involved in the construction of alignment charts are included. Textbooks: *Notes and Lithographs, Mechanical Engineering Department; The Construction of Alignment Charts, Swett.*

2·06. Mechanism of Machines. Lectures and recitations of 2·05, omitting the lectures on alignment charts.

2·07, 2·08. Automatic Machinery. Discussion of automatic machines used in production work, such as wire working machines, automatic screw machines, machine tools, etc.

2·09. Design of Automatic Machinery. A continuation of 2·850, involving a discussion of more complex mechanisms and the design of a full automatic machine.

2·10. Mechanical Engineering Drawing. Drafting-room exercises giving training in the solution of practical problems supplementary to the course in mechanism, such as problems in belting, the design of cams and gears, and the investigation by means of drafting board constructions, of velocities and accelerations of moving parts. Textbooks: *Working Drawings of Machinery, James and Mackenzie; Elements of Mechanism, Schwamb, Merrill and James.*

2·101. Mechanical Engineering Drawing. Abridgment of 2·10.

2·102. Mechanical Engineering Drawing. A continuation of 2·12 involving the use of applied mechanics as well as kinematics.

2·11. Mechanical Engineering Drawing. Abridgment of 2·10.

2·12. Mechanical Engineering and Machine Drawing. Includes parts of 2·10 and 2·13. Textbooks: *Working Drawings of Machinery, James and Mackenzie; Elements of Mechanism, Schwamb, Merrill and James.*

2·121. Mechanical Engineering and Machine Drawing. Abridgment of 2·12.

2·13. Machine Drawing. Lectures and drafting-room exercises giving instruction and practice in detailing from actual machines or design layouts and preliminary sketches; also in making assembly drawings from blue print details. The student is thus given practice in making and reading working drawings and in building up a general drawing from details. Lectures are also given on drafting-room practice and processes for reproducing drawings, such as blue printing, zinc plate and wax plate engraving and half-tone work. Textbook: *Working Drawings of Machinery, James and Mackenzie.*

2·131. Machine Drawing. Abridgment of 2·13.

2·14. Machine Drawing. Drafting-room exercises devoted to making detail and assembly drawings, and lectures on drafting-room practice and methods of reproducing drawings. Textbook: *Working Drawings of Machinery, James and Mackenzie.*

2·14T. Machine Drawing. Similar to 2·14.

2·15. Applied Mechanics (Statics and Kinetics). Resolution and composition of forces by analytical and graphical methods; the laws of equilibrium of force systems with their application in determining the reactions at the supports and the stresses in various types of frames; the analysis of distributed forces; determination of centers of gravity, moments and products of inertia and radii of gyration of plane areas and solids; principal axes and principal moments of inertia in two dimensions only; also a study of kinetics of solid bodies in plane motions, including the application of the principles of momentum and kinetic energy and the determination of work and power. Textbook: *Applied Mechanics, Vol. I, Fuller and Johnston.*

2·151. Applied Mechanics. Part of 2·15, kinetics only.

2·16. Applied Mechanics (Statics). Resolution and composition of forces by analytical and graphical methods; the laws of equilibrium of force systems with their application in determining the reactions at the supports and the stresses in various types of frames; the analysis of distributed forces; determination of centers of gravity, moments and products of inertia and radii of gyration of plane areas and solids; principal axes and principal moments of inertia in two dimensions only. Textbook: *Applied Mechanics, Vol. I, Fuller and Johnston.*

2·20. Applied Mechanics (Strength of Materials). Physical properties of materials; stresses and strains in bodies subjected to tension, compression and shear; the common theory of bending, including shearing forces, bending moments, distribution of normal and shearing stresses; equation of the elastic curve and the determination of slopes and deflections in beams; stresses due to combination of bending and axial loads; theories for determining the strength of columns; the torsion theory and the methods of obtaining the stresses and deformation in shafting and bars subjected to torsion. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·21. Applied Mechanics. Theory of elasticity applied to cases involving plane stress or strain, including applications to shafting and bars subjected to combined bending and torsion, helical springs, and cylinders; analytical and graphical solutions of some more advanced problems in dynamics and strength of materials including stresses in roof trusses and the theory of continuous beams. Textbook: *Applied Mechanics, Vols. I and II, Fuller and Johnston.*

2·211. Applied Mechanics. Includes the graphical solution of some of the more advanced problems in statics and strength of materials, the calculation of stresses and deflections of continuous beams and girders, the theory of reinforced concrete as applied to beams and columns. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·22. Applied Mechanics. A study of the fundamental principles of kinetics and application to engineering problems, including the determination of stresses in the moving parts of machinery; analytical and graphical solutions of some of the more advanced problems in statics and strength of materials. Textbook: *Applied Mechanics, Vols. I and II, Fuller and Johnston.*

2·221. Applied Mechanics. A study of the fundamental principles of kinetics and application to engineering problems; the theory of elasticity applied to cases involving plane stress or strain including applications to shafting and bars subjected to combined bending and torsion, cylinders and flat plates. Textbook: *Applied Mechanics, Vols. I and II, Fuller and Johnston.*

2·231. Mechanics. An elementary course especially arranged for the students in Course IV, including a study of the fundamental principles of statics with applications in analytical and graphical solutions for stresses for simple frames and trusses. The determination of centers of gravity and moments of inertia of plane areas. Textbook: *Applied Mechanics, Vol. I, Fuller and Johnston.*

2·232. Mechanics. A continuation of Course 2·231 especially arranged for students of Course IV. Includes the definitions and relations of the physical properties of materials, simple problems in tension, compression and shear, the common theory of beams, with applications, the analysis of stresses and columns and simple problems in combined bending, and axial loading. Textbook: *Applied Mechanics, Vol. II, Fuller and Johnston.*

2·251. Dynamics of Machines. A study of the forces and stresses involved in machinery, due to the work done and to inertia of the moving parts themselves. Graphical and analytical methods of determining accelerations in plane motion are studied, and application made to the crank-and-connecting-rod problem and the limitation of speed fluctuation by means of a fly-wheel. Harmonic motions, and the motions produced by cams of various forms are discussed. Includes a study of dynamometers for the measurement of power.

2·252. Advanced Dynamics of Machines. Includes a study of the accelerations of points moving in paths of varying curvature; paths and accelerations of any points in links or other machine parts having plane motion, where the motions of two points are given; use of acceleration centers, and velocity and acceleration images; composition and resolution of rotations about intersecting axes; moments of inertia about axes in any directions; natural axes, centrifugal couples and the dynamics of rotation. Open only to students at General Electric Company.

2·254. Dynamics of Engines. Lectures and drawing-room exercises on the inertia forces and the stresses in the running parts of fast gasoline engines. Application is made chiefly to the types of engines used in automobiles.

2·255. Dynamics of Aircraft Engines. An advanced course given to students having considerable knowledge of engine balancing and practical experience with aircraft engines.

2·26. Mechanics of Engineering. Application of the theory of reinforced concrete to the determination of the stresses in beams and columns; followed by advanced problems in mechanics, including the determination of the stresses in moving parts of machinery, losses due to friction, critical speeds, vibrations in high speed machinery, dynamic balancing, applications of the theory of least work, stresses in transmission lines and tramways, problems in the design of ordnance and others with which the mechanical engineer has to deal. Textbook: *Applied Mechanics, Vols. I and II, Fuller and Johnston.*

2·271. Theory of Elasticity. A continuation of 2·891 including a study of the fundamental principles of the theory of elasticity as applied to determining stress components on different planes through a point in a body subjected to plane stress and the relations between these components and the strains in elastic bodies. Includes the solution of a considerable number of problems illustrating the application of the theory as developed.

2·272. Theory of Elasticity. A continuation of 2·271 which includes the application of the principles of the theory of elasticity in the design of built-up guns, also the design of wire-wrapped guns.

2·281, 2·282. Advanced Mechanics and Theory of Elasticity. An advanced course in the strength of materials and dynamics, including the theory of flexture of curved bars and the elastic arch, bending of unsymmetrical bars, the principles of the mathematical theory of elasticity and applications including St. Venant's theory of flexure and torsion, stresses in plates, stresses and strains in rotating shafts, cylinders and discs, the design of compound cylinders, temperature effects, vibration, etc.

2·283. Advanced Mechanics. An advanced course in strength of materials and Dynamics, including the theory of flexure of curved bars, the bending of unsymmetrical bars and applications to the more complex problems in mechanics.

2·284. Theory of Elasticity. A study of the fundamental principles of the mathematical theory of elasticity with applications including stresses in flat places, the design of cylinders simple and compound, the stresses in rotating shafts, cylinders, and discs, temperature effects, vibration, critical speeds, etc.

2·29. Interior Ballistics. The study of pressures developed by powders, development of the pressure volume curve and the discussion of formulas for determining velocity of a projectile in a gun. Textbook: *Ordnance and Gunnery, Tschappat.*

2·30. Materials of Engineering. The manufacture, physical properties and testing of iron, steel, alloys, plaster, lime, cement, concrete, brick, timber and other engineering materials. Special attention is paid to the relationship existing between constitution and physical properties, the effect of change of composition, hot and cold work and heat treatment upon the properties of the metals. Textbook: *Materials of Construction, Mills.* (*Third edition.*)

2·301. Materials of Engineering. The time is devoted to a discussion of the testing and specifications of materials. Open only to officers of the United States Navy. Textbooks: *Materials of Construction, Mills; Engineering Steel, Aitchinson.*

2·304. Materials of Engineering. The manufacture, physical properties and testing of materials of importance in architectural engineering. Considerable attention is paid to the relation existing between constitution and physical properties, the effect of hot and cold work and heat treatment upon the properties of the metals used in building construction. Textbook: *Materials of Construction, Mills.* (*Third edition.*)

2·305. Materials and Testing. Presents the possibilities and limitations of the modern methods available for the examination of materials of construction, including microscopic and macroscopic analysis, examination by means of X-rays and stress analysis by means of polarized light. Open only to students in the Graduate Coöperative Course with the General Electric Company.

2·31. Materials of Engineering. A study of the manufacture, physical properties and testing of iron, steel, alloys, plasters, lime, cement, concrete, brick, timber and other engineering materials. Textbook: *Materials of Construction, Mills.* (*Third edition.*)

2·35. Testing Materials Laboratory. Study of the behavior of engineering materials under stress including tests of concrete and fabrics. Some attention is also given macroscopic examination of metals, microscopic examination of non-metallic materials, stress analysis by means of polarized light, and radiology. Textbook: *Materials Testing, Cowdrey and Adams.*

2·36. 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. Textbook: *Materials Testing, Cowdrey and Adams.*

2·362. 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.

2·363. Testing Materials Laboratory (Concrete). A brief study of the selection of materials and methods of proportioning concrete mixtures. The strength, durability and economy of the mix is studied from the contractor's point of view. Methods of field control and factors affecting the quality of the concrete are particularly stressed.

2·37. Testing Materials Laboratory. Similar to 2·36 but abbreviated.

2·38. Physical Testing of Metals. A practical manipulative course primarily adapted to the needs of those engaged in the sale, purchase or use of metals. It includes the routine of tensile and hardness tests; the determination of elastic properties; and the proper use of machines and measuring devices. Both ferrous and non-ferrous metals will be studied.

2·381. Advanced Testing and Examination of Materials. Offered for teachers of engineering, Army and Navy officers, engineers, graduate students and others having the proper preparation. Applicants for this subject must have a knowledge of applied mechanics including the theory of elasticity; some knowledge of physical chemistry; a fairly complete familiarity with the testing of materials including some work on radiology and photoelasticity together with some experience in heat treatment laboratory work and in metallography. A detailed study of testing machines and their calibration, adaptability and errors in different types of measuring instruments, the effect of form and size of test specimens, measurement of strains in parts subjected to both direct and combined stresses, methods for determining hardness, Erickson tests for sheet metal, determination of the variation in physical characteristics of metals under high and low temperatures using both static and impact methods, effect of heat treatments and overstrain on the physical properties of metals, the testing of timber, and reinforced concrete, microscopic examination of nonmetallic materials, etc. Laboratory instruction supplemented by conferences and lectures. Physical metallurgy: Including microscopic and macroscopic examination of technically important alloys. Photoelasticity: Lectures on photoelastic method with laboratory work. Radiology: A discussion of the methods and apparatus which are used in the examination of materials by means of X-rays. *The subject will not be given unless there are six applicants by May 15, 1929.*

2·390. Reinforced Concrete Design and Laboratory. The design course develops the theory for reinforced concrete beams and columns with applications to the design of floor systems, interior and exterior columns. The laboratory course covers the selection of concrete materials, methods of proportioning for strength and economy, and special treatments of concrete.

2·391. Reinforced Concrete Design. 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. Textbook: *Concrete Engineer's Handbook, Hool and Johnson.*

2·392. Reinforced Concrete Design. A continuation of 2·391 consisting of the complete design of a typical cross section for a building. Special designs are made for corner columns, stairs, floor openings, etc.

2·393. Reinforced Concrete Design, Advanced. For graduate students. Affords opportunity for special problems in reinforced concrete design of a more advanced nature than that covered by 2·391 and 2·392. The problem matter will be determined by consultation between the instructor and the student.

2·394. Concrete Research. For graduate students. Gives opportunity for an investigation of special problems concerning concrete material or concrete construction.

2·395. Concrete Buildings Design and Specifications. The theory of reinforced concrete construction is applied to the design of the typical cross-section of a building. Includes a discussion of economical considerations, cost keeping, and the writing of specifications.

2·40. Engineering Thermodynamics. Begins a detailed study of the laws of thermodynamics with their applications to engineering problems. Includes a discussion of the physical properties of gases and saturated and superheated vapors — especially of air and steam; a study of the ideal and actual cycles of hot air and internal combustion engines. The fundamental laws governing the flow of fluids are next considered with application to orifices and nozzles, the throttling action of porous plugs, throttling valves, calorimeters, etc. The student learns to use the equations, vapor tables and diagrams, through independent solution of problems. The instruction is given by lectures followed by weekly recitation period. Textbooks: *Principles of Thermodynamics, Goodenough; The Temperature Entropy Diagram, Berry; Steam Tables.*

2·41. Boilers and Engines. Covers description of different types of boilers, mechanical stokers, fuels and their combustion, conveyors, super-heaters, feed-water heaters, economizers, traps and various accessories of steam boiler plants. The latter part of the subject deals with the discussion of the various types of gas, gasoline and oil engines, together with the fuel ignition systems and auxiliary apparatus. Gas producers and the principle of combustion are discussed in detail. Textbook: *Steam Boilers, Peabody and Miller; or Gebhardt, Steam Power Plant Engineering.*

2·42. Engineering Thermodynamics. A continuation of 2·40. Completes a discussion of flow of fluids with applications to the steam turbine and then continues with a discussion of the efficiency of the ideal and actual reciprocating steam engines. Consideration is also given to air compressors, humidity and air-conditioning, cooling towers, and other engineering problems. Instruction and textbooks same as for 2·40.

2·43. Refrigeration. Includes a discussion of problems arising in compression refrigerating systems, a study of the properties of various refrigerants, and the laws of heat flow with application to walls, pipes, furnaces, etc.

2·46, 2·461. Heat Engineering. Begins with the study of valve gears which are treated and designed by both the Reuleaux and Zeuner methods. Following valve gears, the laws of thermodynamics are discussed and the application of the laws shown by application to engineering problems. The subject includes a discussion of thermodynamics of saturated vapors and of superheated steam. Many engineering problems involving thermodynamics and their application are used as illustrations. The accessories of a power station, including condensers, heaters, circulating pumps, dry vacuum pumps are discussed. Textbooks: *Thermodynamics of the Steam Engine, Peabody; Mechanism of the Steam Engine, James and Dole; Power Plant Machinery, Vol. II, James and Dole; Steam Tables, either Marks and Davis, or Peabody.*

2·47, 2·471. Heat Engineering. A continuation of 2·46. Includes the thermodynamics of mixed gases and vapors, heat transmission, Rankine cycle efficiencies, flow of fluids, injectors, probable power of engines, the principles of heating and ventilation. Also discussion of steam boilers, their accessories and their operation. Textbooks: *Thermodynamics of the Steam Engine, Peabody; Steam Boilers, Peabody and Miller, or Gebhardt, Steam Power Plant Engineering.*

2·48. Internal Combustion Engines. Oil and gasoline engines, adapted to the needs of naval constructors.

2·49. Refrigeration. A thermodynamic study of the absorption refrigerating system, of the properties of various brine solutions, of problems encountered in the manufacture of ice, and in other applications of mechanical refrigeration. A general discussion of the application of refrigeration to warehouses and industrial processes, refrigerator cars, etc., including also the proper handling of foods in storage, fungus growths and their effect on the decay of foods in storage.

2·491. Refrigeration. Lectures and conferences on the types and applications of refrigerating machinery similar in character to 2·49 but less theoretical.

2·501. Advanced Refrigeration. 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.

2·502. Advanced Heat Transmission. A study of the variations of surface coefficients, conductivities, etc., under varying conditions followed by a discussion of the 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 to cases involving fluctuating temperature conditions.

2·503. Advanced Heat Engineering. Rapid review of the fundamental principles of thermodynamics and the use of the temperature entropy diagram, discussion of nozzle flow, cooling tower calculations followed by the thermodynamics of mixtures of gases and vapors with various applications, liquefaction of gases and separation of gaseous mixtures, the laws of heat transmission, study of the variation of surface coefficients, and the application of the laws to various power station accessories.

2·51. 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.

2·58. Power Plant Design. Includes: first, a study of the fundamental data required, such as location, water supply, fuel supply and load conditions; second, the choice and layout of the machinery for the plant for best economy consistent with dependability, including a study of typical plants. Calculations of the sizes of apparatus and computations to show probable fuel consumption and cost of operation will be made. Third, a study of the buildings, especially foundations and structural work, together with the principal calculations; fourth, the making of drawings to include plan, elevation, and necessary sections to show the location of apparatus and main pipe lines. These drawings will be sufficiently complete in detail to make it possible to calculate. Fifth, the probable total first cost of the plant and the operating cost. Textbook: *Notes on Power Plant Design, Miller and Holt.*

2·581. Power Plants Advanced. An advanced course on Modern Power Plants including a study of the design and installation of high pressure boilers, 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, heaters, etc., including turbine and machinery foundations and layouts. Lectures and problems will be supplemented by trips where possible.

2·59. Mechanical Equipment of Buildings, Heating and Ventilation. Includes: first, a study of the elementary principles of the thermodynamics of gases and steam with their application to the equipment of a building; second, a study of the principles and practice of heating and ventilation, and third, a discussion of the various other mechanical equipment of a building, such as elevators, dust collecting systems, etc. Fifteen hours of this subject are given over to trips. Textbook: *Heating and Ventilation, by Allen & Walker.*

2·601. Engineering Laboratory. Designed to give a fundamental knowledge of methods of testing machinery in operation. Begins with exercises such as calibration of gauges, the use of planimeters, steam engine indicators, friction brakes, etc., and continues with problems involving heat engineering such as the use of steam calorimeters, the measurement of steam by orifice, a steam engine test and a test on a single stage air compressor. Hydraulic experiments include flow measurements by orifice, nozzle, Pitot tube, Venturi meter and weirs. A short course on Gas and Fuel Analysis is given as part of this subject. A report is required from each student on every laboratory exercise.

2·602. Engineering Laboratory. A continuation of 2·601, involving the testing of larger units including a test of a boiler plant and a few tests on internal combustion engines. More complete and detailed reports of the tests are required than in the previous subject. Six laboratory exercises on heat measurements are given as a part of this subject.

2·603. Engineering Laboratory. A continuation of 2·601. Similar to 2·602 but omitting the boiler test and heat measurements.

2·611. Engineering Laboratory. An experimental subject teaching the use of various instruments used for testing power machinery preparatory to the subsequent subjects 2·612 and 2·613. A few exercises are used for the study of valve gears of steam pumps and engines. Tests are made on an engine, an air compressor and air lift pump. Equivalent to the first half of 2·601.

2·612. Engineering Laboratory. A continuation of 2·611. Tests are run on steam engines, pumps and fans. The methods employed in conducting these tests and the reports required are intended to demonstrate the proper procedure for such testing and to teach the student to write a complete report of the work and to draw correct conclusions from the results obtained. Equivalent to the second half of 2·601.

2·614. Engineering Laboratory. Covers the same ground as 2·601 but less complete reports are required.

2·615. Engineering Laboratory. A continuation of 2·612 or 2·614. Part of 2·602 including a test on a steam boiler plant.

2·62. Engineering Laboratory. Similar to 2·601 with the exception that exercises on internal combustion engines are taken instead of the gas and fuel analysis.

2·621. Engineering Laboratory. Covers part of 2·62.

2·63. Engineering and Hydraulic Laboratory. Work is designed to teach the use of instruments required for testing steam and hydraulic machinery, also to give some practice in conducting tests on such machinery. A report is required from each student on every experiment.

2·631. Engineering and Hydraulic Laboratory. Similar to 2·63 but more time is devoted to hydraulic experiments.

2·64. Refrigeration Laboratory. A general experimental course on refrigerating machines and experiments on heat transmission. The equipment consists of compression and absorption types and includes small commercial and domestic units using ammonia, sulphur dioxide and methyl chloride refrigerants. A constant temperature room is made use of in the testing of household units together with recording devices for power and temperature measurements.

2·65. Power Laboratory. Exercises in the laboratory with outside work on calculations and reports. The object is to familiarize the student with the method of testing various types of power equipment and the proper method of writing reports of such tests. In addition, an attempt is made to familiarize the men with the operation of pumps and engines. Open to army officers only.

2·651. Gas Engine Laboratory. Consists in the stripping and assembling of different types of gasoline engines and accessories used in the Ordnance Department, United States Army. Complete performance and efficiency tests are made on these engines. A considerable amount of time is spent both on operation and on what is known as "Troubles" with the idea of familiarizing the men with the various troubles which are likely to occur in field operations. Open to Army Officers, Navy Officers, R. O. T. C. and automotive students. Notes prepared by the instructor in charge will be used. Textbooks: *Automobile and Air Craft Engines, Judge; The Gasoline Motor, Heldt; Electrical Equipment, Heldt; catalogues and instruction books published by manufacturers of engines and accessories; The Testing of High Speed Internal Combustion Engines by Judge; The Internal Combustion Engine, Vols. I and II by Ricardo.*

2·652. Internal Combustion Engines. Consists of classroom discussions and laboratory demonstrations of the fundamental principles underlying the operation of the modern high speed internal combustion engine. Textbook: *Engines of High Output, H. R. Ricardo.*

2·66. Automobile Laboratory. Construction and operation of various motor vehicles, engines, accessories and equipment explained in detail by instructors. Tractors, tanks, motor vehicles, automobile, airplane and marine engines and equipment used for demonstration and study. Students prepare notes and sketches of work covered.

2·661. Maintenance and Operation of Automotive Equipment. Lectures followed by conferences where the maintenance and operation of motor vehicles is considered from the standpoint of design for efficient maintenance and operation, followed by a study of systems in use by various operating companies. The maintenance and operation of rail cars, busses, taxicabs and trucks is studied. Fleet operations, store delivery systems, street railway bus lines, and the relation of motor vehicles to steam and electric railways are studied. Preparation time is spent in the study of reports of operating companies and engineering papers. Textbook: *S. A. E. Journal, engineering papers, companies' cost sheets, etc.*

2·671. Engine Testing. Prony brakes, water brakes, and electric dynamometers studied and operated. Engines mounted, lined up and couplings fitted for testing. Airplane, automobile, marine and tractor engines tested for complete performance including brake and indicated horse powers, fuel consumption, efficiencies, etc. Study of distribution and combustion characteristics by exhaust gas analysis. Effect on engine performance of changes in cooling, lubrication, carburetion, and ignition systems studied. Investigations of detonation, distribution, vibration, etc., conducted. Effect of various adjustments and use of accessories on engine performance obtained. Textbook: *Manufacturers Handbooks, Engineering Papers and Reports; The Testing of High Speed Internal Combustion Engines by Judge; S. A. E. Data Sheets and Test Forms.*

2·672. Motor Vehicle Testing. Fifteen hours devoted to lectures and recitations. Sixty-five hours given to testing of motor vehicles. Chassis dynamometers, accelerometer, etc., used. Performance of motor vehicles studied in laboratory and on road. Riding comfort, braking ability, fuel mileage, effect of various tires on performance, etc., investigated. Accessories tested. Preparation time devoted to design of test apparatus, reports, and reading of current literature. Textbook: *Manufacturers Handbooks, Automotive Magazine, Engineering Papers and Engineering Reports; S. A. E. Handbook and Journals.*

2·681. Aero Engine Laboratory. Devoted to the study of engine mounting, couplings, fuel measuring devices, power measuring devices and instruments used in aero engine testing. Exhaust gas analysis. Short test runs made and performance of engines obtained. Gives practice in the fundamentals of testing. Textbook: *Manufacturers and Government Handbooks and Reports, S. A. E. Journals, Data Sheets and Test Forms, etc.*

2·691. Aero Engine Laboratory. Lectures on the fundamentals of aero engine construction, design, and operation and the study in the laboratory of the aero engines and their parts. Short engine tests are made to obtain performance of engines and give experience in handling test apparatus, and engine operation. Textbook: *Manufacturers and Government Handbooks and Reports.*

2·70. Machine Design. Embraces typical problems in machine design which may be solved by the application of the principles of statics. As an introduction the student is required to make complete calculations and drawings for the design of one of the simpler machines in which the stresses are statically determinate, such as a punch, shear, press or riveter. The remainder of the time is spent in the design for a fire-tube, water-tube or marine boiler, a vulcanizer, stand-pipe or steel stack. In this connection the shells of cylinders, riveted joints, and the staying of flat surfaces are thoroughly discussed. Graphical methods are employed for the analysis of motions and the determination of forces wherever possible. Textbooks: *Design of Steam Boilers and Pressure Vessels, Haven and Swett.*

2·71. Machine Design. The design of machines involving dynamic forces. Such a machine as a power-driven punch, press, shear or pump is chosen as a type and its various proportions as far as possible are calculated by rational methods. The stiffness and strength of shafting, belts, ropes, fly-wheel stresses, force fits, journals, and bearings, together with the stresses in moving parts, are studied at considerable length. A complete set of drawings and calculations for a complicated machine of the above type is required.

2·711. Machine Design. Similar to 2·71, but briefer and adapted more directly to questions relating to manufacture and duplication of parts.

2·712. Machine Design. An extension of 2·711 with special reference to combined stresses and problems involving rigidity of parts.

2·721. Machine Design. Lectures and calculation and drawing upon the principle and action of modern machine tools together with the design of pressure vessels such as tanks, boilers and standpipes. Numerous problems are studied in relation to cutting and feeding speeds. The stresses are thoroughly analyzed in the shells and joints of pressure vessels. Textbook: *Riveted Joints for Pressure Vessels, Haven and Swett.*

2·722. Machine Design. An extension of 2·721 with special reference to complicated machines under dynamic loads. The subjects of standardization and duplication of machine parts are given careful attention.

2·731. Machine Design. Lectures upon the applications of machine design to the airplane engine and the apparatus used in testing such motors. The fundamental study includes gears, shafts under combinations of bending and twisting, bolt and screw fastenings, journals, ball and roller bearings, couplings, clutches, and high speed disc wheels.

2·732. Machine Design. An extension of 2·731 including an analysis of numerous stresses in parts of airplane engines with special stress calculations upon unusual machine elements. Textbook: *Library research.*

2·741. Machine Design, Advanced. 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. Textbook: *Library research.*

2·742. Machine Design, Advanced. An extension of 2·741 with special reference to the stresses in turbine discs together with the design and action of brakes. Textbook: *Library references.*

2·743. Advanced Machine Design. A systematic application of the principles of mechanics applied to the design of machines of complicated character, centrifugal effects, balancing, lubrication, combined stresses as well as stresses in turbine discs are discussed and calculations carried along with the design.

2·75. Machine Design, Advanced. Arranged for Ordnance Design, United States Navy.

2·761. Machine Design. A thorough analysis of the stresses and factors of safety in the power plant of the naval torpedo, including bearings, gears, the action of combined bending and twisting and the distortion of parts. Textbook: *Library reference and notes prepared for class.*

2·762. Machine Design. An extension of 2·761 with a special study of the stresses in air turbine discs and the design of the necessary equipment for testing the power plants of torpedoes. Textbook: *Library reference.*

2·77. Engine Design. Lectures and drawing-room exercises in the design of reciprocating engines for stationary plants. Typical engines are studied with reference to special requirements of the services in which they operate and to shop methods of construction, as well as to thermodynamic and mechanical principles, including engine balancing. A problem is assigned on the design of some type interesting to the student, and the principal parts are laid out on the drawing board.

2·781. Industrial Plants. A study of problems involved in the organization of a modern manufacturing plant and the planning, construction and equipment of the buildings required. The subjects included may be grouped as follows: (*a*) organization of the industry including the office and engineering departments, methods of superintendence, employment and cost of labor, and scheduling the work; (*b*) factors to be considered in selecting a suitable site for a given industry; (*c*) the construction of the foundations for an industrial plant; (*d*) the heating, ventilating and air conditioning of the factory; (*e*) the construction of a mill or shop of the three following types—slow burning, mill steel frame, and reinforced concrete. Textbook: *Notes prepared for class.*

2·782. Industrial Plants. An extension of 2·781 with special reference to the design of the structures and the distribution of power in mechanical processes. The mechanical equipment of the building including lavatories, stair towers and safety appliances. The complete design of a brick and a concrete-steel factory is included in this course. Textbook: *Notes prepared for class.*

2·79. Gasoline Automobile. Covers the general principles of gasoline automobile construction and operation. Includes the study of the engine and its accessories, carburetors, ignition, starting and lighting systems, storage batteries, lights; the chassis and its component parts, clutches, transmission, steering gear, axles, brakes, etc.

2·801, 2·802. Automotive Engineering. Fundamentals of automotive engineering are the bases of this course — engines and chassis; theoretical considerations of the general principles governing the action and design. It includes a study of the conditions within the cylinder, flame propagation, turbulence, detonation, lubrication and oil dilution, influence of shape and size of combustion chamber and valve arrangement, spark plug location, factors influencing m. e. p., manifold distribution, carburetion, cooling, sources of loss of efficiency, etc. A study is made of all important parts and procedure of design is outlined. In addition to the engine it includes clutches, gear sets, with calculation of bearing loads and choice of bearings, universal joints, rear axle drives with calculation of bearing loads, rear axles, front axles, steering gears, springs, brakes, etc.

2·811, 2·812. Automotive Design. The calculation and design of engines and chassis, supplementing the course in automotive engineering. All essential parts are carefully studied and drawings as well as the calculations are made. The student is given almost free choice of the type of machine for his individual design.

2·850. Automatic Machinery. A discussion of a number of fully automatic machines representative of various classes of machinery, such as wire-working machinery, can-making and can-capping machinery, printing machinery, weighing, package and wrapping machinery, labeling machines, fibre box machines, etc. Problems assigned include a motion diagram for a full automatic machine, analyses of indexing devices and designs for some of the simpler automatic mechanisms.

2·851. Fire Protection Engineering. The growing demand for men equipped with a knowledge of fire-proofing and fire-protective apparatus renders it necessary to make a special study of this branch of engineering. The erection, installation and operation of protective devices of all kinds are carefully studied. A number of problems are worked out showing how modern shops and mills may be safeguarded against fire in the most effective manner. Textbook: *Crosby-Fiske-Forster, Handbook of Fire Protection.*

2·852. Locomotive Engineering. Lectures dealing largely with the steam locomotive, but in which are briefly discussed the electric, the diesel, and the diesel electric locomotive. The question of power and tractive effort of the locomotive is considered in connection with train resistances due to speed, to grade and to curve. The details of construction of boiler, valve gear and running gear are taken up and calculations made of the stresses in main and side rods, counter balancing, bearing pressure of journals, crank pins, etc. A very considerable amount of time is devoted to a consideration of locomotive accessories such as stokers, superheaters, feed-water heaters, thermic syphons, air-brake equipment, etc., and some attention is given to locomotive operation, particularly with reference to breakdowns on the road.

2·853. Locomotive Engineering. A study of the construction of modern locomotives from detail drawings, the general principles of locomotive design, the calculation of stresses in parts of the engine, balancing of driving wheels, superheaters, stokers, feed-water heaters and their effect on the efficiency of the engine.

2·854. Mechanical Equipment of Buildings. Description and discussion of the general principles of construction of the mechanical equipment of large office buildings, including such subjects as elevators, pneumatic systems of dust collection, water supply systems, water-heating systems, sewage disposal, etc.

2·855. Steam Turbine Engineering. A study of the different types of modern steam turbines, by means of lectures and discussions. Their theory, construction and operation are taken up in sufficient detail to make the student familiar with the best practice. Problems illustrating simple design and the thermodynamics of steam turbines are worked out. Turbine economics and the special features of turbine auxiliaries are considered. Knowledge of the steam turbine and nozzle work taken in heat engineering of the third year is assumed. Textbook: *Steam Turbines, Moyer; or Church, Principles of Steam Turbines.*

2·858. Inspection Methods. A study of the principles of shop inspection, including shop measurements, measuring instruments and gauges, tolerances, dimensional standardization, calibration of shop standards, and analysis of production problems by means of measurement. Textbooks: *Library Research and Notes prepared for class.*

2·87. Textile Engineering. Lectures on the machinery and processes employed in the production of textiles with special reference to mechanical fabrics. The process is studied from the bale of raw material to the finished cloth. In addition, thirty hours are applied to special work in the Textile Testing Laboratory, involving the determination of the strength twist, staple, elasticity and moisture content of fabrics and yarn. The design of a yarn mill and weave shed is taken as a problem and a complete set of floor plans are calculated and designed to fit the requirements. Textbook: *Notes prepared for class.*

2·871. Textile Engineering. Similar to 2·87.

2·872. Design of Cotton Machinery. The determination of stresses existing in the fundamental parts of cotton working machines. The analyses of the velocities, especially those of a variable nature, in the twisting and winding mechanisms of spinning and roving machinery. The study of gears, ball and roller bearings, belts, chains and speed cones, and the design of their application to the various elementary parts of textile machinery.

2·873. Design of Wool Working Machinery. A study of woolen and worsted machinery with particular reference to the determination of stresses and velocity relationships in the mechanism employed in carding, condensing, spinning and finishing processes.

2·874. Dynamics of Textile Machinery. A study of the inertia forces present in high speed reciprocating and rotating textile machinery with especial reference to the effect of the same upon manufacturing structure, and upon the accuracy of the machine's product. Textbook: *Hanton, Mechanics of Textile Machinery.*

2·875. Textile Technical Analysis. A study of the complete analysis of a given woven fabric determining throughout its physical properties, weight, yardage, absorptibility, porosity, tensile strength, elasticity, thickness, "off-square," and yarn properties, together with the determination of the necessary machinery to manufacture the fabric.

2·876. Principles of Fabric Structure. Lectures on the construction of felted, woven, knitted and braided fabrics, together with a description of the machines employed. Includes felting machinery; automatic, box, dobby head and jacquard looms with the analyses of typical weaves; circular, warp and jacquard knitting machines; and the principles of operation of braiding machines.

2·88. Ordnance Engineering. 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 course.

2·891. Mechanics. Devoted to the study of the fundamental principles of mechanics necessary for the solution of problems arising in the design of ordnance of various types.

2·892. Ordnance Problems. Devoted to the solution of problems arising in the design of ordnance; including recoil and counter-recoil mechanisms, the stresses in the parts of gun carriages and mounts of different types, the power for operating, elevating and traversing mechanisms, the stresses in projectiles, etc.

2·90. Forging. Systematic instruction in the use of each tool, the study of each material worked, with an explanation of its various grades and of the proper methods of working each, and the discussion of methods of making large forgings. The ground covered includes instruction in the building and care of fires, heating, drawing, forming, bending and twisting, upsetting, upsetting while bending, upsetting for square corners, punching, bolt making, welding, chain making, and the construction of hooks and ring bolts. The work in steel includes drawing, forming, welding, refining and tempering, and spring and tool making. Training is given in the use of the power hammer; and drop forging is also included.

2·901, 2·902. Forging. Similar to 2·90.

2·91. Foundry. Deals with the principles and practice of foundry operation and the production of all classes of castings. Includes instruction by lecture, demonstration and practice in hand and machine molding and core making; mixing, melting and pouring metals. Castings are first made in white metal for practice, then in aluminum, brass and in cast iron, when the students are taught pouring and the running of metal furnaces. Illustrated lectures on floor, sweep, pit and loam molding; malleable iron and steel casting; permanent molds and die casting; heat treatment of castings; application of X-ray tests for internal defects in castings; foundry layout, equipment, safety methods and modern methods of progressive production.

2·911. Foundry. Covers part of 2·91.

2·92, 2·923. Pattern Making. Includes the elements of joinery and wood turning. Lectures, demonstrations and practice in hand and machine methods. Typical patterns and core boxes are constructed. The principles of molding are carefully considered. Illustrated lectures on the construction of solid, split and loose-piece patterns; large, part and skeleton patterns for floor, loam and sweep work; master and metal patterns; mounting of patterns on plates and their preparation for use on molding machines.

2·921. Carpentry.

2·941, 2·942. Machine Tool Laboratory. Given by lectures and demonstrations. Includes laying out work, grinding tools, chipping cast iron, pneumatic chipping and drilling, filing and fitting cast iron and steel machine parts, alignment and babbitting of bearings, measuring hardness of metals with scleroscope, drilling, reaming, counterboring and tapping, grinding drills by hand and machine, belt lacing, soldering electric and oxyacetylene welding. Instruction is also given in 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.

2·951. Machine Tool Laboratory. Instruction in machine processes and the use of hand tools is given by lectures and demonstrations, supplemented by notes and textbooks. Each student is assigned problems involving laying out work, both hand and pneumatic chipping and drilling, filing and fitting cast iron and steel parts, alignment and babbitting of bearings, scraping machine slides, steam pipe fitting by hand and machine, hardness tests of metals with scleroscope, tapping, grinding drills and other tools by hand and machine; centering, squaring, straight and taper turning and fitting, screw cutting, finishing and polishing, gear cutting, mandrel making, hardening, tempering, grinding, and electric and oxyacetylene welding. Special attention is paid to cutting angles and adjustments of cutting tools and cutting speeds for each material worked. The machines used are engine lathe, centering machine, milling machine, drilling machine and grinding machine. Textbook: *Advanced Machine Work*, *Smith*.

2·952. Machine Tool Laboratory. A continuation of 2·951. Includes planing flat and angular surfaces, keys and keyways, tool making, hardening and case hardening, oil and color tempering, grinding and lapping, making taps, milling cutters and cylindrical gages. The machines used are engine lathe, speed lathe, centering machine, milling machine, drilling machine, planer, shaper, cylindrical cutter, and surface grinding machines, automatic gear cutting machine, gear shaper, thread milling machine and broaching machine. Instruction is given in the use of gages for the standardization of machine parts, standard precision measuring machine, contour measuring machine, lead test indicator and measuring with light waves. Textbook: *Advanced Machine Work, Smith.*

2·96. Machine Tool Laboratory. Covers part of 2·951 including instruction in mechanical processes, both hand and machine. Textbook: *Advanced Machine Work, Smith.*

2·961. Machine Tool Laboratory. Covers a small portion of 2·951. Textbook: *Advanced Machine Work, Smith.*

2·971. Machine Tool Laboratory. Covers a part of 2·951.

2·972. Machine Tool Laboratory. A continuation of 2·971 and includes boring, knurling, inside and outside screw cutting, cylindrical grinding, eccentric turning, tool making such as making mandrels, taps, hardening and tempering. Textbook: *Advanced Machine Work, Smith.*

2·98. Production Methods. A study of the production methods used by leading industries, manufacturing machines and appliances that are in general use such as electrical machinery, telephone apparatus, sewing machines, uses of aluminum and aluminum alloys in machine parts and appliances, die castings, pressed metal, tubing, pipe, pipe fittings and valves, machine tools, clocks, watches, cash registers, firearms, phonographs, radio apparatus, typewriters, conveyors, agricultural machinery, automotive construction. Estimating cost of production is considered.

2·981. Manufacturing Processes. Methods of constructing automobiles, trucks, busses and tractors. Includes methods of machining automotive parts, such as cylinder blocks, pistons, connecting rods, crankshafts, camshafts, ball and roller bearings, axles, steering knuckles, drive shaft, rear axle housings, differentials, flywheels, universal joints, clutches, brake mechanisms, uses of carrier systems, unit and final assemblies such as steering columns, rear axles, engines, chassis, radiators and bodies.

2·99. Metrology and Dimensional Engineering Standardization. Includes first, a study of fundamental units of measure, measuring systems, and calibration of standards; second, the purpose of measurements in scientific and research work, engineering in general use; third, a study of conventional measuring instruments, their characteristics and methods of calibration; fourth, accuracy of measurements; fifth, analysis of measurements; sixth, shop measurements and analysis by means of measurement; seventh, dimensional engineering standardization; and eighth, inspection engineering. Textbooks: *Library Research, American Engineering Standards, S. A. E. Handbook, and Notes prepared for class.*

MINING AND METALLURGY
(Including Petroleum Production)

The study of Mining Engineering and Metallurgy covers such a large field of technical endeavor that the courses given cannot follow all the details of the several branches. The aim of instruction is to ground the student in the fundamental principles of the professional studies, and to train his mind and hand that he may be a close observer, a good reasoner and a conscientious worker.

Instruction is given by lectures and recitations, by laboratory work and by summer schools. Work in the department covers studies in mining, ore-dressing, petroleum engineering, metallurgy, metallography and assaying. With these are interwoven auxiliary courses in physics, chemistry, mineralogy, geology and in civil, mechanical and electrical engineering.

There are four options. Option 1 covers the field of mining engineering, but its scope is sufficiently broad to enable the graduate to engage in the practice of those branches of metallurgy which commonly make a part of mining operations. Option 2 is devoted to petroleum production engineering, embracing prospecting, development, production and transportation of oil and gas. Option 3 is designed for the metallurgist and emphasizes the fundamental sciences and arts on which metallurgy depends. A short course in elements of mining is included, and electives allow the taking of lectures on geology and mineral deposits. Option 4 is arranged to give intensive training in problems concerned with metals and alloys, their structures, properties, uses, mechanical and heat treatment and methods of testing. Opportunity is offered for advanced studies leading to the degrees of Master of Science and Doctor of Science.

Subjects 3·00 to 3·99 (see page 66)

3·00. Introduction to Mining and Metallurgy. A brief orientation course designed to inform the student regarding the fields of activity of the mining engineer, the petroleum engineer and the metallurgist. 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. Includes a study of prospecting and exploring with applications of churn drilling and diamond drilling; mineral land titles; explosives, mining development, rock excavation, tunneling and shaft sinking; support of ground and timbering; mine equipment and operation embracing air compressing, hoisting, drainage, ventilation, underground transport, shaft signaling, machine drills, shoveling machines; and surface plant, including head frames, aerial tramways and cableways. Textbook: *Peele, Mining Engineers Handbook.*

3·02. Mining Methods. A continuation of 3·01 including the study of such subjects indicated under 3·01 as have not been completed in the first term; also, mine production with description of underground mining methods and selection of the proper method; special types of mining, as: coal mining, steam shovel mining, dredge operations on alluvial deposits, hydraulic mining and petroleum, salt and sulphur wells.

3·03. Mining Economics. Embraces studies of mineral resources, metals, fuels and non-metals; the economic effects of geographic situation and of transportation facilities; sampling, selling and purchasing of ores, fuels and other mineral products; inquiry into the principles of smelting contracts. Textbook: *Finlay, Cost of Mining.*

3·04. Mining, Principles of. 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; also the consideration of health, welfare, safety, and accident prevention, mining regulations and employers liability insurance. Textbook: *Hoover, Principles of Mining.*

3·05. Mining, Elements of. Designed 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. The subjects treated in the lectures are 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. Textbook: *Young, Elements of Mining.*

3·061, 3·062. Mining Engineering, Advanced. Planned for graduate students who have had some experience in mining practice and mining engineering, and who desire to do advanced work in some branch of the subject not specifically covered by other courses scheduled. The student is expected to make his own choice of the special division of the subject and of the allotment of time. The latter may be devoted variously to lectures, conferences, assigned readings, library studies, drawings, computations and written reports.

3·08. 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 various mines in the vicinity.

3·09. Mining Law. The history, interpretation and application of the United States mining law for graduate students who have had some experience in the practice of mining engineering. Reading and discussions. Textbook: *Lindley, On Mines.*

3·101, 3·102. Mine Valuation. 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. The study and analysis of the reports of mining 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. Geophysical Prospecting. Lectures supplemented by laboratory instruction in manipulation of geophysical apparatus and field exercises. The lectures deal with the elements of prospecting by the various scientific means; including magnetic, electric, seismic and gravimetric methods. The purpose of the laboratory is to train the students in the use of the instruments. The field exercises provide opportunity for taking readings following typical field practice.

3·14. Geophysics, Theory and Applications. For graduate students who have some knowledge of the various scientific methods of prospecting. Comprises lectures, conferences, library studies and written reports. Facilities for field work if desired. Geophysical prospecting is studied from the theoretical point of view and actual examples of its application are presented. The allotment of time is subject to special arrangement.

3·21. Ore Dressing. 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. Textbook: *Richards and Locke, Textbook of Ore Dressing.*

3·22. Ore Dressing Laboratory. Offers the student an opportunity to become familiar with the principles and actual operation of ore-dressing apparatus. 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. In addition, individual tests are made on crushing machines, sizing screens, hydraulic classifiers, magnets and flotation machines. One very important part of this work carried out by the student 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. Lectures and laboratory; 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 cleaning up his products and preparing reports. Textbook: *Richards and Locke, Textbook of Ore Dressing.*

3·241, 3·242. Ore Dressing, Advanced. 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. 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. Conferences and problems involving the various factors of equipment costs, operating cost, efficiency of operation and profit.

3·271, 3·272. Ore Dressing, Design. 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. One lecture, one recitation and one four-hour laboratory exercise a week. In the lectures are discussed 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. Textbook: *Bugbee, Fire Assaying.*

3·32. Fire Assaying and Metallurgical Laboratory. A composite subject; consisting of elementary work in fire assaying followed by brief laboratory work in fire metallurgy.

Fire assaying covers only the assay of ores for silver, gold and lead. The work in the fire metallurgy includes the roasting of copper ores and the refining of metallic copper. May not be given unless six or more apply. Textbook: *Bugbee, Fire Assaying.*

3·331, 3·332. Fire Assaying, Advanced. 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. Deals mainly with the production and refining of the metals. The principles of the subject are covered in thirty lectures. The remainder of the time is used in the library and laboratories. The laboratory work, which so far as possible is coördinated with the lectures, consists of various roasting, sintering, smelting and leaching tests followed by a discussion of the economic application of the results obtained. Textbooks: *Hofman and Hayward, Metallurgy of Copper; Metallurgy of Lead.*

3·411. Metallurgy: Copper and Lead. The lectures are given simultaneously with 3·41. The time for laboratory and library work is shortened. Textbooks: *Hofman and Hayward, Metallurgy of Copper; Metallurgy of Lead.*

3·412. Metallurgy: Copper, Lead, Zinc, etc. The lectures on copper and lead are simultaneous with 3·41. In addition there are twelve lectures covering briefly zinc, aluminum and fuels. The laboratory work is confined to twenty-five hours. Textbooks: *Hofman and Hayward, Metallurgy of Copper; Hofman, Metallurgy of Lead; General Metallurgy, Metallurgy of Zinc and Cadmium.*

3·42. Metallurgy: Gold and Silver. The principles of the subject are covered in thirty lectures. The laboratory work and problems are in connection with the lectures, and the results are discussed in weekly seminars.

3·421. Metallurgy: Gold and Silver. Shorter than 3·42 with less time for lectures and laboratory.

3·43. Metallurgy: Iron and Steel. 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 in the classroom 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. Textbook: *Stoughton, Metallurgy of Iron and Steel.*

3·431. Metallurgy: Iron and Steel. The lectures are simultaneous with 3·43, but less time is devoted to library work and plant visits. This subject is recommended for Army and Navy officers requiring a knowledge of iron and steel for ordnance or structural purposes. Textbook: *Stoughton, Metallurgy of Iron and Steel.*

3·432. Metallurgy: Iron and Steel. The class work is simultaneous with 3·43. Library work and plant visits are omitted. Textbook: *Stoughton, Metallurgy of Iron and Steel.*

3·44. Metallurgy: General, Zinc and Minor Metals. 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. Textbook: *Hofman, General Metallurgy, Metallurgy of Zinc and Cadmium.*

3·45. Metallurgy, Heat Treatment of Steel. Takes up the heat treatment of steel and includes 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. It consists of three lectures per week and treats at varying lengths of 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.

3·501, 3·502. Metallurgy: Iron and Steel, Advanced. 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. 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.

3·521, 3·522. General Metallurgy, Advanced. 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.

3·531, 3·532. Non-ferrous Metallurgy, Advanced. Designed 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 number of hours 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 of this course is confined to production and refining. Those desiring to study the properties of metals and alloys should register for 3·651, 3·652.

3·541, 3·542. Gold and Silver Metallurgy, Advanced. 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.

3·56. Metallurgical Plants. 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. 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 are 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 ot 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. Textbook: *Williams and Homerberg, Principles of Metallography.*

3·611. Metallography. Same as 3·61, but with less laboratory practice.

3·615. Metallography. Conferences and laboratory work dealing with the metallographic examination of metals used in torpedo construction. (Open only to officers of the United States Navy taking course in torpedo design.)

3·621, 3·622. Metallography. Similar to 3·61 but with much greater detail both in class work and in the laboratory.

3·641. Physical Metallurgy (Non-ferrous). An intensive study of the non-ferrous metals and alloys, their mechanical properties, uses, corrosion, methods of testing and similar topics.

3·642. Physical Metallurgy (Ferrous). Similar to 3·641 but dealing with iron and steel.

3·651, 3·652. Physical Metallurgy, Advanced. 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, 3·654. Physical Metallurgy. Conferences and laboratory work, for graduate students, dealing with the structure and physical properties of iron, steel and other metals and the changes taking place when the materials are subjected to mechanical work, distortion, alternating stresses and heat treatment.

3·655. Aircraft Metallurgy and Metallography. Conferences and laboratory exercises dealing with the manufacture and use of alloys in aircraft construction. Special attention will be given to the light alloys, but other metals will be briefly considered. (Open only to graduates in aeronautical engineering.)

3·66. Applications of Metallography. Laboratory conferences, given in the graduate year, arranged to familiarize the student with the applications of metallography to industrial problems.

3·67. Physics of Metals. A discussion of the application of physics, physical chemistry and thermodynamics to the theory of alloy formation, structure and properties.

3·68. Microstructure of Ores and Metals. Class and laboratory exercises devoted to the microscopic examination of polished specimens of metals and alloys; also the identification of common ore minerals in polished sections and the preparation and examination of the products arising in the various stages of ore dressing and metallurgy.

3·70. Heat Treatment. Conferences and laboratory work dealing with the effect of heat treatment on the physical properties of iron, steel and other metals.

3·701. 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 or ordnance construction. Open only to officers of the United States Navy taking torpedo design or ordnance design.

3·702. Heat Treatment. A continuation of 3·70, devoted to the study of the effect of heat treatment on the metals used in the automotive industry.

3·703. Heat Treatment. Lectures and laboratory work dealing with the constitution of metals used in construction and the effect of heat treatment on their physical properties. Open only to students in the Graduate Coöperative Course with the General Electric Company.

3·71. Heat Treatment. Conferences and laboratory work dealing with 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.

3·711. Heat Treatment. Similar to 3·70.

3·72. Heat Treatment and Metallography. Conferences and laboratory exercises dealing with the study of the heat treatment and metallographic testing of metals used in automotive construction.

3·731, 3·732. Physical Metallurgy. Conferences and laboratory exercises dealing with the structure and physical properties of metals used in torpedoes or ordnance construction. Open only to officers of the United States Navy.

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 sub-surface 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. Designed 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. The subjects treated in the lectures include oil and gas land titles, methods of development and production, transportation and storage of petroleum.

3·85, 3·86. Petroleum Production and Utilization. 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. Consists of a five-day trip to the oil and gas fields of western Pennsylvania.

3·901, 3·902. Oil and Gas Land Valuation. Considers the factors entering into the valuation of oil and gas properties, given by the case system. The time is devoted to lectures, conferences, assigned readings, drawings, computations and written reports. Designed for graduate students who have had some experience in petroleum production.

3·911, 3·912. Advanced Petroleum Engineering. Planned 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 courses 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. 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. Oil Well Waters. Seminar topics relative to the control of oil well waters.

ARCHITECTURE

The Department of Architecture offers two courses: Course IV, Architecture; and Course IV-A, Architectural Engineering; the former, a five-year course, leads to the degree of Bachelor in Architecture; the latter, covering four years, leads to the degree of Bachelor of Science in Architectural Engineering. The graduates of each course are equipped to assume their differing professional responsibilities entirely independent of one another, though modern practice will frequently bring them together with a better understanding of one another's problems than would have been possible without the background of subjects that they have taken in common.

The teaching of these two Courses has steadily developed under the conviction that the ever-widening field of professional opportunity offered ample scope for each. It consequently has seemed fundamentally unsound to train students in one course with the impression that they were qualified to assume the obligations of the other.

Certain subjects are obviously and properly taught in common, such as English and history, economics, drawing, mathematics and perspective; certain professional and semi-professional subjects, as history of civilization, art and architecture, philosophy of architecture, office practice, professional relations, and lectures on building construction. The more highly specialized subjects pertaining to the distinctive characteristics of the two courses are necessarily taught separately.

In all professional work the methods of instruction are so far as possible individual. Even in such subjects as architectural history and European civilization and art, which must be presented in the lecture room, written exercises and personal conferences keep the instructors in touch with the progress of each student. In the subjects of design and freehand drawing individual criticism and correction form, to a very large extent, the basis of instruction.

As the function of the architectural school is to give training in fundamentals, efforts are concentrated upon imparting to the student a very clear understanding of the general principles of the subject, and upon training his powers of analysis and application. It is believed undesirable, in fact dangerous, to spend too much time upon the hampering limitations of ordinary practice before the student has acquired sufficient knowledge of the subject to discriminate between the general and the special case.

Daily progress and attention to work are insisted upon, and the results of class exercises during the term are considered quite as trustworthy a measure of a student's development and power as are the formal examinations.

The student is strongly advised to spend a part of the summer vacation in an office. The experience that he gets there of practical problems and conditions will be a great aid to him in a clearer understanding of the value of his school work.

Subjects 4·00 to 4·99 (see page 66)

4·021, 4·022. Freehand Drawing. Includes drawing from the cast and architectural ornament in charcoal, pencil or pen and ink, also quick sketching direct from the human figure.

4·031, 4·032. Freehand Drawing. A continuation of 4·022. Drawing from the nude, memory drawing, and direct pen-and-ink sketching from the figure.

4·041, 4·042. Freehand Drawing. A continuation of 4·032. Drawing from the nude, memory drawing, and direct pen-and-ink sketching from the figure.

4·051, 4·052. Freehand Drawing and Decorative Design. Advanced work open only to students who have passed 4·042. The students make life-size drawings from the nude, and study the principles of decorative figure design.

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. Given by short lectures and individual classroom instruction.

4·071, 4·072. Modeling. Aims primarily to develop the student's sense of a third dimension in his study of architectural composition. Given by means of sketch exercises in modeling wax upon a given program of an architectural character.

4·081, 4·082. Color, Theory and Exercises. Aims to familiarize the student with the various theories of color, both scientific and aesthetic, and to give him practice in the use of color. Given by lectures and problems.

4·091, 4·092. Color, Design and Application. A continuation of 4·081, 4·082, the problems being of a more architectural character.

4·11. Shades and Shadows. Planned to give the fundamental knowledge necessary for casting the conventional shadows employed in architectural design. Given by means of 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. Textbook: *Notes on Shades and Shadows, H. W. Gardner.*

4·12. Perspective. Lectures and drafting-room exercises. The first part treats of the general theories of perspective and the methods of revolved plan and perspective plan. The latter part is devoted to practical work involving variations, short cuts and office manipulations.

4·13. Perspective. Lectures and classroom exercises. Consideration is given to the fundamental phenomena of appearance, the general theory of conical projection and its application to perspective, the method of revolved plan upon which all shorter methods are based, curves and apparent distortion. The subject is continued with 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. Textbook: *Principles of Architectural Perspective, Lawrence.*

4·20. Office Practice. An analysis of the methods followed in architects' offices in the preparation of plans and specifications as well as details for a good building.

4·211, 4·212. Office Practice. Lectures and exercises in the drafting room to illustrate the principles governing the making of working drawings, details and specifications. Plans of executed work are examined and discussed, and, wherever practicable, visits are made to the buildings under discussion. The character and use of building materials are discussed, with special reference to their influence upon architectural design. This subject should enable a student without previous office experience to be of some value as a junior assistant in an architect's office during his vacation periods.

4·22. Office Practice. An analysis of working drawings and specifications used in the construction ot buildings. Plans and specifications of a building under construction near Boston will be examined and discussed, frequent trips made to the building and written reports upon its construction required. Sufficient drafting of plans and details will be required to familiarize the students with the principles governing their preparation.

4·241, 4·242. Professional Relations. 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; also 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 students are encouraged to take part in the discussions and to express their personal opinions. Textbooks: *Handbook of Professional Practice, American Institute of Architects; Law of Architecture and Building, Clinton H. Blake, Jr.*

4·25. Estimating. Designed to give the students some knowledge of the methods used in making estimates of cost as applied to building. Students cannot register for this course after the second exercise. Textbook: *Mimeograph Notes.*

4·311, 4·312. Theory of Architecture. Lectures supplementing the course in design and closely related to it.

4·321, 4·322. Theory of Architecture. Lectures supplementing the corresponding course in Design and closely related to it.

4·331, 4·332. Theory of Architecture. Lectures supplementing the corresponding course in Design and closely related to it.

4·411, 4·412. Architectural History. A series of thirty lectures, illustrated by stereopticon, covering the periods of Egyptian, Assyrian, Persian, Greek and Roman architecture, supplemented by reference reading and theme writing and fifteen hours of classroom sketching from architectural elements.

4·413, 4·414. Architectural History. The same course as 4·411, 4·412, omitting the classroom sketching and theme writing.

4·421, 4·422. Architectural History. A continuation of 4·412 with fifteen illustrated lectures covering the periods of Byzantine, Romanesque, Gothic and Renaissance Architecture, supplemented by fifteen hours of class sketching, and by reference reading.

4·423, 4·424. Architectural History. The same course as 4·421, 4·422, omitting the classroom sketching.

4·471, 4·472. European Civilization and Art. A survey of the civilization and art of the later Hellenic and Roman world. Method and apparatus as in G57 of which this forms a continuation. Textbooks: *Breasted, Ancient Times*; *Tarbell Greek Art.*

4·481, 4·482. European Civilization and Art. Modern painting: a study of its development, problems, predominant influences, from the Renaissance to the present time.

4·49. History of Renaissance Art. A short consideration of its relation with mediaeval art and its consecutive phases in architecture, sculpture and painting.

4·52. Philosophy of Architecture. A series of conferences in which architecture is considered from a theoretical rather than an historical point of view. It serves to supplement the drafting-room instruction in design in furnishing a résumé of the fundamental principles of architecture and its relationship to civilization and the other arts allied with architecture.

4·61. Town Planning. Intended to acquaint the student with the characteristic problems of the town planner, the purpose being to so equip the architect that he may the better coöperate with either engineer or landscape architect, as well as to acquaint him with the history and development of these arts. Lectures accompanied by reading and work at the drafting board.

4·712. Design I. The beginning of the study of the principles of architectural composition by means of problems. Given with individual instruction in the drafting room and criticism of the student's work before the class. In combination with the lectures in theory of architecture, the student is made familiar with the elements of buildings derived from classic precedent. It also serves to teach the student the principles and methods of architectural drawing and rendering. Textbook: *Gromort, Elements of Architecture.*

4·721, 4·722. Design II. A continuation of 4·712. Includes making preliminary sketches, in a period of twelve hours for a given program, and developing these sketches to a final result in a period of from four to five weeks. Also includes sketch problem exercises of twelve hours duration.

4·731, 4·732. Design III. A continuation of 4·722. Extends the instruction in the principles of architectural composition to buildings of simple requirements and varied character. Includes making preliminary sketches in a period of twelve hours for a given program, developing these sketches to a final result in a period of from four to five weeks, and also sketch problem exercises of twelve hours duration.

4·741, 4·742. Design IV. A continuation of 4·732, the problems in composition being more advanced. The system of preliminary sketches, developed problems and sketch problems is continued. Includes the preparation of the thesis required for the Bachelor's degree.

4·751, 4·752. Design V. 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 Master in Architecture.

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.

4·80. Building Construction. Lectures and discussion 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 material.

4·811. Constructive Design. Devoted to the 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. Textbook: *Mimeograph Notes.*

4·812. Constructive Design. A continuation of 4·811 including simple steel framing, the plate girder, and the elements of design in reinforced concrete. Textbook: *Mimeograph Notes.*

4·90. Structural Drawing. Intended to supply the preliminary knowledge of structural steel shapes and familiarity with the use of steel handbooks necessary for the study of structural design, and to give some practice in drawing. Some elementary computation on the properties of sections is also included. Advantage is taken of opportunities to view the work of the template and fabricating shops in one or more visits to a structural steel plant. Typical shop drawings of a structural steel building frame are made, including the details of a plate girder. Textbook: *Mimeograph Notes.*

4·911. Structural Analysis. A consideration of 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 are studied. Textbook: *Mimeograph Notes.*

4·912. Structural Analysis. A continuation of 4·911 including the analysis and design of a wooden roof truss. Textbook: *Mimeograph Notes.*

4·921. Structural Design. Problems in architectural construction, including general steel framing, the design of plate and box girders, with a careful analysis of the stresses in a shallow girder. Textbook: *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. For description of courses see Division of General Studies, page 238.

G56. European Civilization and Art.

G57. European Civilization and Art.

CHEMISTRY

Instruction in general Inorganic Chemistry is given to all students in regular Courses except that of Architecture, throughout the first year. The subject is designed not only to impart a knowledge of the principles of the science and of the descriptive chemistry of the metallic and non-metallic elements, but to constitute an introduction to scientific methods of experimentation, observation and reasoning.

The instruction in chemical subjects is continued in the Courses in Chemistry, Physics, Biology and Public Health and Geology, and in those of Mining, Sanitary, Electrochemical and Chemical Engineering and in Option 3 of the Course in Engineering Administration. It includes analytical, physical, organic and industrial chemistry, as well as elective subjects in such specialized lines as gas, oil, air, water, food, sugar and proximate technical analysis and metallography. In all of these subjects classroom instruction is combined with laboratory work. Students in the Course in Chemistry devote, as a rule, more time to these subjects than students in other courses, and their work is, accordingly, somewhat more advanced.

Opportunities for research work under the direction of the instructors in the various branches enumerated above are unusually extensive, and the general and special laboratories are well equipped for advanced work of this character.

The aim throughout all the courses of chemical instruction is to teach the student self-reliance, to inculcate habits of accurate thought and work, and to afford a scientific education that will fit him to cope successfully with new scientific and technical problems.

Subjects 5·00 to 5·99 (see page 66)

INORGANIC CHEMISTRY

Undergraduate Subjects

5·00. Chemistry, Entrance. Lectures, recitations and laboratory given during the summer to cover the entrance requirements in chemistry.

5·01, 5·02. Chemistry, Elementary. The fundamental principles of chemical science and the descriptive chemistry of the more common elements and their important compounds. Students who elect courses in which chemical subjects are continued beyond the first year are given laboratory work in synthetic inorganic chemistry. Students taking other courses study certain special applications of chemistry to engineering problems. Textbooks: For the chemical group only, *Blanchard and Phelan, Synthetic Inorganic Chemistry.*

5·04. Chemistry, Elementary. Covers in abbreviated form the subject matter of 5·01 and 5·02. Textbook: *J. W. Mellor, Modern Inorganic Chemistry.*

5·05. Atomic Structure, Elementary. A non-mathematical presentation of modern views on this subject.

5·061, 5·062. Inorganic Chemistry. Presents the physical and chemical properties of the elements and compounds. Much time is devoted to recent investigations in inorganic chemistry.

INORGANIC CHEMISTRY

Graduate Subjects

5·07. Inorganic Chemistry, Advanced. 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.

ANALYTICAL CHEMISTRY

(A) Qualitative and Quantitative Division

Undergraduate Subjects

5·10. Qualitative Analysis. Preliminary experiments illustrate principles and give practice in writing equations and in manipulation. The student is required to analyze simple substances and industrial products such as minerals, pigments, slags and alloys. Textbooks: *A. A. Noyes, Qualitative Analysis; Treadwell-Hall, Analytical Chemistry, Volume I.*

5·101. Qualitative Analysis. Similar to 5·10 except for reduction in hours of laboratory exercise.

5·11. Qualitative Analysis. Abridgment of 5·10. For students not specializing in chemistry.

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. Textbooks: *Treadwell-Hall, Analytical Chemistry, Volume II; Hamilton and Simpson, Calculations of Analytical Chemistry.*

5·121. Quantitative Analysis. 5·12 with increased laboratory assignment.

5·122. Quantitative Analysis. 5·12 with increased time assignment for water analysis.

5·13. Quantitative Analysis. Continuation of 5·12. Analysis of silicates, minerals, ores and alloys including electrolytic and electrometric methods, and when possible, an original study of some special analytical problem.

5·131. Quantitative Analysis. 5·13 with decreased laboratory assignment and including some instruction in elementary gas analysis.

5·132. Quantitative Analysis. Abridgment of 5·131.

5·133. Chemical Analysis of Alloys. Analysis of iron, steel, bronze, aluminum alloys and bearing metals. For students in mining and metallurgy (Physical Metallurgy Option) only.

5·141. Analytical Chemistry. A composite course including qualitative and quantitative analysis of the rarer elements; gas analysis (5·31); special methods (5·39); applications of analysis to special industries; specifications and interpretation of results.

5·142. Analytical Chemistry. Continuation of 5·141.

5·16. Analytical Chemistry. Special methods designed for laboratory conditions of the practice school in chemical engineering.

5·18. Qualitative Analysis, Advanced. A study of the reactions of the rarer elements and their detection. Textbook: *Noyes and Bray, Qualitative Analysis for the Rare Elements.*

ANALYTICAL CHEMISTRY

(B) Food and Water Division

Undergraduate Subjects

5·20. Chemistry of Water and Sewage. Chemical examination of potable waters and sewage with lectures on the sanitary significance of the results.

5·22. Water Supplies and Wastes Disposal. Selection and treatment of potable waters and the disposal and purification of wastes. Textbook: *Woodman and Norton, Air, Water and Food.*

5·23. Sanitary Chemistry. Chemical problems in the selection and examination of water; the purification of water supplies and the treatment of municipal and industrial wastes. Laboratory technique of water purification and sewage disposal plants.

5·25. Chemistry of Foods. Analytical methods, fundamental basis of nutrition, extent, character and legal status of food adulteration. Textbook: *Woodman, Food Analysis.*

5·251. Chemistry of Foods. Abridgment of 5·25.

5·26. Food Analysis. Problems in state and municipal food control, systems of food inspection and methods of food analysis.

ANALYTICAL CHEMISTRY

(C) Technical Analysis Division

Undergraduate Subjects

5·30. Proximate Analysis. Examination of alkaloids, asphalts, inks, oils, paints, paper, rubber, soaps, tanning materials, etc. Develops a critical spirit of investigation rather than merely the technique of analytical methods.

5·31. Gas Analysis. The technical analysis of commonly occurring gaseous mixtures and consideration of losses due to waste gases. Textbooks: *Gill, Gas Analysis for Chemists* or *Gill, Gas and Fuel Analysis for Engineers.*

5·33. Study of War Gases. Manufacture and testing of war gases and their absorbents.

5·35. Applied Chemistry. Properties, testing and applications of paints, oils, varnishes, lubricants, wood preservatives, alloys. Boiler scale and corrosion of metals are discussed.

5·37. Chemistry of Road Materials. Application and tests of bitumens, tars, oils, paints and chemicals used in roads and road structures.

5·38. Lubricating and Fuel Oil Testing. Technology and physical and chemical testing of the mineral, animal and vegetable oils, to determine their applicability and safety. Means of detecting adulteration of different oils. Textbook: *Gill, Handbook of Oil Analysis.*

5·381. Oil Testing and Petroleum Refining. 5·38 with increased time assignment for petroleum chemistry and petroleum refining.

5·39. Special Methods. Use of the microscope, polariscope, saccharimeter, viscosimeter, refractometer, turbidimeter, nitrometer, and precision centrifuge.

ORGANIC CHEMISTRY

Undergraduate Subjects

5·41, 5·42. Organic Chemistry I. Discussion of the compounds of carbon, typical methods of preparation, chemical and physical properties of the various classes of compounds, sources and technical preparation of the simpler substances. Textbook: *Norris, Principles of Organic Chemistry.*

5·411, 5·421. Organic Chemistry I. Differ from 5·41 and 5·42 only in the greater emphasis placed upon compounds of military importance.

5·412. Organic Chemistry. 5·413 with one conference-recitation hour per week additional.

5·413. Organic Chemistry. Brief course for students not specializing in chemistry.

5·414, 5·424. Organic Chemistry Laboratory. Ultimate analysis, organic preparations, identification of organic compounds and special experimental problem.

5·415, 5·425. Organic Chemistry Laboratory. Differ from 5·414 and 5·424 in the emphasis placed upon compounds of military importance and in shorter time required.

5·416, 5·426. Organic Chemistry Laboratory. Organic preparations, typical reactions associated with each class of organic compounds and methods for their identification.

5·417, 5·427. Organic Chemistry Laboratory. Differ from 5·416 and 5·426 only in the emphasis placed upon compounds of military importance.

5·418. Organic Chemistry Laboratory. Abridgment of 5·414 and 5·424. For students in Engineering Administration (Chemical Engineering Option).

5·428. Organic Chemistry Laboratory. Abridgment of 5·424 for students in Biology and Public Health.

5·429. Organic Chemistry Laboratory. Abridgment of 5·424. For students in Biology and Public Health, General Science and Electrochemical Engineering.

5·43. Powder and Explosives.

5·431. Organic and Explosives Laboratory. Closely associated with 5·424 but including the analysis and testing of black and smokeless powder, preparation of picric acid, T. N. T., etc.

ORGANIC CHEMISTRY

Graduate Subjects

5·51T, 5·52T. Organic Chemistry II. The important principles of the science are emphasized from a more mature point of view.

5·53. Organic Chemistry III. Topics, varied from year to year, are presented in lectures accompanied by assigned reading and discussion.

5·54T. Organic Chemistry IV. A course in correlation designed to produce a familiarity with the phenomena exhibited by organic compounds.

5·55. Organic Qualitative Analysis. The study of systematic methods for the identification of organic compounds.

5·56. Technical Organic Chemistry. The factors involved in the industrial application of organic chemistry.

5·57T. Chemistry of Dyes.

5·581T, 5·582T. Advanced Organic Laboratory.

5·59. Recent Advances in Organic Chemistry. Offered in alternate years.

PHYSICAL CHEMISTRY

Undergraduate Subjects

5·61T, 5·62T. Physical Chemistry I and II. Topics considered are: Pressure-volume relations of gases; vapor pressure; boiling point, freezing point and osmotic pressure of solutions; molecular and ionic theories; electrical transference and conduction; reaction rate and chemical equilibria; phase equilibria and thermochemistry. Textbooks: *Noyes and Sherrill, An Advanced Course of In-*

struction in Chemical Principles; Sherrill, Laboratory Experiments of Physico-Chemical Principles

5·63, 5·64T. Physical Chemistry III and IV. Continuation of 5·62T. Application of the laws of thermodynamics to the equilibrium of chemical reactions and to the electromotive force of voltaic cells. General principles relating to surface phenomena and to the colloidal state, atomic structure based on the nature of radiations emitted by atoms.

5·681. Physical Chemistry, Elementary. Special topics for students in Engineering Administration (Chemical Engineering Option), Mining and Metallurgy (Metallurgy Option) and Geology.

5·683. Physical Chemistry, Elementary. Special topics for students in Mechanical Engineering.

5·684. Physical Chemistry, Elementary. Special topics for students in Biology and Public Health.

PHYSICAL CHEMISTRY

Graduate Subjects

5·71T, 5·72T. Physical Chemistry. For graduate students who have not had the equivalent of 5·62T. Textbook: *Noyes and Sherrill, An Advanced Course of Instruction in Chemical Principles.*

5·73. Free Energy. Discussion of methods for determining the free energy of substances, and a systematization of such values. Textbook: *Lewis and Randall, Thermodynamics and the Free Energy of Chemical Substances* (for supplementary reading).

5·741, 5·742. Kinetic Theory of Gases, Liquids and Solids. Textbook: *J. H. Jeans, Dynamic Theory of Gases.*

5·75T. Thermodynamics. The principal general equations of thermodynamics from the entropy point of view.

5·76. Thermodynamics and Chemistry. The development of equations for the treatment of chemical reactions and of equilibria in chemical systems. Textbook: *Gibbs, Thermodynamics.*

5·77. Thermodynamics and Chemistry. The phase relations for heterogeneous systems are treated, special attention being given to binary mixtures Textbook: *Roozeboom, Die Heterogenen Gleichgewichte.*

5·78T. Quantum Theory Applications. The historical development and applications of the quantum theory. Textbooks: *Sommerfield, Atomic Structure and Spectral Lines; Crowther, Ions, Electrons and Ionizing Radiations.*

5·79T. Theory of Solutions.

SPECIAL TOPICS IN CHEMISTRY

5·81T. Chemical Literature I. Reading and discussion in German and French.

5·82T. Chemical Literature II. Methods of using the journals, books and indexes.

5·83T. History of Chemistry.

5·842. Optical Methods.

5·843. Engineering Chemistry.

5·851. Methods of Electrochemical Analysis.

5·852. Organic Physical Chemistry. Alternate years. (Not offered in 1929–30.)

5·853, 5·854. Sub-Atomic Chemistry.

5·855. Theories and Applications of Catalysis.

RESEARCH

5·90. The Logic of Scientific Inquiry. 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.

5·911, 5·912. Journal Meeting in Inorganic Chemistry.

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, Organic or Physical Chemistry.

5·96. Thesis Conference.

5·961, 5·962. 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.

5·98. Research. Research for any of the advanced degrees in inorganic, analytical, organic or physical chemistry.

ELECTRICAL ENGINEERING

The instruction in Electrical Engineering aims to give a foundation in those principles of electricity and magnetism upon which rest the development and the advancement of the electrical arts. Coordinated with this instruction in the theory of electricity and magnetism, and enforcing it, are courses on the larger problems of engineering, together with the work in the laboratories, embracing a study of the instruments, methods and plant used in modern electrical engineering practice, special emphasis being laid on a study of sources of error, economy of time and precision of results.

The unusually extensive equipment of the Augustus Lowell Laboratory of Electrical Engineering makes it possible to familiarize the undergraduate student with the various types of apparatus and the engineering methods with which he will be brought into contact in his later professional work, and also affords opportunity for graduate students to carry out original investigations. The latter opportunities are enhanced by the large libraries and research laboratories of the department.

Excursions to important industrial works with which the vicinity of Boston abounds keep the students in touch with present practice in electrical engineering.

In Course VI-A the instruction and experience in shop and office processes and in public utility management are added to the scientific instruction of Course VI.

Subjects 6·00 to 6·99 (see page 66)

6·00. Principles of Electrical Engineering (Electric, Dielectric and Magnetic Circuits). Recitations and problems. Fundamental concepts of electrical engineering and the laws of the electric, dielectric and magnetic circuits. Textbook: *Timbie and Bush, Principles of Electrical Engineering.*

6·01. Principles of Electrical Engineering (Direct-Current Machinery). Recitations and supervised problem work. Mathematical and physical interpretation of the principles underlying the design, construction and performance of direct-current machinery. Textbook: *Langsdorf, Principles of Direct-Current Machines.*

6·02. Principles of Electrical Engineering (Alternating Currents and Alternating-Current Transformer). Recitations and supervised problem work. Mathematical and physical interpretation of alternating currents and alternating-current transformers for power and communications, including single-phase and polyphase alternating currents, vector representation, use of complex quantities, effective values, power, non-sinusoidal waves, series circuits, and the transformer. Textbooks: *Lawrence, Principles of Alternating Currents; Lyon, Problems in Electrical Engineering; Lawrence, Principles of Alternating-Current Machinery; Lyon, Problems in Alternating-Current Machinery, Second Edition.*

6·021. Principles of Electrical Engineering. First half of 6·02.

6·023. Principles of Electrical Engineering. Last half of 6·02 and first half of 6·03.

6·03. Principles of Electrical Engineering (Continuation of Alternating-Current Machinery). Recitation and supervised problem work. Discussion of the different types of rotating alternating-current machinery for the generation and distribution of power. (The transformer is discussedin 6·02.) Text books: *Lawrence, Principles of Alternating-Current Machinery; Lyon, Problems in Alternating-Current Machinery, Second Edition.*

6·031. Electrical Engineering Principles. First half of 6·03.

6·032. Principles of Electrical Engineering. Last half of 6·03.

6·04. Principles of Electrical Engineering. Recitation and supervised problem work. 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. Textbook: *Woodruff, Principles of Electric Power Transmission and Distribution.*

6·041. Principles of Electrical Engineering. First half of 6·04.

6·042. Principles of Electrical Engineering. Second half of 6·04.

6·06. Principles of Electrical Engineering (Electric and Magnetic Circuits). Recitations and supervised problem work. Fundamental concepts of electrical engineering and the laws of electric and magnetic circuits. Textbook: *Timbie and Bush, Principles of Electrical Engineering.*

6·07. Principles of Electrical Engineering (Direct-Current Machinery and Alternating Currents). Recitations and supervised problem work. Principles underlying the construction and performance of direct-current machinery, and an introduction to the theory of alternating currents. Textbooks: *Langsdorf, Principles of Direct-Current Machinery; Lawrence, Principles of Alternating Currents; Lyon, Problems in Electrical Engineering.*

6·08. Principles of Electrical Engineering (Alternating-Currents and Alternating-Current Transformer). Recitations and supervised problem work. Theory of single and polyphase alternating-currents and of the alternating-current transformer. Textbooks: *Lawrence, Principles of Alternating Currents and Principles of Alternating-Current Machinery; Lyon, Problems in Electrical Engineering and Problems in Alternating-Current Machinery, Second Edition.*

6·09. Principles of Electrical Engineering (Alternating-Current Machinery and Electric Transmission). Recitations and supervised problem work. Continued study of alternating-current machinery and problems involving local distribution networks carrying heavy currents. Textbooks: *Lawrence, Principles of Alternating-Current Machinery; Lyon, Problems in Alternating-Current Machinery, Second Edition.*

6·121. Principles of Electrical Engineering (Alternating-Current Theory). Recitation and problem work on alternating-current theory, including vector representation, use of complex quantity, vector values, power, impedance, react-ance, parallel and series circuits, single-phase and polyphase currents. Textbooks: *Lawrence, Principles of Alternating Currents; Lyon, Problems in Electrical Engineering.*

6·122. Principles of Electrical Engineering (Electrical Machinery). Recitation and problem work. Theory and operation of transformers, alternators, alternating-current motors, synchronous converters, and direct-current machines. Electrical principles are discussed in connection with the operation of the above electric machinery, rather than in connection with design. Textbooks: *Lawrence, Principles of Alternating-Current Machinery; Langsdorf, Principles of Direct-Current Machines; Lyon, Problems in Alternating-Current Machinery.*

6·123. Principles of Electrical Engineering (Transmission of Electrical Power and Communication). Recitations and problem work on the principles underlying high and low tension transmission and distribution of electric power; the fundamental theory of electrical communications, together with their applications to railroad signals, telegraph and telephone.

6·20. Power Transmission Equipment. Construction and characteristics of the equipment employed in the transmission of electric power and application to transmission line design.

6·21. Industrial Applications of Electric Power. Lectures on engineering electricity in industry with the aim to establish scientific bases for applications to motor drives, electric heating, electric lighting, load cycles and their connection with the economical use of electric power. Problems involving duty cycles, handling of materials, machining metals and electric furnaces and ovens are used to illustrate these features.

6·221. Central Stations. Lectures dealing with thermal principles and economic considerations influencing the generation of electric power. The generating station is studied with regard to those factors which influence the energy consumption 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; study of load curves; and analysis of the cost of electric energy.

6·222. Central Stations. Lectures dealing with the theoretical electrical principles and economic considerations influencing the generation of electric power. The generating station is studied as regards influence of bus layout and reactor location on synchronizing power, limitation of short circuits currents, maintenance of bus voltage and transfer of power under normal 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 for the electrical equipment; factors influencing selection of electrical equipment.

6·23. Electrical Equipment of Buildings. Lectures on the design of electric wiring, lighting and elevator systems for buildings. Textbook: *Cook, Interior Wiring.*

6·241, 6·242. Electric Railways. An introductory course of lectures and recitations covering the application of electric power to local and trunk line transportation. Essential calculations are made, such as speed-time curves, energy consumption and simple distribution layouts. Various systems, service requirements and existing electrifications are also discussed from economic and engineering viewpoints.

6·251. Electric Machinery Design. Direct-current and induction machines. Materials of construction, methods of construction, and the influence of the various factors of design on manufacture and operation of machines are considered.

6·252. Electric Machinery Design. Design of transformers and synchronous machines, primarily a continuation of 6·251 but also complete within the term.

6·27. Illumination. Lectures and discussions, dealing with production measurement and utilization of light together with a survey of the bearing of lighting on industrial production, sanitation and factory welfare, industrial codes, street lighting and headlighting. Textbook: *Cady and Dates, Illuminating Engineering.*

6·281. Principles of Wire Communication. The problem of transmission over long lines with distributed constants in the steady state, including composite and loaded lines. Exchange area and toll transmission, repeaters, balancing networks, elementary filters and carrier telephony.

6·282. Principles of Radio Communication. Elementary theory underlying radio communication. Circuits under free and forced vibrations are discussed with special emphasis upon their applications to radio. High-frequency power sources are described and some attention is given to the thermionic oscillator as a power source. Modulation, demodulation and amplification by present methods are studied in some detail. Some time is spent on general applications of thermionic tubes.

6·29. Storage Batteries. Theory, construction, care and application of storage batteries. Fifteen lectures. Given in one term of fourth year if applied for by six or more students.

6·301. Principles of Electrical Communication. Principal systems of telegraphy, telephony and radio in practical use with reference to the principles and modes of operation.

6·302. Principles of Electrical Communication. Some time is spent on general network theory including communications transformers, equivalences among three terminal networks, and electrostatics. The subject of units is considered in preparation for the remainder of the term's work which is on the general subject of ionic conduction.

6·311. Principles of Electrical Communication. General treatment of the principles of ionic conduction in gases and in vacua. A comprehensive study is made of the characteristics of thermionic tubes and of gaseous conduction tubes in use today with special emphasis upon their engineering applications and limitations as circuit elements. The work includes a consideration of networks containing such circuit elements as a part.

6·312. Principles of Electrical Communication. Alternating currents steady state transmission over uniform unloaded and loaded lines. Wave propagation over transmission conductors and in free space. Concept of electric wave filter operation in the steady state. A brief theoretical consideration of skin effect. Radiation from simple antenna systems.

6·330. 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. Offers problems in the manipulation and study of various apparatus involved in communications measurements with the purpose of intimately associating theoretical deductions with actual observations upon which they are based and of stimulating the student toward an appreciation of the value of creative experimental investigation. The work includes bridge measurements, vacuum tube measurements and artificial line measurements including those at radio frequencies. Textbook: *Communications Laboratory Notes.*

6·40. Elements of Electrical Engineering. Recitations and problems. Applications of the general principles of the electric and magnetic circuit to the generation, distribution and utilization of direct and alternating-current power. Textbook: *Hudson, Engineering Electricity.*

6·41. Elements of Electrical Engineering. Recitations and problems. Applications of the general principles of the electric and magnetic circuit to the generation, distribution and utilization of direct and alternating-current power. Textbook: *Hudson, Engineering Electricity.*

6·42. Elements of Electrical Engineering. Recitations and problems. 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. Textbook: *Hudson, Engineering Electricity.*

6·43. Generation and Distribution of Electric Energy. Lectures and problems dealing with the thermal, economic and electric principles of electric generating stations, the electric principles and economic considerations affecting the distribution of electric energy and an analysis of the cost of electric energy.

6·44. Electric Transmission and Control. Lectures and problems. Theoretical principles and economic considerations influencing the transmission of electrical energy. The effect of hydro-electric generating equipment on the power limits and stability of the transmission system.

6·451, 6·452. Alternating Currents and Alternating-Current Machinery. Principles of alternating currents and alternating-current machinery with special reference to mechanical and naval problems. Given especially for students in Course XIII-A and adjusted each year to meet the requirements of these students. Textbooks: *Electrical Engineering* (1925), *C. V. Christie, Reference Book; A Course in Electrical Engineering, Vol. II, C. L. Dawes.*

6·46. Industrial Applications of Electric Power. Similar in material to 6·21, but with considerably less outside preparation required.

6·501, 6·502. Electrical Engineering Seminar. 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.

Much attention is given to the reactions observable between scientific discoveries and the practice of design, manufacture, operation and management and also the reactions observable between scientific and social development.

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 Circuits. Methods of solving problems concerning power networks. The theory of multi-circuit transformers. Treatment of unbalanced circuits by the method of symmetrical components with applications. The introduction and effect of harmonics with particular reference to the harmonics caused by transformers. A comprehensive graphical treatment of transmission systems, particularly in a steady state. Textbook: *Dahl, Electric Circuits — Theory and Applications, Vol. I.*

6·512. Electric Circuits. The problem of the maintenance of synchronism in, and the behavior of the machines connected to, a transmission system during disturbances. A comprehensive exposition of analytical and graphical methods for the determination of power limits and stability. Analysis of transients in lumped circuits with constant and variable parameters. Discussion of some of Heaviside's, Wagner's and Carson's formulas. Traveling waves on lines, over-voltage due to surges, reflections at junctions and terminals, and other matters relating to transients on long lines. Textbook: *Dahl, Electric Circuits — Theory and Applications, Vol. I.*

6·513. Electric Circuits. Transient stability of power systems during disturbances. The point-by-point method of analysis. Discussion of methods for improvement of stability, such as recent developments in exciters, improved control of exciter circuits, etc. A comprehensive analysis of transients in lumped circuits with variable parameters (for instance, circuits containing iron, circuits in which arcing occurs during switching, etc.) Discussion of some of Heaviside's, Wagner's and Carson's formulas and of certain traveling-wave problems which have not been treated in preceding courses in electric circuits.

6·521. Advanced Alternating-Current Machinery. Application of the method of symmetrical phase components to the study of synchronous and induction machines when operating in the steady state under unbalanced conditions. Determination of the heat loss developed in conductors embedded in slots when carrying alternating currents. The effect of stranding and of special shapes of conductor.

6·522. Advanced Alternating-Current Machinery. Application of harmonic analysis to synchronous and induction machines, particularly in regard to the distribution of flux in the air gap and its effect upon the generated e.m.f., the power developed, the iron losses and in causing vibration. Behavior of alternating-current machines in the transient state under both balanced and unbalanced conditions. The effect of sudden changes in the terminal potential, such as produced by short circuit. Also the effect of sudden changes in the load torque.

6·531, 6·532. Organization and Administration of Public Service Companies. Lectures associated with a large amount of reading, studying of financial and operating statistics and forms of organization, and further associated with written dissertations by the students on important topics. The characteristics of corporations, their utility to society and the reasons for adopting this form of organization for public service companies. The general problems of the public service companies of various classes, including their best internal organization; the comparative features of operating companies and holding companies; the financial conditions in public service companies compared with those in ordinary businesses with which the general public is more familiar; the relations of assets; the turnover of capital, risks in the business, and available rewards to owners and employees; rates of charge for service, valuation of property, limitations on rate of return to capital, the relation of financial reserves to investment in plant; the influence of the character of the organization and its personnel on economics of operation, on excellence and reliability of service, the duties of public utility companies and their public relations.

The intention is to give the students a knowledge of the characteristics of and the place held in the national life by public service companies, to the extent needed by electrical engineers and others who have to do with engineering and administration in association with such companies.

6·541, 6·542. Power Generating Stations. 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 operating conditions as influenced by the bus layout of the generating station; principles of relay characteristics and their selection and applications within the station.

The theoretical work is supplemented by studies of electric power generating station practice with regard to physical layout of the electrical bay of the generating station with three phase and isolated phase arrangement; layout and design of cell structure for electrical equipment; layout of turbine and boiler plant.

6·551, 6·552. Railroad Electric Traction. Aims to give thorough technical grounding in the fundamentals of railroad electric traction, with sufficient economic background to insure an appreciation of transportation in general and electrification in particular. Stress is laid on current developments at home and abroad.

The subject covers the equipment, operation and mechanical design of rolling stock; energy consumption and economy; study of distribution systems; preliminary estimates and proposition work involving the application of the principles discussed throughout the year. Specialized details of design are necessarily omitted.

6·561, 6·562. Principles of Electrical Communications. The first term covers the theory of electric filters, their design and application. Some time is spent introducing the subject in order to emphasize general network theory and to show the relation of such filters to their parallels in acoustics and optics.

The second term covers the more advanced study of electron tubes and their association with electric circuits and apparatus. Emphasis is placed upon the graphical solution of certain typical problems.

6·57. Illumination. Reading and discussion of advanced problems.

6·58. Operational Circuit Analysis. A study of the fundamental properties of circuits by means of the Heaviside Operational Calculus. The substantiation of this method by classical analysis, especially by the Fourier Integral. Special circuit problems such as that of traveling waves on transmission lines. Textbook: *Bush, Operational Circuit Analysis.*

6·651, 6·652. Electric Power Distribution. The theoretical and economical principles of electric power distribution and the systems which are used for the purpose. The distribution system is studied relative to the limitation of short-circuit currents, maintenance of voltage, general theory of short-circuit and power transients, and the control and transfer of power. Secondary distribution networks are studied relative to the division of load between transformers, transformer spacing, and the various types of alternating-current and direct-current systems. The economic considerations of distribution systems and secondary networks are studied relative to the effect of load characteristics such as demand diversity factors, load density, increase in load, transformer and sub-station location and capacity, conductor size and system peaks. The theoretical principles of relay selection and application are studied. The structures of typical schedules of rates of charges for electric service are analyzed.

6·661, 6·662. Principles of Electric Machine Development. Design of direct-current and alternating-current machines. The fundamental principles of the magnetic circuit, the circuits of heat flow and of air flow as exemplified in such machines. Predetermination of characteristics. The relation of changes in design to changes of the inductance of machines, and of the starting and pull-out torques of motors. The effect of shape of the pole face in alternating-current and direct-current machines. Methods of applying machine characteristics to the calculation of short-circuit currents. Flux Plotting. Methods of predetermining losses. Special construction to minimize losses. Special types of armature and field windings of direct-current machines (interpole windings, pole face windings, multiplex windings, and other special windings). Commutation. Regulation. Speed variation in motors. Various formulas are compared, their derivation studied, their agreement with tests investigated and rational improvements analyzed.

6·70, 6·71, 6·72. Electrical Engineering Laboratory. Study of technical electrical measurements and dynamo-electric machinery. For purposes of administration, the work is divided into two parts: (*a*) Technical Electrical Measurements. — The work in technical electrical measurements consists of ten exercises in the first term of the third year, seven in the second term of the third year. Particular attention is given to tests to determine the character and behavior of the materials of electrical engineering under various circumstances and to the study of electrical measuring instruments. The laboratory exercises are supplemented by a series of conferences in which the general subject of technical electrical measurements is discussed. (*b*) Dynamo-Electric Machinery. — The work in dynamo-electric machinery consists of ten exercises in the first term of the third year, seven in the second term of the third year and ten in the first term of the fourth year. The tests in the third year include the determination of the characteristics, efficiency, regulation and heating of direct-current machinery and transformers. In the fourth year tests for efficiency, heating, regulation and the like are made on alternating-current machines. The laboratory exercises are supplemented by conferences. Preliminary reports are prepared and submitted by students before performing each experiment in the laboratory. Textbooks: (*a*) *Laws, Electrical Measurements; Special Directions for Measurements Division.* (*b*) *Instructions for Students in Electrical Engineering Laboratory, Sixth Edition,* 1929; *Ricker and Tucker, Electrical Engineering Laboratory Experiments, Second Edition.*

6·73. Electrical Testing, Advanced. Opportunity is offered to advanced students to obtain additional training in electrical testing through the solution of special problems selected to meet the needs of the individual student.

6·74. Electrical Engineering Laboratory. The work is laid out in accordance with the needs of the individual student. It covers a variety of special problems on direct- and alternating-current machinery and transformers. Students are encouraged to work out original problems approved by the instructor in charge.

6·75, 6·76, 6·77, 6·78. Electrical Engineering Laboratory. Laboratory exercises devoted to the study of technical electrical measurements and dynamo electric machinery. The subject matter is similar to that of 6·70, 6·71, 6·72. Textbooks: Same as for 6·70, 6·71, 6·72.

6·781. Electrical Engineering Laboratory. A course of twelve experiments in alternating-current machinery.

6·79. Electrical Measurements. Laboratory exercises devoted to the study of the more fundamental electrical and magnetic measurements and including the testing of the various electrical instruments in common use.

6·80. Electrical Engineering Laboratory. Intended for those students who desire to do more than the regularly required amount of undergraduate work in the Electrical Engineering Laboratory. The experiments are arranged to suit the requirements of the individual student.

6·81, 6·82, 6·83. Electrical Engineering Laboratory. Laboratory exercises devoted to the study of technical electrical measurements and dynamo-electric machinery. Similar to 6·70, 6·71, 6·72.

6·84. Electrical Engineering Laboratory. Consists of experiments designed to illustrate the fundamental principles and operating characteristics of direct and alternating-current machinery. Textbooks: *same as in* 6·85.

6·85. Electrical Engineering Laboratory. Eleven exercises designed to familiarize students with the elements of technical electrical measurements and with the characteristics and operation of the ordinary types of electrical machinery. Textbooks: *Ricker and Tucker, Electrical Engineering Laboratory Experiments, Second Edition; Instructions for Students in Dynamo Laboratory, Sixth Edition,* 1929.

6·86. Electrical Engineering Laboratory. Seven exercises similar to 6·85.

6·871, 6·872. Electrical Engineering Laboratory. Twelve experiments designed to illustrate the operating characteristics of the common forms of alternating-current machinery and the execution of some of the more important acceptance tests. Given especially for students in Course XIII-A and adjusted each year to suit their requirements. Textbooks: *Ricker and Tucker, Electrical Engineering, Laboratory Experiments; Instructions for Students in Electrical Engineering Laboratory, Sixth Edition,* 1929.

6·88. Electrical Engineering Laboratory. Study of electrical measurements and the testing of dynamo machinery.

In electrical measurements the students calibrate portable indicating instruments of the types later used in the testing of dynamo machinery. Watt-hour meters and instrument transformers are also calibrated.

In the dynamo machinery laboratory, operating tests are made on shunt, series, compound and interpole motors, on shunt and compound generators singly and in parallel, on the balancer set and the three-wire system. The operating characteristics of the above are determined by means of load and no-load runs. Heat run acceptance tests are made. Transformers, alternators, induction and synchronous motors as well as other types are tested for performance characteristics.

Each laboratory exercise is preceded by a conference, and a preliminary report is prepared by the student. In the final report the student is required to analyze and explain the results obtained in the tests. Textbooks: *Ricker and Tucker, Electrical Engineering Laboratory Experiments; Instructions for Students in Dynamo Laboratory, Sixth Edition,* 1929.

6·89. Electrical Engineering Laboratory. Nine laboratory exercises similar in subject matter to those of 6·85. Textbooks: *same as* 6·85.

6·901 to 6·904. Manufacturing Practice. These numbers cover the manufacturing subjects taken by the coöperative students at the various plants of the General Electric Company. The major portion of the assignments are to the Lynn works and the remainder to the Schenectady, Pittsfield and Erie works of this company. 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.
Foundry Practice.
Standardizing Laboratory and Meter Testing.
Direct-Current Motor Test.
Alternating-Current Motor Test.
Illumination Department.
Transformer Test.
Turbine Test.
Factory Production.
Air Compressors.
Power Plant.
Research in various departments including the Lynn, Schenectady and Pittsfield Research Laboratories.

These courses also include a series of weekly lectures on Manufacturing Methods given by the various heads of departments. Each student is required to submit a report on each lecture and these reports are read by the lecturer and by the English Department of the Institute.

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 6·934. A Public Utility Practice. The courses in Public Utility Practice are given by the Edison Electric Illuminating Company, the Boston Elevated Railway Company and Stone & Webster, Inc. The various departments to which the students are assigned are listed below in the approximate order in which the work is given.

Edison Electric Illuminating Company of Boston

Maintenance of Line Departments.
- Repair and Testing of Transformers.
- Locating and Repairing Trouble in Low and High Tension Lines, both Overhead and Underground.

Standardizing and Testing Departments.
- Standardizing the various types of Electrical Equipment.
- Steam and Chemical Tests.
- Electrical Tests on Power House and Substation Equipment.
- Transmission Lines and Electrical appliances of all kinds.

Steam Division of Generating Department.
- Boiler Room, Repairs, Firing, Tests, Turbine Work and Operating.

Electrical Division of the Generating Department.
- Operating and Repairing Electrical Generating Equipment.

Sales Department.
- Office Methods.
- Rate Computing.
- Power Estimating and Commercial Engineering.

Installation Department.
- Testing and Repair of Meters.
- Maintenance of Street Lighting System.
- Installing and Maintaining Service to Customers.

Supply Department.
- Purchasing, Receiving, Inspecting and Shipping.

Electrical Engineering Office.
Scientific Research and Study covering the many Public Utility Problems.

Boston Elevated Railway Company

Department of Rolling Stock and Shops.
- Car House Pits.
- Rapid Transit Shops.
- Armature Shop.
- Machine Shop.
- Truck Shop.

Maintenance Department.
- Engineering Division.
- Architectural Division.
- Everett Car Shop.
- Tie Plant and General Yard.
- Accounting and Inspection.
- Surface Lines Division.
- Repairs, Installation and Welding, etc.
- Rapid Transit Lines.
- Track, Steel Maintenance and Erection Division.
- Signal Division.
- Building Division.

Transportation Department.
- Switchman, Conductor, Motorman.
- Time Table and Traffic.

Power Department.
- Wire and Conduit Division.
- Power Station and Substation.
- Electrical Engineering.

Miscellaneous Work.
- Civil Engineering.
- Mechanical Engineering.
- General Manager's Office.
- Special Work.

Stone & Webster, Inc.

Boston Office.
- Messenger Service.
- Drafting — Electrical, Steel, Mechanical, Concrete and Architectural Drawings.

Construction Department.
- Surveying, Foundations, Concrete Construction, Steel Work, Mechanical and Electrical Installations.

Statistical Department.
- Analyzing and Tabulating Data of Various Construction and Operating Projects.
- Cost Accounting.

Operating Department.
Operation of Gas Plants, Electrical Power Plants, Experience in Boiler House, Generating and Switching Departments.
Special Assignment.
Final Assignment will be in that department of the Company in which the student desires to specialize.

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.

6·931. Public Utility Practice (Stone & Webster). First term's work at the plants of Stone & Webster, Incorporated.

6·932. Public Utility Practice (Stone & Webster). Second term's work at the plants of Stone & Webster, Incorporated.

6·933. Public Utility Practice (Stone & Webster). Third term's work at the plants of Stone & Webster, Incorporated.

6·934. Public Utility Practice (Stone & Webster). Fourth term's work at the plants of Stone & Webster, Incorporated.

6·941 to 6·944. Communications Practice. These numbers cover the Communications work taken by the coöperative students at the various plants and laboratories of the Bell Telephone System. The first assignment is spent in the Western Electric Company's Plant 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 training period 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

The Department aims to prepare men for the following fields of professional work:

Biological Research and preparation for medicine
General Sanitation and Public Health Engineering
Public Health Administration
Industrial Hygiene
Food Technology
Fisheries Technology
Biochemistry and Fermentations

The first two years of the work in this Department are largely devoted to the subjects of mathematics, physics, chemistry and those of general cultural character. A foundation course in Biology is given in the second year. In the third and fourth years the work is largely of an essentially professional character. Special emphasis is laid on the instruction in anatomy, physiology and bacteriology. The distinctly professional subjects fall into three distinct groups dealing with the more important aspects of bacteriology, public health, technology and conservation of foods, and the problems of fermentation and biochemistry.

The aim of the instruction in the lower years is to give a solid foundation; in later years, to develop professional attainment.

The first option, public health, stresses the application of biology and bacteriology to individual and community health. It forms an excellent preparation for the varied and highly technical types of service in the municipal and state departments of health or in the great non-official health agencies; for research or technical positions in laboratories or in the manufacture of biologic products and for teaching. This course is especially recommended as a foundation for the study of medicine and gives excellent preparation for the best Class A medical schools.

A modification of this program with the introduction of engineering subjects has been set up, which 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 supply; the development of engineering projects for securing healthful environment through proper housing; the elimination of dangerous pests; drainage, etc.

The second option, industrial biology, is designed especially for those who wish to enter the broad field of food engineering or fermentation. Rapid development is taking place in fisheries, food preservation and fermentation industries, and bacteriology and biochemistry are essential subjects for men entering these fields. In the curriculum for Option 2, the subjects designated *a* meet the requirements of the fishery industries, while those marked *b* serve to prepare students for technical careers in the fermentation and packing industries in general. In this option, engineering and business subjects may be elected to fit men thoroughly for the industries to be served.

Subjects 7·00 to 7·99 (see page 66)

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. Textbooks: *Textbook of Zoölogy, Galloway and Welch, Fourth Edition.*

7·011. Methods of Teaching General Biology. Designed to give a fundamental knowledge of biology as illustrated by the study of a simple plant and animal in contrast with a complex plant and animal. The course will briefly survey the plant and animal kingdoms by the actual study of carefully selected types.

In addition, excursions will be planned to nearby points rich in biological material.

The general plan followed is one which has been used with great success in Boston schools, and is designed especially to give teachers of biology suggestions and specific illustrations of the materials and the methods which have been found most satisfactory in high school teaching. Given in Summer Session only. Textbooks: *Brown, Textbook of Botany, Ginn and Company; Hegner's College Zoölogy, Macmillan*, or any standard college textbook.

7·03. Theoretical Biology. 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. Textbook: *Castle, Genetics and Eugenics.*

7·05. Microscopy of Fibres. A study of microscopic structure and method of identifying the principal textile and cordage fibres of both plant and animal origin. Sectioning, staining and chemical examination is included. Plant fibres especially considered are cotton, linen, sisal hemp, jute and ramie; animal fibres, wool, mohair and silk. Rayon and other artificial fibres may also be studied.

7·06. Botany. Beginning with the lowest forms of vegetable life, the various groups of algae and fungi are systematically studied and afterwards, higher cryptogams. Some attention is also paid to the structure and development of flowering plants. Textbook: *Coulter, Barnes and Cowles, Textbook of Botany, Volume I.*

7·07. Mycology. Many decomposition processes are caused by the attacks of fungi of various kinds. This course provides a brief survey of the principal types of molds and related fungi of technical interest especially in the decomposition of foods, the wet and dry rots of timbers and in the mildewing and weakening of fabrics, or of fibres used in the textile and cordage industries. The isolation of fungi and their cultivation is taught. Experimental studies on mildewing of cotton and fabrics, and on methods for its prevention make up a part of the laboratory work.

7·08. Parasitology. Invertebrate zoölogy with special reference to the parasitic forms and their relation to disease in man and the domestic animals. Lectures with demonstrations. Textbook: *Chandler, Animal Parasites and Human Disease, Third Edition.*

7·09. Parasitology, Advanced. Advanced work in parasitology involving intensive study of some of the more important parasites causing diseases of domestic animals and man. The student will be required to study fresh materials from original sources, the aim being to acquaint him with methods of isolation and investigation which he could apply in problems of this character which might arise in his professional career.

7·10. Zoölogy. A systematic study of the invertebrate animals, considering their form, structure, distribution and economic value. Textbook: *Galloway and Welch, Textbook of Zoölogy.*

7·11, 7·12. Anatomy and Histology. Comparative anatomy of vertebrates, including man, together with the development of the body and the microscopical anatomy of each of the principal organs. An important feature is practice in embryological and histological technique. Each student makes a series of preparations for his own use. Affords a sound basis for the subsequent study of human anatomy, physiology, personal hygiene and public health. Textbooks: *Walter, Biology of the Vertebrates; Kingsley, Guides to Dissection, the Dogfish; Bigelow, Directions for Dissection of the Cat; Lewis and Bremer, Textbook of Histology; Harman, Laboratory Outlines for Embryology.*

7·13. Cytology. For students who have had a laboratory course in histology. May be arranged as a seminar course on special topics in the literature of the subject or as a laboratory course of special methods and research.

7·14. History of Biology. A survey of the development of biology and the principal theories which have led to our present knowledge. The lives and works of the great biologists will be studied chronologically.

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.

7·18. Technical Aspects of Entomology. 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 a 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. Textbook: *Martin and Weymouth, Elements of Physiology* (1928 *edition*).

7·22. Personal Hygiene and Nutrition. 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. Required reference book: *Bulletin* 28, *United States Department of Agriculture, American Food Materials.*

7·23. Applied Nutrition. 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, 7·29, 7·291. Biology and Bacteriology. Deals with the fundamental principles of biology, the behavior of living matter, growth, etc., and the general relation of microörganisms to chemical changes such as fermentation, putrefaction and disease. (Courses V and IX-A in second term have less work in water bacteriology.) Textbooks: *Hilliard, A Textbook of Bacteriology and its Applications; Prescott and Winslow, Elements of Water Bacteriology.*

7·281. Sanitary Biology. Includes a survey of the fundamental principles of biology, and the more specialized study of the microörganisms which are of significance in the examination of water for drilling purposes. Field trips for collection of samples by the use of various types of apparatus and the laboratory technique of water examination are given particular consideration.

7·301, 7·302. Bacteriology. Fundamental work in the biology of the bacteria. The first term is given to general bacteriology with thorough study of selected types. The second term is devoted to special study of the bacteriology of water, sewage, air and foods. Textbooks: *Park and Williams, Pathogenic Microörganisms; Prescott and Winslow, Elements of Water Bacteriology, Wiley,* 1915; *Standard Methods of Water and Sewage Analysis; Standard Methods of Milk Analysis.*

7·31. Bacteriology. Lectures, with conferences and demonstrations presenting the salient facts of structure, distribution and behavior of bacteria, their relation to disease, to water purification and waste disposal, and to problems of food preservation, spoilage, etc., which might be encountered in the administration of military camps and similar operations.

7·321, 7·322. Bacteriology, Advanced. Lectures, seminars and minor research problems involving the more difficult points of bacteriological technique, the study of the metabolism of microörganisms, the theory and practice of testing disinfectants of unusual character, and the study of representative types of the higher bacteria. In general, the subjects are approached from the biochemical viewpoint.

7·33. Plant Diseases. A brief survey of the types of plant diseases of economic significance which are caused by bacteria and fungi.

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 water supply. The work includes sampling at various depths, 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., and the sanitary surveys of watersheds. Textbook: *Whipple, The Microscopy of Drinking Water.*

7·34T. Microscopy of Waters. Laboratory work to illustrate the technic of microscopical examination of waters. Brief discussions of certain aspects of conditions under which various organisms occur, and their significance. Textbook: *Whipple, The Microscopy of Drinking Water, 4th Ed.*

7·35. Planktonology. Takes up a consideration of those animals and plants which drift about in the water, unattached. They are the greatest single source of fish food, either directly or indirectly. The identification, life history and distribution are particularly considered.

7·361. Industrial 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. Textbooks: *Marshall, Microbiology; Blakiston,* 1921; *Fuhrmann, Einfuhrung in die Grundlagen der technischen Mykologie.* Numerous other books for collateral reading.

7·362. Industrial Microbiology. A continuation of the preceding with more detailed laboratory investigation on a semi-commercial scale.

7·371, 7·372. Industrial Microbiology. 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.

7·421, 7·422. Food Fishes. Lectures, recitations or conferences, and laboratory work on economically important fishes and shellfish; including the natural history of food fishes, and their relations to oceanic and fresh-water environment, fishing methods and equipment, and the protection of fishing grounds against pollution and other destructive agencies. In the laboratory, students acquire knowledge of the structure and developmental stages of selected types of fish and shellfish, and practice in determining species. Visits to fish wharves and vessels with taking of notes and writing of reports will form an important part of the work.

7·43. Fish Culture. Two lectures a week on the rearing of fresh water and marine fish, clams, oysters, and lobsters; including methods of taking and fertilizing the eggs, design, construction and management of hatching apparatus, and the care and transportation of the young fry.

7·441, 7·442. Technology of Fishery Products. The methods of handling, curing and preservation of fishery products. Refrigeration, dehydration, salting and canning are studied from the bacteriological, chemical and nutritional aspects. The examination of special processes, of treatment packaging, and transportation, as well as the utilization of by-products will also be considered. Textbook: *Tressler, Marine Products of Commerce, Chemical Catalog Co.*, 1925.

7·50. Infection and Immunity. 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. Textbooks: *Park and Williams, Pathogenic Microörganisms, Lea and Febiger; Hiss and Zinsser, A Textbook of Bacteriology, D. Appleton and Company.*

7·52. Industrial Hygiene. The various prejudicial effects of factory life upon health, including occupational accident, 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. Textbook: *Collis and Greenwood, The Health of the Industrial Worker.*

7·541, 7·542. Public Health Administration. 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.

7·543. Public Health Institute.

7·551, 7·552. Public Health Laboratory Methods. Practical methods in use in state and municipal bacteriological laboratories are considered. Training is given in the cultural diagnosis of diphtheria, examination of specimens for tuberculosis, the Widal reaction in typhoid fever, the microscopical diagnosis of malaria, the Wassermann test, the Kahn test, etc. Textbooks: *Park and Williams, Pathogenic Microörganisms, Lea and Febiger; Hiss and Zinsser, A Textbook of Bacteriology, D. Appleton and Company.*

7·553. Public Health Laboratory Methods. A practical course in diagnostic methods and other procedures employed in public health laboratories. Training is given in laboratory diagnosis of diphtheria, tuberculosis, typhoid fever, malaria, and certain other communicable diseases and in the Wasserman and Kahn tests. This course is valuable for physicians, laboratory technicians and those preparing for administrative positions in public health. Given in Summer Session only.

7·56. Public Health Surveys. A discussion of the methods employed in studying the health of a community, the factors considered and the interpretation of accumulated data. A critical study of well-known surveys will also be made. Textbook: *Horwood's Public Health Surveys.*

7·57. Municipal Sanitation. 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 foodstores and restaurants, control of insects and rodents, ventilation, etc. Textbook: *Ehlers and Steel's Municipal and Rural Sanitation.*

7·58. Vital Statistics. 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. Textbook: *Whipple's Vital Statistics.*

7·601, 7·602. Health Education. 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.

7·603. Health Education Methods. Designed for teachers and for school nurses who have teaching responsibilities. Begins with a brief statement of the organization and administration of school health work, but devotes most of the time to a detailed consideration of the subject matter and procedure in health teaching through the various grades. New methods of health teaching as they have been developed in experimental work by the instructor and by other health workers in various parts of the country will be described. These methods include teaching with the aid of motion pictures, story-telling, scrap books, competitions, weight records, etc. Observation and practice work in the Greater Boston schools will occupy fifteen hours. If this subject is taken for credit no other subjects may be taken for credit simultaneously. Summer Session only.

7·604. School Health Administration. 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.

7·605. Hygiene of the School Child. Presenting the fundamental scientific facts upon which Health Education is based, with consideration of the recent discoveries in nutrition, heleotherapy, the health value of posture and related phases of personal hygiene. Important points in the lectures and assigned reading will be illustrated by laboratory demonstrations, a number of which will be designed with the view of their being repeated in the Health Education classroom of the public schools. If this subject is taken for credit, no other subject may be taken for credit simultaneously.

7·62. Health Surveys and Statistics. A critical examination of the method and content of standard health surveys, with a consideration of community health score cards and suggested satisfactory schemes of organization for municipal health activities. Analysis, discussion and interpretation of the morbidity and mortality statistics of disease, and their relationship to current public health problems. A portion of the work will consist of original problems and reports which will be discussed in a seminar.

7·63. Public Health Field Work. 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. 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. The specialized study of the dangers, and of the principles of industrial hygiene 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.

7·66. Epidemiology. 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, cerebro-spinal meningitis is included.

7·67. Communicable Disease Control. Conferences, chemical and laboratory exercises on the control of the common communicable diseases. A large part of the work is done at the South Department of the Boston City Hospital.

7·68. Pathology. The principles of general pathology, with laboratory studies on prepared slides.

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.

7·711. Technology of Food Products. Detailed discussion of the methods of food preservation and manufacture of special food products. The packing house, flour, fishery, canning, confectionery, and food specialty industries are discussed, from the bacteriological, chemical and nutritional aspects.

7·712. Technology of Food Products. A continuation of 7·711, with laboratory studies on selected phases of certain industries.

7·80. Biochemistry. Primarily a laboratory course with experiments designed to illustrate basic principles of biochemical procedure, as applied in various fields. The laboratory 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. Enzyme Chemistry. Recitations and reports, with laboratory work on quantitative study of enzyme hydrolyses, their products, and the conditions governing activity.

7·90. Biological Literature. Exercises intended to encourage the student in the reading of current biological literature in English, German and French, and to help him acquire facility in preparing reviews of special topics.

7·91, 7·92. Biological Colloquium. A weekly meeting of the staff and fourth year and graduate students. Each student presents from time to time reports of his own investigations or digests of current scientific literature, and receives friendly criticism as to his conclusions or his manner of presentation or both.

7·93. Biological Seminar. Meetings of staff and graduate students for the consideration of current problems in biology and its applications. All candidates for higher degrees are required to prepare digests on assigned topics for presentation and discussion at meetings of the staff and graduate students.

The following subjects are offered as General Studies. For description of courses see Division of General Studies, page 238.

G71. Principles of Biology and Heredity.

G75. Biological Reproduction.

PHYSICS

(Including Theoretical and Industrial Physics and Electrochemical Engineering)

The course in physics is designed to give a sound fundamental training in theoretical and experimental physics intended to prepare such physicists as are needed in educational institutions and in research laboratories of large industries and scientific organizations.

A large proportion of students in physics plan to take graduate work. The facilities for graduate instruction enable them to extend their theoretical, experimental or industrial development in one or another direction, according to their qualifications and desires.

By collaboration with a staff actively engaged in theoretical and industrial physical research, the graduate student is effectively initiated into the method of pursuing a definite research problem, selected as much as practicable along the line of his specialization.

A weekly Physics Seminar keeps undergraduate and graduate students in touch with recent fundamental developments in physics, while acquainting them with current physical literature.

Electrochemical Engineering

The course in electrochemical engineering aims to provide a fundamental training in the principles of electrical engineering together with a broad knowledge of chemistry, upon which as a foundation the more specialized work of theoretical and applied electrochemistry is based. The demand for men with a training along the above lines is steadily increasing as electrochemical and electric furnace operations become more and more general. The large industrial research laboratories also offer excellent opportunities for electrochemical engineers.

The instruction in electrochemistry extends throughout the third and fourth years. A large amount of time is devoted to laboratory work for which purpose two laboratories, established in connection with the Rogers Laboratory of Physics, have been especially equipped for performing all types of electrochemical and electric furnace operations. Owing to the limited capacity of these laboratories, however, the number of students who can be admitted is necessarily restricted. In the senior year students in Course XIV are allowed considerable option in the choice of studies in the Departments of Electrical Engineering, Chemical Engineering and in Metallurgy.

Subjects 8·00 to 8·99 (see page 66)

8·00. Physics (Entrance). Corresponds to the entrance requirements in Physics. Students passing the course are not required to take the entrance examination. No laboratory work will be given. Textbook: *Practical Physics by Black and Davis, Revised Edition.*

8·01. Physics (Mechanics). Lectures, laboratory and recitations devoted to a discussion of the statics of a particle and of a rigid body, the general conditions of equilibrium, composition and resolution of vectors, moments and couples, the kinetics of a particle, laws of accelerated motion, motion of particles in plane curves, motion of projectiles, friction, work, energy and power, angular velocity and acceleration, moment of inertia, dynamics of rotation, elasticity, gravitation. Free use is made of trigonometry and elementary calculus. Textbook: *Mechanics and Light, Drisko.*

8·012. Physics (College Class). Given during the first ten weeks of the first term for the benefit of 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 before transferring. In cases where the previous laboratory training has been sufficient to warrant, the laboratory requirement of this course will be waived. The work includes a discussion of energy and power, angular velocity, angular acceleration, moment of inertia with calculus derivations, universal gravitation, hydraulics, periodic motion, harmonic motion and wave motion. Calculus is used to a considerable extent.

8·02. Physics (Mechanics and Optics). Lectures, laboratory and recitations. The first part of the subject is devoted to a discussion of vibratory and harmonic motion, hydrostatics, hydraulics and wave motion. The latter part is devoted to optics including a discussion of reflection, refraction, total reflection, lenses and mirrors, spherical and chromatic aberration, achromatism, optical instruments, interference, diffraction and the diffraction grating, wave length measurement, radiant energy, spectrum analysis, ultraviolet and infra-red radiation, color, polarization, light production and distribution. Textbook: *Mechanics and Light, Drisko.*

8·03. Physics (Electricity). A quantitative study of Ohm's Law, Joule's Law, electromagnetic induction and the magnetic circuit, galvanometers and meters. Free use is made of the calculus, and many types of problems assigned and discussed. Textbook: *Special Printed Notes and Problems.*

8·034. Physics (College Class). Given during the first ten weeks of the first term for the benefit of 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 before transferring. In cases where the previous laboratory training has been sufficient to warrant, the laboratory requirement of this course will be waived. Among the topics studied are the electrostatic field, capacitance, electromagnetic induction, and the behavior of circuits carrying variable currents. Free use is made of the calculus, and particular emphasis is laid upon fundamental alternating current behavior and simple cases of oscillatory current circuit phenomena.

8·04. Physics (Electricity and Heat). Electricity: 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, pulsating currents, and electronic conduction are discussed. Many problems are assigned for solution.

Heat: The general theory of heat and laws of conduction and of radiation are discussed. Methods of measurement of temperature and other thermal constants are taken up in the laboratory and the lectures, and many important applications to industrial processes are emphasized. Textbook: *Special Printed Notes and Problems.*

8·05. Sound, Speech and Audition. A study of the dynamics of sound, vibrating systems, strings, membranes, pipes, resonators, etc. Also a study of speech and audition.

8·06. Acoustics, Illumination and Color. A discussion of topics 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 course is intended as an introduction to research or thesis work. Textbook: *Goodwin's Precision of Measurements and Graphical Methods.*

8·071. Physical Measurement and Precision. A general discussion of measuring instruments, methods of measurement and interpretation of results.

8·09. Acoustics. Application of mechanics to acoustical systems, a study of problems in sound insulation and architectural acoustics and a brief discussion of speech and hearing. There will be some experimental work in the course.

8·10. Heat Measurements. Laboratory experiments and lectures on heat of combustion, thermal conductivity and temperature measurement.

8·11. Heat Measurements. The theory and practice of heat measurements, particularly for industrial problems.

8·12. Heat Measurements. Enlargement of 8·11.

8·13. Heat Measurements. The various means of measuring temperatures, thermal conductivity of materials of construction, heats of combustion of coals, petroleum and gas will be studied theoretically and by experiments. The effect of radiation in true measurement of temperature and loss of heat from furnace walls will be considered in detail.

8·14. Heat Measurements II. 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.

8·15. Photography. Lectures on the theory and practice of photography with special emphasis on the scientific applications. The first half of the course deals with the sensitometry of negative and positive materials, color sensitivity, graininess, resolving power and other miscellaneous characteristics. The general solution to the tone reproduction problem is indicated. The second half of the course deals principally with applications which include record photography, telephotography, stereoscopic photography, motion picture photography, color photography, photography by infra-red and ultraviolet light and X-rays, aerial photography, the photographic recording of sounds, the transmission of photographs by wire and radio, photosculpture, etc.

8·151. Photographic Laboratory. Laboratory exercises in photographic manipulation, determination of the characteristics of photographic materials, color sensitivity and use of filters, telephotography, microphotography, the making of lantern slides, etc. Open only to students with credit for 8·15.

8·16. Optics Seminar. 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.

8·172. Optics. Lectures covering the fundamental principles of geometrical and physical optics. The subject of geometrical optics is approached from the standpoint of both the designer and the user of optical instruments. The topics considered include the computation of rays calculations of image size and position in thick lens systems, the photometry of optical instruments, entrance and exit pupils and windows, depth of field, monocular and binocular vision and instruments. Under physical optics the topics include the nature of light, refraction, dispersion, interference, diffraction, polarization, photometry, spectrophotometry and color. A few of the more important phenomena in physiological optics are included also.

8·18. Optical Measurements. Laboratory exercises illustrating the principles, methods and manipulation of optical instruments.

8·191. Photomicrography and the Theory of the Microscope. Lectures with laboratory exercises in the theory of the microscope and practical laboratory technique in photomicrography. Open to seniors or graduate students with credit for 8·04.

8·193. Advanced Geometrical Optics. Lectures intended primarily for students intending to specialize in optics. Open only to graduates or to seniors who have previously demonstrated marked ability in this field.

8·194. Advanced Physical Optics. Lectures intended primarily for students intending to specialize in optics. Open only to graduates or to seniors who have previously demonstrated marked ability in this field.

8·20. Electricity. Intermediate work in electricity, in continuation of 8·03 and 8·04. Emphasis is placed on the fundamentals of electrical theory, and the usual theorems of the electrostatic field are developed. A careful study is made of the properties of the electric circuit, including resistance, inductance and capacitance, and relations developed whereby these constants may be evaluated for special cases. Some attention is given to the method of "dimensions" and to the interrelations of the several systems of units. This is followed by a detailed study of the behaviour of circuits carrying varying currents, including an introduction to transmission line theory and allied topics. The remainder of the course has to do with ionic and electronic conduction in gases at low pressures, and various applications to commercial devices. Reference text: *Starling, Electricity and Magnetism.*

8·203. Electricity (Laboratory). A course in intermediate Electrical measurements designed to accompany Course 8·20. Reference text: *Specially prepared Laboratory Notes.*

8·21. Elements of Electron Theory and Electron Apparatus. The fundamentals of the modern theory of electrons are presented, and the varied lines of experimental evidence on which the theory is based are discussed. The latter includes measurement of the charge and mass of the electron, the phenomena of conduction in gases, thermionic emission, photoelectric effects, etc. In the latter part of the course, the various specific tubes which depend for their operation on electron conduction in space are taken up. Textbook: *Crowther, Ions, Electrons and Ionizing Radiations.*

8·212. Gaseous Conduction. The facts and theory of conduction in gases are studied in some detail. Particular attention is paid to the electric arc, the spark, the glow discharge, corona and other cases of engineering importance.

8·22. Introduction to Physical Science. A non-mathematical representation of the methods and ideas of theoretical physics.

8·221. Mechanics and Hydrodynamics. Point mechanics up to and including Hamilton's principle and the canonic equations of motion. The general equations of elasticity and hydrodynamics and their application to vortex-free motion.

8·222. Heat and Kinetic Theory. Heat conduction and the Fourier Analysis; First, Second and Third Laws of Thermodynamics; Introduction to the Kinetic Theory of Gases.

8·231, 8·232. Physics II. The first part includes the theory of heat conduction with a discussion of various initial and boundary conditions leading to solutions in terms of Fourier's Series and Integrals, Cylindrical and Shperical Harmonics. A brief course in Thermodynamics follows, including the First and Second Laws and their application to various problems in Physics and Chemistry, concluding with the subject of chemical affinity and Nernst's Heat Theorem. In the second part (20 weeks) electro-magnetic theory is studied, using vector calculus. The theory is built up on the elementary conceptions of charges and their fields, perfect conductors, dielectrics and currents and their field. The rival conceptions of action at a distance and action from the neighborhood are constantly kept in view. The introduction of an interaction between the electric and magnetic fields leads to the culminating point of the theory; Maxwell's equations and the Lorentz transformation, conservation of energy and momentum are shown to depend on the existence of energy and momentum in the field. Special solutions of Maxwell's equations are then considered, such as those which correspond to charges in uniform and in accelerated motion, to monochromatic and to white light, to reflection and to refraction. The motion of electrons under the influence of electromagnetic waves is shown to explain scattering, dispersion and absorption.

8·241. Electromagnetic Theory. The fundamental ideas of Maxwell's theory, covering the following topics: the electrostatic field, dielectrics, energy and mechanical forces in the electrostatic field, the electric current, the electromagnetic field, induction, the fundamental circuital laws and the Poynting vector.

8·242. Electromagnetic Wave Propagation. A continuation of 8·241 covering: plane waves in isotropic homogeneous dielectrics and in imperfect dielectrics; penetration of electromagnetic waves in metals, the complex Poynting vector and theory of skin-effect; the propagation along parallel wires and cables, general theory of propagation of electromagnetic disturbances and Hertz's solution. Applications to the theories of propagation of electromagnetic waves along the surface of the earth and of radiation from antenna systems.

8·25. Practical Spectroscopy. Instruction will be by lecture and laboratory work ending with simple research problems. The principles, practice and applications of spectroscopy without using advanced mathematics and covering the following topics will be discussed: prisms and grating spectrographs for infra-red, visible, and ultraviolet; their construction and adjustment; interference methods, purification of organic compounds; the analysis and interpretation of their absorption spectra. Emission spectra of elements and compounds in arc and spark; their identification and estimation. Precision wave length determinations. Refractive indices in ultraviolet and photometry of spectra. Textbook: *Baly's Spectroscopy, Longmans, Green & Co.*

8·26. Dielectric and Magnetic Molecular Properties. Molecular explanation of the phenomenological constants of gases and liquids and their dependence on pressure and temperature. Debye's theory of dielectrics, Kerr effect, anomalous dispersion, Born's theory of the migration speed of ions, Langevin's theory of magnetism, the magneton, electrocaloric and magnetocaloric effects and related problems. Textbook: *P. Debye, Polar Molecules.*

8·27. Descriptive Atomic Theory. Contains a description of the various experiments and experimental results which have led to our present theory of the atom. Some ten of the more important experiments are shown as lecture demonstrations. Includes Millikan's work on the fundamental charge, the Brownian Movement, isotopes, radioactivity, the work with α particles, the photoelectric effect and the quantum theory, ionization and resonance potential, line series, X-ray spectra, and the Bohr theory. Textbook: *The Structure of the Atom, Andrade.*

8·29. Lattice Theory of the Solid State. The methods and results of crystallography and the X-ray investigations of crysal structure will be discussed. The following topics will be considered: homeopolar 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. Textbook: *M. Born, Problems of Atomic Dynamics; Atomtheorie des festen Zustandes.*

8·301, 8·302. Atomistic Theories. A comprehensive study of the theories of atomic structure and constitution of matter, including: a systematic development of statistical mechanics starting from the Hamilton canonic equations of motion, a study of ergodic and quasiergodic systems with applications to the classical Maxwell-Boltzmann molecular theory of gases, Boltzmann's H-theorem and the concept of entropy, and an introduction to the quantum theory from the statistical viewpoint. This is followed by a study of the modern theories of atomic structure including the Bohr theory, its accomplishments and difficulties, and the later work of Born, Heisenberg and Schrodinger. The theories of fine structure of band spectra, and of the Stark, Zeeman and Paschen-Back effects are given. Emphasis is laid on the fundamental, philosophical and mathematical methods of attack and not on the descriptive side which is assumed familiar to the student. Reference books: *Cl. Schaefer, Einfuhrung in die theoretische Physik. Bd.* 2; *A. Sommerfeld, Atomic Structure and Spectral Lines.*

8·31. Celestial and Atomic Mechanics. A general introduction to the Hamilton-Jacobi theory and the calculus of perturbations, including: the n-body problem, the Newcomb-Lindstedt and Bohlin expansions of the perturbation function, Poincaré's periodic solutions, and the theorems of Poincaré and Bruns. Next, a brief survey of Bohr's semi-classical atomic dynamics is given, the reasons for its breakdown are discussed and an introduction to the new atomic mechanics of De Broglie, Schrodinger, Born, Heisenberg are given, concluding with a study of the relation between these different theories and the macromechanics of Galileo and Newton. The topics vary considerably from year to year. Reference books: *E. T. Whittaker, Analytical Dynamics; C. V. L. Charlier, Mechanik des Himmels; M. Born, Problems of Atomic Dynamics, and original articles in the literature.*

8·321. Electromagnetic Theory. Similar to 8·241, but with more emphasis on those aspects of the subject which are of interest to the pure physicist. The topics include: the electrostatic field in free space, conductors, dielectrics, magnetic field, induction, Maxwell's equations and special solutions; dispersion, absorption and scattering.

8·322. Introduction to Modern Theoretical Physics. A general introduction to relativity and quantum physics, intended to acquaint the student with the trend of modern physics and familiarize him as much as practicable with current physical literature.

8·33. X-rays and Crystal Physics. Lecture and laboratory work dealing with the theoretical consideration of X-ray emission and absorption and the general properties of the radiations. A considerable portion of the work will be devoted to the consideration of the diffraction of X-rays by crystals.

8·36. Radiation Measurements Laboratory. Aims to familiarize the student with modern instruments and methods for quantitative measurement and analysis of ultra-violet, visible and infra-red radiation.

Determinations of the transmissions of various glasses, analysis of the radiation from such sources as the quartz mercury arc, carbon arc and incandescent lamp will be made by means of the filter-radiometer, radiation potentiometer, and spectro-radiometer, using thermopiles, photoelectric cells, selenium cells, etc.

8·361. Radiation Measurements Laboratory, Advanced. Research problems covering development of new methods of measurement and their use in making radiation analyses.

8·37. General Theory of Radiation. (Offered in alternate years.) Selected topics from the following: Kirchhoff's law, black-body radiation, the pressure of radiation, Stefan-Boltzmann's and Wien's laws, entropy and temperature of a monochromatic radiation, energy-distribution in normal spectrum according to the classical theory and to the quantum theory, pure cavity radiation. Textbook: *M. Planck, Wärmestrahlung.* (Not offered 1929–30.)

8·381. Theory of Relativity. Special relativity, the Principle of Equivalence, Einstein's law of gravitation, Schwarzschild's solution and its consequences, cosmological considerations, electricity and distant parallelism. Textbook: *Mathematical Theory of Relativity, Eddington.*

8·382. Quantum Mechanics. Bohr's theory and its difficulties, wave mechanics with applications to special examples, Zeeman and Stark effect, collision phenomena, the interaction between atom and radiation, Heisenberg's Principle of Indetermination, intensity and selection rules, Dirac's theory of the electron spin, fine structure, Pauli's principle, chemical valency. Attempts at a relativistic theory of quanta. The topics vary from year to year.

8·431. Elasticity and Photoelasticity. The principles of the theory of elasticity are taken up in sufficient detail to give the necessary foundation to those students who wish to continue with laboratory research in photoelasticity or further specialized work in theoretical and applied elasticity. The following topics are covered: the general theory of stress and strain up to the stress equations, and the strain equations in cartesian coördinates, the general Lame stress strain relations assuming the generalized Hooke's law, and their simplification in isotropic solids to the more usual stress-strain relations involving two elastic constants. In the latter part of the term the principles of the photoelastic method of stress analysis are discussed, the apparatus is described and demonstrations of the laboratory technique are given. Textbook: *A. E. H. Love, Mathematical Theory of Elasticity;* Notes supplied for the course.

8·432. Photoelasticity. A combined lecture and laboratory course on the analysis of elastic problems by means of the photoelastic method, based upon the temporary double refraction of transparent materials when stressed. The laboratory work includes the solution of well-known classical problems for instruction in the method followed by original research on particular engineering problems suggested by the students or members of the staff. The problems are discussed from a theoretical point of view in lecture or conference hours.

8·44. Applications of X-Ray and Photoelasticity. A joint lecture and laboratory course in the applications of the X-ray and photoelastic methods of examination of engineering materials and structures. The work in X-rays includes the theory and practice of radiography and crystal analysis. The work in photoelasticity covers the theory and practice of stress analysis by means of polarized light.

8·46. Industrial Radiology. Lectures and laboratory work covering the theory and practice of industrial radiology, including the examination of opaque materials by means of X-rays and the study of the granular and atomic structure of crystals with particular reference to metallic crystals.

8·61. Ceramics. This course is intended as an introduction to the more advanced ceramic courses. 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.

8·63. Fundamental Ceramic Processes. Intended to give a thorough insight into the processes which occur in the manufacture of ceramic articles, with sufficient laboratory work to illustrate principles involved.

8·64. Physical Properties of Ceramic Products. The method of measuring the physical properties of finished ceramic products is taken up, as well as the means for controlling these properties during the manufacture. Typical tests are carried out in the laboratory.

8·70. Physics of Colloids. Covers the mathematical theories of Brownian motion, coagulation, sedimentation, surface tension and absorption. Thermodynamics of colloids, electric charge and stability. Electrokinetic and capillar electric effects. Applications of Debye's Theory of strong electrolytes to colloids. Viscosity and color of sols.

8·801, 8·802. Principles of Electrochemistry. The fundamental principles of physics and physical chemistry underlying electrochemical phenomena are discussed from the standpoint of thermodynamics and kinetics. Particular emphasis is directed to the study of electrical conduction in solutions. The instruction is by lectures, discussions and the solution of problems. Reference text, *Thompson's Theoretical and Applied Electrochemistry.*

8·82. Electrochemistry. 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. Reference: *Thompson's Theoretical and Applied Electrochemistry, and other standard texts, and Scientific Journals.*

8·83. Electrochemistry, Advanced. The mechanism of electrode potential phenomena is studied in detail. This includes the experimental data on overvoltage and the theory of overvoltage; the mechanism of oxidation and reduction potentials; and electrocapillary phenomena and absolute potential. Abstracting and criticizing journal articles on these subjects is included in the assigned work.

8·84. Photochemistry. Elements of the quantum theory of spectra, application of the same to photochemical reactions in gases, liquids and solids, kinetics of photochemical reactions, temperature coefficients of reactions, catalysis, photoelectrochemical reactions, energy relations underlying transformations of radiant and chemical energy. The instruction is by lectures, informal discussion, problems and reports. Textbook: *Special notes.*

8·851, 8·852. Applied Electrochemistry. Consideration of the industrial applications of electrochemistry. The subjects discussed include 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 of the last part of the second term consists in working out the details of design of one or more electrochemical plants for specific processes. Textbook: *Thompson, Theoretical and Applied Electrochemistry.*

8·86. Electrochemical Laboratory. Carried on in conjunction with 8·82. Includes measurements of electrical conductance, single potentials, decomposition voltages, over-voltages, polarization, and practice in electroplating. Textbook: *Special notes.*

8·871, 8·872. Applied Electrochemical Laboratory. Affords practice in the use of various types of electric furnaces together with efficiency tests on their output. Arc, resistance and induction types of furnace are provided. The production of steel, ferrosilicon, calcium carbide, carborundum and aluminum are among the processes studied. Efficiency tests on technical processes involving electrolysis in aqueous solutions are also included, *e.g.*, the production of hypochlorite, chlorate, etc. *Admission limited to the capacity of the laboratory.* Textbook: *Neostyle notes.*

8·89. Electric Furnaces. 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. Descriptive lectures on electric furnace operation accompanied by a selected number of laboratory exercises described under 8·872. Textbook: *Thompson, Theoretical and Applied Electrochemistry and Neostyle notes.*

8·90. 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. The laboratory work consists in the electric furnace experiments of 8·87. Textbook: *Thompson, Theoretical and Applied Electrochemistry.*

8·93. Colloquium. Students present before the class for discussion reviews of current articles on electrochemistry appearing in the English and foreign journals, and memoirs on assigned topics in modern physics and electrochemistry.

8·98. 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. Given during first term, and offered only to fourth-year and special students in Course XIV.

8·99. Physical Instruments. The design, principles and manipulation of instruments used for the determination of measurements of length, weight, density and other physical constants is included in this subject. The special instruments involving optical and electrical applications as especially applied to textile measurements are studied also.

The following subject is offered as a General Study. For description see Division of General Studies, page 238.

G66. Descriptive Astronomy.

GENERAL SCIENCE, ENGINEERING AND MATHEMATICS

Courses IX-A, IX-B, IX-C

General Science IX-A

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 inter-related sciences. There is, also, an opportunity to elect a substantial amount of such humanistic studies as English, Modern Language, History, Economics and Social Science.

It offers, in other words, an opportunity for a broad training in science without sharp specialization. Such a course possesses many advantages in view of the ever increasing inter-relations 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.

General Engineering IX-B

This course is designed to meet the needs of those who desire a training in fundamental engineering subjects, and who either do not wish to specialize in any particular branch of engineering to the extent demanded by one of the regular courses, or who may wish to follow out some line or lines of work not provided for by the schedule of any particular engineering 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.

In all cases the choice of electives must be approved by the committee in charge of Course IX.

Mathematics IX-C

The Institute offers exceptional opportunities for the study of mathematics particularly as applied to scientific and engineering work.

The schedule outlines a course of study leading to the Bachelor's Degree for students who desire to specialize in applied mathematics. It is a course well adapted to serve as a preparation for later specialization in pure mathematics, in mathematical-physics, or along lines of experimental physics or engineering requiring a high degree of proficiency in mathematics.

Considerable latitude in the choice of subjects is provided for in the electives of the junior and senior years in order that the student shall be able to take, if he so desires, a considerable amount of work in general studies, or in scientific and engineering subjects in which mathematics play an important part, in addition to his purely mathematical subjects. For example, he may elect courses in Thermodynamics, Mechanics, Electricity, or in Physical Chemistry.

While a definite schedule for the second year is offered, any student who has completed satisfactorily the work of the first two years in any of the professional courses of the Institute, or their equivalent, provided always that a creditable record has been obtained in mathematics and physics, may be admitted to the work of the third year in this course.

Subjects 9·00 to 9·99 (see page 66)

9·10. Industrial Psychology. The applications of psychology to industrial problems of selection, placement and efficiency of personnel, with some treatment of the psychology of marketing. Given in summer session only.

9·11. Educational Psychology. In addition to a treatment of the customary topics of educational psychology (instincts, intelligence, memory, learning, individual differences, and the like), this course will present the contributions of the newer psychologies, psychoanalysis, behaviorism, and Gestalt. Consideration will also be given to the problems of particular school subjects. Given in Summer Session only.

9·12. Tests and Measurements in Education. This course has a threefold aim: (1) an acquaintance with a wide range of tests of general and specific abilities (including scholastic aptitude or "intelligence" tests, achievement tests in school subjects, special sensory and motor tests and trade tests); (2) a familiarity with the theory and techniques of measurement; and (3) an opportunity for a discussion of experiences and problems in practical measurement. Given in Summer Session only.

9·20. Methods of Teaching General Science in Senior and Junior High Schools. A study of methods of teaching general science to high school pupils. Typical experimental lectures will be given which illustrate the best methods of presenting the subject. Given in Summer Session only.

9·21. Methods of Teaching Physics in Senior High Schools. A study of methods of teaching physics to senior high school pupils. Experimental lectures will be given to illustrate the best methods of presenting the subject matter. Given in Summer Session only.

9·22. Methods of Teaching Chemistry in Senior High Schools. A study of methods of teaching chemistry to senior high school pupils. Experimental lectures will be given to illustrate the best methods of presenting the subject matter. Given in Summer Session only.

9·23. General Science Laboratory. Affords practice in setting up apparatus and performing experiments, such as would be used in a demonstration class in science. Given in Summer Session only.

9·24. Principles of Secondary Education. A study of the principles of secondary education, as they apply to the junior and senior high schools; cardinal principles and their application to curricula, organization, supervision, classroom methods, and teaching technique. Discussion of practical educational problems of the classroom teacher of the junior and senior high schools. Given in Summer Session only.

CHEMICAL ENGINEERING

The course in Chemical Engineering is designed to give the student a thorough foundation in chemistry and in the elements of mechanical and electrical engineering, followed by training in the special field of chemical engineering, *i.e.*, in the solution of the engineering problems of chemical industry. The instruction of the first two years is therefore wholly in other departments, and of the third year mainly so. The professional instruction within the department begins with chemical engineering and industrial chemistry in the third year and is followed by chemical engineering and laboratory work in the fourth.

Because of the composite character of the course, it is impossible to include in the undergraduate instruction material other than the fundamentals required in professional work. On this account, special attention is given to post-graduate courses, and the student who hopes to attain professional leadership should plan for at least one post-graduate year leading to the Master's Degree.

Laboratory instruction in chemical engineering is carried out mainly in the School of Chemical Engineering Practice, located in six industrial plants in Buffalo, New York; Bangor, Maine; Boston, Mass.; and Bayonne, N. J. This school has facilities for only a limited number of students and its privileges are restricted to those whose work at the Institute has, in the opinion of the Department, shown marked promise of professional success. The work of the

Practice School may be taken either as a part of a post-graduate program leading to the Master's Degree (X-A) or as the last part of the undergraduate course (X-B).

The function of the Research Laboratory of Applied Chemistry is to afford special training in industrial research. The student cannot profitably undertake such work without a thorough theoretical foundation. Normally this will require a Master's Degree or its equivalent. The laboratory is able to give financial assistance to a limited number of men of unusual capacity in research.

Students interested in post-graduate work should consult the bulletin on Graduate Study and Research.

Subjects 10·00 to 10·99 (see page 66)

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. A series of reports by the students on the progress of their theses, presented before the rest of the students and the instructing staff.

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.

10·20. Industrial Chemistry. The more important industrial chemical processes, including metallurgy, 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 and one hour a week of memoirs presented by individual students upon important topics. Textbook: *Thorp, Outlines of Industrial Chemistry.*

10·201. Industrial Chemistry. Identical with 10·20 except for omission of memoirs.

10·202. Industrial Chemistry. Identical with 10·20 except that especial emphasis is laid on ordnance and chemical warfare topics, particularly in memoirs.

10·21. Industrial Chemistry. A continuation of 10·20. Devoted to those industries which deal with amorphous solids, including glass, ceramics, leather, paints, textiles, paper, rubber, etc. Textbook: *Thorp, Outlines of Industrial Chemistry.*

10·211. Industrial Chemistry. Identical with 10·21 except that memoir work of 10·20 is included.

10·212. Industrial Chemistry. Identical with 10·21 except that the mechanical operations of chemical industry are taken up in place of memoirs.

10·214. Industrial Chemistry. Similar to 10·21 modified to meet the needs of R. O. T. C. students.

10·22. Industrial Chemistry. Continuation of 10·20.

10·224. Industrial Chemistry. Similar to 10·22 modified to meet the needs of R. O. T. C. students.

10·25. Industrial Stoichiometry. Stoichiometric calculations connected with the processes of chemical industry. The subject matter is an expansion of the problem work of 10·20. Intended especially for college men who have had descriptive industrial chemistry. Textbook: *Lewis and Radasah, Industrial Stoichiometry.*

10·26, 10·27. Industrial Chemical Laboratory. 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.

The process is first examined in the light of available literature, and is analyzed as to the probable factors which enter into its successful operation. Commencing with the preparation of the raw material it is next carried out in a quantitative manner in the laboratory on as large a scale as is consistent with reasonable accuracy and despatch. Each chemical operation is analytically controlled, rapid methods of the requisite accuracy being employed. The physical properties of the solutions, precipitates and final products are critically observed and the choice of the apparatus to be recommended is based upon quantitative experimentation carried out in the laboratory. Finally, each student submits an informal report upon the process and plant, with plant layout and estimate of costs. Questions of labor, depreciation, interest and insurance are discussed in the class, and so far as is possible are involved in the students' reports.

10·28. Chemical Engineering. A study of the thermal properties of matter and the energy relationships underlying mechanical and elementary chemical processes. Emphasis is laid upon the application of fundamental principles to such operations as combustion, heat recovery in both continuous and discontinuous processes, heat engines, compression and pumping of fluids with particular reference to the handling of corrosive substances and to the quantitative phases of applying and dissipating heat in the control of chemical reactions on an industrial scale.

10·29. Chemical Engineering. A continuation of 10·28.

10·30. Chemical Engineering Laboratory. (In effect 1930–31.)

10·31 — 10·36. Chemical Engineering. 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. Throughout the course, emphasis is laid on quantitative relationships and these are illustrated by the solution of numerous problems. Textbook: *Walker, Lewis and McAdams, Principles of Chemical Engineering.*

10·31. Chemical Engineering (Dynamics of Fluids, Flow of Heat, Evaporation and Distillation).

10·311. Chemical Engineering. Similar to 10·31, modified to meet the needs of R. O. T. C. students.

10·32 Chemical Engineering (Humidity, Humidification, Drying and Subdivision, and Separation of Solids).

10·321. Chemical Engineering. Similar to 10·31, modified to meet the needs of R. O. T. C. students.

10·33. Chemical Engineering (Dynamics of Fluids, Flow of Heat, Evaporation and Distillation).

10·331. Chemical Engineering.

10·34. Chemical Engineering (Humidity, Humidification, Drying and Subdivision, and Separation of Solids).

10·341. Chemical Engineering.

10·35. Chemical Engineering.

10·361. Chemical Engineering.

10·362. Chemical Engineering.

10·41 — 10·50. Special Topics in Chemical Engineering. The purpose of each of this group of subjects 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 quantitative study of the basic principles of distillation, as applied to binary mixtures both of complete and limited miscibility and to multicomponent systems. Typical 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 detailed study of the basic principles of drying. Quantitative problems dealing with driers of the rotary, tunnel, loft, compartment and drum types.

10·43. Evaporation. A detailed study of the various factors involved in evaporation, such as heat transmission, entrainment and frothing. Considerable attention is paid to multiple effect operation, both with parallel and reversed flow of steam and vapor. Vapor compression evaporation is also considered.

10·44. Combustion. This subject is offered primarily for students of the School of Chemical Engineering Practice who have completed the field station work. It includes a study of world fuel resources, the production and utilization of natural gas and manufactured fuels, the chemistry of combustion, and the equipment commonly used.

10·45. Mechanical Separation. In addition to studying the usual methods of mechanical separation by filtration, elutriation, flotation, etc., the industrially important methods of fog, mist and fume elimination are considered.

10·46. Extraction. (Gases by Liquids.) 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.

(Gases and Liquids by Solids.) 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. Includes a study of the individual or film coefficients of heat transfer for evaporating, condensing, warming and cooling, followed by application in the design of stills, condensers, heat exchangers, finned surfaces, etc. Special attention is paid to the correlation of data by the methods of dimensional analysis, and to the interrelationships between heat transfer, fluid friction and absorption. For problems involving the batch warming and cooling of solids, the Fourier equations are applied graphically.

10·52. Chemical Engineering II. Offered for graduates of other schools whose training in Chemical Engineering has been along somewhat different lines from that given in 10·31 and 10·32. Emphasis is placed on basic theories in flow of fluids and flow of heat and application is made to problems of an advanced character. Attention is paid to recent developments in Chemical Engineering.

10·53. Chemical Engineering Design. Open only to students who have taken the fieldwork of the School of Chemical Engineering Practice. The problems given involve the design of a complete plant, from the viewpoint of both chemical engineering and economics.

10·54. Economic Balance in Chemical Industry. Lectures and conferences planned to develop original power in the solution of problems in chemical industry. The problems chosen cover a wide range of topics, but in each case the various factors under the control of the designer are analyzed quantitatively, in order to determine the optimum design from the viewpoint of cost and economic return.

10·62. Applied Chemical Thermodynamics. Presents and illustrates those elements of thermochemistry and thermodynamics of most importance in the field of chemical engineering.

10·63. Applied Colloid Chemistry. 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 Laboratory. An opportunity is given to carry out selected experiments. Apparatus is available for surface tension measurements, ultra-microscopic studies, etc.

10·65. Applied Colloid Chemistry. Lectures with extensive collateral reading, involving a thorough review of the fundamentals of colloid chemistry, followed by a study of its applications in various chemical industries. Include the influence of molecular structure and size on the physical and chemical properties of materials; the structure of the liquid, the crystalline and the amorphous states of matter; the characteristics of suspensoids and emulsoids; the phenomena of adsorption, gelation, endosmosis, co-precipitation of colloids, crystal growth, hysteresis and other distortion effects, and the like. Emphasis will be placed upon modern methods of laboratory study and investigation, such as the technique of measuring and controlling ionic concentrations in colloidal systems and the use of X-rays in the determination of molecular structure. Especial attention will be paid to the applications in rubber, textile, paper, leather, glue and similar industries. (Given in Summer Session only.)

10·67. Applied Colloid Chemistry Seminar. Conferences, involving round table discussion of important new developments in Colloid Chemistry of outstanding interest. The topics will be announced in advance and the students will be expected to prepare themselves to take part helpfully in the discussion. (Given in Summer Session only.)

10·68 — 10·79. Special Topics in Industrial Chemistry. The purpose of each subject of this group is to study thoroughly and in detail one special branch of applied chemistry. The aim is to master the fundamental principles and general chemistry underlying the industry and the technique of their application to the solution of its problems rather than the details of plant methods and operations. Especial attention is given to the interrelationships of the industry in question with other fields of chemistry and engineering.

10·68. Corrosion
10·69. Leather
10·70. Sulphuric Acid.
10·71. Glass, Ceramics and Refractories.
10·72. Iron and Steel.
10·73. Starch and Cellulose.
10·74. Petroleum.
10·75. High Pressure Processes.
10·76. Nitrogen Fixation.
10·77. Rubber.
10·78. Interphase Reactions
10·79. Paints, Oils and Varnishes.

10·81. School of Chemical Engineering Practice — Bangor Station. 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 to December and from January to May and may be taken only in conjunction with two of the other field stations.

10·82. School of Chemical Engineering Practice — Boston Station. At the Boston Station 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 South Wilmington plant of the Merrimac Chemical Company which manufactures heavy chemicals, and at the Revere Sugar Refinery, Charlestown, Massachusetts. Offered from July to December and from January to May, inclusive, and may be taken only in conjunction with two of the other field stations.

10·83. School of Chemical Engineering Practice — Buffalo Station. The work at the Buffalo Station deals primarily with flow of fluids, flow of heat and combustion, the work extending over a wide field. Heat balances and efficiency tests are 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, Lackawanna, New York. Offered from July to December and from January to May, inclusive, and may be taken only in conjunction with two of the other field stations.

10·84. School of Chemical Engineering Practice — Bangor Station. Similar to 10·81. Given during the second period of the academic year. May be taken only in conjunction with 10·85 and 10·86.

10·85. School of Chemical Engineering Practice — Boston Station. Similar to 10·82. Given during the second period of the academic year. May be taken only in conjunction with 10·84 and 10·86.

10·86. School of Chemical Engineering Practice — Buffalo Station. Similar to 10·83. Given during the second period of the academic year. May be taken only in conjunction with 10·84 and 10·85.

10·87. School of Chemical Engineering Practice — Bayonne Station. This field station, located at the Bayonne Refinery of the Tidewater Oil Company, Bayonne, New Jersey, is operated jointly with Fuel and Gas Engineering and is open to a limited number of students in the School of Chemical Engineering Practice who wish to substitute it for one of the other field stations, 10·81, 10·82 or 10·83. It includes a study of oil refining methods and equipment by means of investigations dealing with the distillation, cracking and purification of petroleum and its distillates. The plant equipment includes the usual types of stills, fractionating columns, cracking units and accessory heat interchangers and furnaces. Offered from July to December, inclusive, and may be taken only in conjunction with two of the other field stations.

10·90. Experimental Research Problem. 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. Regular conferences are held with research students by the Staff of the Research Laboratory of Applied Chemistry and of the Laboratories of Chemical Engineering in which the work is conducted.

10·93. Automotive Fuels. The course will be divided into three parts, first a brief treatment of petroleum chemistry and description of the principal refining processes; sources of supply, resources and availability of various kinds of automotive fuels. Second, a discussion of the principles of combustion in internal combustion engines, with particular reference to the reactions in cylinders and distributing systems. Among the problems taken up are the influence of volatility in starting and in operation, the physical and chemical properties of fuels to meet specifications, and a study of detonation from a chemical point of view. The third part of the course deals with lubrication and lubricants, including a brief discussion of sources of supply and methods of manufacture. The theories of lubrication of journal bearings are considered.

10·94. Organization and Methods of Industrial Research. The methods of attack used in industrial research are considered. Specific problems of industrial importance are submitted to each member of the class who is asked to outline in detail for criticism of the class the method of attack suggested for its solution.

10·991, 10·992. Seminar in Chemical Engineering. A series of talks by members of the staff and others on timely subjects in chemical engineering.

SANITARY ENGINEERING. XI

(See description under Civil and Sanitary Engineering, page 145)

GEOLOGY

This Department offers courses which lead to the degree of Bachelor of Science in Geology, Master of Science, Doctor of Philosophy and Doctor of Science.

The growth of economic geology is a comparatively recent development. There exists now a broad demand for men who have made a special study of the practical application of geology to metal mining, to non-metallic products like clay and building stone, to petroleum and coal, and to engineering work and hydrology. Such men must have an education in engineering subjects along with their geological training, and it is just this which is provided for in this course. Among its graduates are many of the most prominent practical geologists of the present day.

For a long time there has existed a demand for teachers in the various branches of geology and for those who desire to devote themselves to teaching, the degree of Bachelor of Science in Geology is a stepping stone to the higher degrees necessary for such work.

Mineralogy, petrography, geology in all its branches, including physiography, geological surveying and economic geology, are included in the curriculum. In view of the growing importance of the geology of coal and petroleum special lecture courses are established for this branch of the science. The examination, sampling and valuation of ore deposits are also emphasized.

Ample provision is made for graduate studies for candidates desiring to obtain the higher degrees and for special students. The subjects for this advanced work include microscopic analysis, mineralogy and crystallography, chemical mineralogy, advanced petrography, advanced economic geology, geology of North America and of Europe, geology of Asia, geology of igneous rocks, paleontology and organic evolution.

A beneficial coöperation in graduate studies has been established with the Department of Geology of Harvard University by which advanced students are allowed to attend Harvard courses in subjects not regularly given at the Institute and vice versa. Among such Harvard courses open to advanced students are geometrical crystallography, geology of igneous rocks, physiography and climatology offered, respectively, by Professors Charles Palache, Reginald A. Daly and R. DeC. Ward.

The department offers a number of courses especially designed to meet the needs of students in other branches of science or engineering. Mineralogy, geology, geological surveying and economic geology, and the geology of coal and petroleum are given to students in Course III (Mining Engineering). Short courses in mineralogy and geology are offered for students in chemistry, chemical engineering and metallurgy. Students in civil, sanitary and municipal engineering and building construction take courses in engineering geology. Architectural engineering students study the occurrence of materials of construction. Gas and fuel engineers study the occurrence of coal and petroleum. Physical crystallography is offered for students in physics and metallography. Optical identification of crystalline substances is given to students in chemistry and metallurgy.

In addition to these technical courses three general studies are offered by the department, in economic geography, geology and organic evolution.

Students working for the Doctor's degree in chemistry, physics, biology, metallurgy or mining engineering, may elect a minor in the Department of Geology taking work in mineralogy, crystallography, paleontology or geology.

Subjects 12·00 to 12·99 (see page 66)

12·01. Mineralogy. Principally a laboratory study of about one hundred and twenty of the most common minerals. Textbooks: *Warren, Determinative Mineralogy; Dana, Manual of Mineralogy.*

12·02. Mineralogy. A continuation of 12·01, for students in Course XII and others desiring further work in mineralogy. A number of additional minerals are studied and the elements of crystallography are reviewed. In the lectures the minerals are described and the mode of formation of a number of mineral groups is considered. Textbook: *Dana-Ford, Textbook of Mineralogy, third edition.*

12·03. Mineralogy. Designed as an option for students in Courses V and X and for others desiring a short course in mineralogy. A general determinative study of about sixty common and important minerals. Crystallography is given as part of this subject. Textbooks: *Warren, Determinative Mineralogy; Dana, Manual of Mineralogy.*

12·04. Mineralogy, Advanced. Detailed study of many common and some of the rare minerals by means of optical, blowpipe and other methods. In the lectures and seminar hours the chemical composition of mineral groups is treated. The laboratory work will include the preparation and use of immersion liquids, specific gravity separations, etc.

12·05. Mineralogy, Advanced. A shorter treatment of 12·04. It differs only in that fewer minerals are considered.

12·15. Petrography. Lectures on the occurrence and genesis of rocks of all types and of laboratory work using the polarizing microscope in the study of thin sections of rocks. Supplemented by field excursions to instructive nearby localities.

12·161, 12·162. Petrography, Advanced. Study of selected suites of rocks, reading of petrographic literature, and the preparation of a written report on at least one suite of rocks.

12·20. Optical Identification of Crystalline Compounds. A short course in the identification of crystalline substances with the aid of the polarizing microscope. It prepares the student to rapidly identify crystalline compounds without resorting to chemical analyses. The methods, which have a wide range of application in industrial and research problems, are particularly useful in cases in which chemical methods are not applicable, as in the identification of minute amounts of compounds, and in the accurate identification of each of the individual compounds of intimate mixtures.

12·211. Optical Crystallography. Study of the optical properties of crystals with special reference to the identification of crystals 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. This is a longer treatment than the subject matter given in 12·20.

12·212. Optical Crystallography. Primarily a laboratory course of an advanced character in which the student applies his knowledge of optical crystallography previously acquired in 12·20 or 12·211 to minor research problems in his own special field, or to problems assigned to him by the instructor. The student is largely placed upon his own initiative but his work is directed and advised by frequent conferences with the instructor in charge. The hours of the course are varied to suit the need of the student.

12·22. Optical Ceramics. Primarily a laboratory subject in which the methods of petrography are applied to the study of ceramic products, such as cement, glass, porcelain, chinaware, refractories, tile, terra cotta and brick.

12·25. Physical Crystallography. Emphasis is placed upon the physical properties of crystals as related to crystal structure. The fundamentals of crystallography are first presented from a classical viewpoint. The student becomes acquainted with the concepts of symmetry from brief laboratory work on crystal models and crystal measurement. With this background, the subject of crystal structure is introduced. The remainder of the course consists of a discussion of the various physical properties and their dependence on crystal structure. Among the topics considered are: crystal habit and size, cleavage, cohesion, elastic deformation, recrystallization, twinning, electrical conductivity, crystal optics, and hardness. The theory is illustrated by laboratory work, including the plastic deformation of single crystals.

12·30. Geology. General dynamical geology. Textbook: *Shimer, Introduction to Earth History.*

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. Textbooks: *Shimer, Introduction to Earth History, Pirsson and Knopf, Rocks and Rock Minerals, second edition.*

12·321, 12·322. Geology. Geology adapted to the needs of engineers. Textbook: *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. Field investigation and mapping of assigned areas with research in connected problems. Also excursions to areas of special interest.

12·36. Field Geology. A ten-day summer courses in an area in New Jersey and Pennsylvania where an interesting geological history is presented, and where paleozoic sediments are conspicuously folded and faulted. Instruction and practice is given in detailed geological mapping and in field methods of geological work.

12·37. Field Geology. A short series of field trips to supplement 12·322.

12·38. Physiography. A study of the characteristics and development of land forms and the methods of interpretation of topographic maps.

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 areal and detailed 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. Textbook: *Lindgren, Mineral Deposits, third edition.*

12·41. Economic Geology Laboratory. 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. Considers the application of geology to: prospecting for new orebodies, 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. Laboratory study of specimens or suites of specimens from mineral deposits; metallographic or petrographic work, structural problems.

12·433, 12·434. Economic Geology Seminar, Advanced. Seminar including reading and reports based upon the literature of ore deposits.

12·44. Economic Geology of Fuels. The origin and the geological occurrence and utilization of deposits of natural gas, petroleum and coal.

12·46. Economic Geology of Non-Metallic Deposits. 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.

12·47. Economic Geology of Non-Metallic Deposits, Advanced. Consists mainly of laboratory work on non-metallic deposits.

12·48. Engineering Geology and Hydrology. Relations of geologic processes and structures to engineering problems. Also includes the study of underground waters from the standpoint of the engineer and the geologist.

12·49. Geology of Materials. For students of architecture who have had no previous work in geology. Describes the character and mode of occurrence of materials of construction.

12·50. Historical Geology. An extension of 12·31, including a study of the more common fossils. Textbook: *Grabau, Historical Geology.*

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. Textbook: *Shimer, Introduction to the Study of Fossils.*

12·521, 12·522. Paleontology, Advanced. Consists largely of laboratory work and assigned reading upon some aspect of index fossils, or the evolution of fossil or living forms.

12·53. Index Fossils. The determination of the geologic age of rock formations through a study of their included organic remains. Textbook: *Grabau and Shimer, North American Index Fossils.*

12·54. Micropaleontology. A study of fossil microscopic plants and animals, especially foraminifera.

12·55. Organic Evolution, Advanced. Reading and discussion upon various phases of organic evolution.

12·581, 12·582. Stratigraphy. Consists of lectures, assigned reading and laboratory work on sedimentary rocks. Also the petrographic study of sediments and methods of heavy mineral correlation.

12·60. Structural Geology. A descriptive course in types of structures found in rocks, their mode of origin, and methods of their interpretation. A review is given of the principal views on the major structural elements of the earth, and the evidence for and against such views is presented. Textbook: *Leith, Structural Geology, 1923.*

12·61. Diastrophism and Vulcanology. A descriptive course given in 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 life 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, 12·632. Geological Seminar, Advanced. Reading and reports based upon various phases of geologic literature. For graduate students.

12·64. Geology of North America. The physiography, stratigraphy, igneous bodies and general geologic structures of North America.

12·65. Geology of Europe. Similar in plan to 12·64, but dealing with the continent of Europe. (Offered in alternate years.)

12·66. Geology of Asia. The grand structural divisions of the continent; the stratigraphic sequence; the record of disturbances and the vulcanism; the distribution of economic resources in their relation to structure, time and diastrophic history. The life record of Asia, briefly stated. (Offered in alternate years, not given in 1929–30).

12'80. Geology of Coal and Petroleum. Presents in detail the geological occurrences of petroleum and coal deposits and the methods of investigating petroleum and coal properties.

The following subjects are offered as General Studies. For description see Division of General Studies, page 238.

G60. Geology.

G62. Economic Geography.

G64. Organic Evolution.

NAVAL ARCHITECTURE AND MARINE ENGINEERING

Naval architecture and marine engineering (Option 1) is intended for those who expect to be ship-designers, shipbuilders, or marine-engine builders or who desire to enter allied industries. The special work of the regular course is given in the form of lectures and recitations, and drawing and computation during the third and fourth years.

The option in ship operation is intended for students who wish to enter the fields of ship operation and management or to engage in other maritime pursuits, such as marine insurance, admiralty law, and the various branches of marine transportation. This course is a combination of engineering, economics, and business studies, especially prepared to train men for activities in this field.

The Department also offers a graduate course in Naval Construction (XIII-A) for Naval Constructors of the United States Navy.

Subjects 13'00 to 13'99 (see page 66)

13'01. Naval Architecture. General theory of naval architecture; units of measurement employed, methods of quadrature exact and approximate; principles of flotation, including displacement, stability and trim. Preparation of ship's lines for required conditions. Geometry of ship forms.

13'011. Naval Architecture. Courses 13'011 and 13'021 are abridgments of 13'01 and 13'02 and treat the subject more from the point of view of the ship owner and operator than from that of the designer and builder. General theory of naval architecture; ship forms and coefficients, displacement, stability, trim, rolling and pitching, flooding of compartments.

13'02. Naval Architecture. Continuation of 13'01, including grounding, docking, launching, tonnage, freeboard, steering and theory of sea waves.

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; longitudinal strength.

13'03. Naval Architecture. 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.

13'11. Theory of Warship Design. An historical account and a discussion of the evolution of modern warships. General design comprising the determination of the principal elements of design, stability and behavior in a seaway. Textbooks: *Modern History of Warships, Hovgaard, Spon, London; General Design of Warships, Hovgaard, Spon, London.*

13·12. Theory of Warship Design. Completion of the lectures on general design comprising construction of lines, preliminary weight calculations, watertight subdivision, buoyancy and stability of submarines, troop transports and oil tankers; final weight calculations. Artillery, development, distribution and installation; ammunition; stowage and transport; torpedo and mine installations. Protection against artillery fire, submarine attack and air bombs. Conning towers. Textbooks: *Modern History of Warships, Hovgaard, Spon, London; General Design of Warships, Hovgaard, Spon, London; Speed and Power of Ships, D. W. Taylor, Wiley, N. Y.*

13·13. Theory of Warship Design. Structural design of warships, comprising materials used in hull construction, strength calculations of the entire hull as well as of its various members and a discussion of riveted joints used in shipbuilding. History of development of machinery; preliminary design and installation of boilers, engines and propellers, as far as this work concerns the naval architect; coaling and coal stowage; oil fuel. Rudders and steering gear. Drainage, ventilation and heating of warships. Textbooks: *Structural Design of Warships, Hovgaard, Spon, London; Modern History of Warships, Hovgaard, Spon, London.*

13·14. Theory of Warship Design. Structural design of warships completed, comprising a discussion of the design of the main structural features; plating, framing, decks, bulkheads, stem and sternpost. Anchors and anchor gear; towing and warping gear. Boats and boat handling appliances. Advanced lectures on stresses in gun-turrets; effects of underwater explosions and protection against such attack; strength of submarines. Docking stresses. Riveted joints. Textbook: *Structural Design of Warship, Hovgaard, Spon, London.*

13·21. Warship Design. Construction and fairing of a set of lines from approximate offsets. Calculation of displacement and stability by ordinary methods used in commercial shipbuilding.

13·22. Warship Design. Preparation of a complete preliminary design of a warship.

13·23, 13·24. Warship Design. Preparation of a complete preliminary design of a warship in continuation of 13·22.

13·31. Ship Construction. Yachts and vessels of wood construction; historical and technical development of wood construction as applied to small boats, yachts and merchant vessels.

13·32. Ship Construction. Introduction of iron and steel and development of the metal hull in detail, with special regard to the requirements of the registration societies.

13·33. Ship Construction. Continuation of 13·32 dealing with carpenter and joiner work, plumbing, ventilating, heating and lighting.

13·37. Merchant Shipbuilding. Deals with the design and construction of merchant vessels with special reference to their employment as auxiliaries during war time, and reconditioning for their original work when the war service is completed.

13·38. Shipyard Organization. Division of authority and responsibility of the various officials; their duties and necessary qualifications; the efficient handling of labor and materials; the sequence of work; recording of wages, materials and costs, also methods of estimating costs for tendering.

13.39. Shipyard Practice. Lectures dealing with industrial organization, management, operation, equipment and practice of ship and navy yards as applied to warship construction and repair.

13·41. Ship Drawing. Instruction in the principles of yacht design, drawing and fairing of yacht forms, and in the use of the special drawing instruments. The student is given the opportunity to make a half model of his design of yacht.

13·411. Ship Drawing. Instruction in drawing and fairing lines, layout of midship section from rules of registration societies, structural drawings of ships.

13·42, 13·43, 13·45, 13·46. Ship Design. Further instruction in drawing lines, calculations for displacement, curves of form and stability calculations. Calculation of launching problem, laying out inboard, profile and deck plans, midship section with scantlings. Calculations of weight, trim, strength, etc. Special plans of details. The student is required also to make a half model of this design with such assistance being given as he may require.

13·47. Ship Design. Lectures and drawing-room exercises for students in ship operation. Each student works up the preliminary design of a merchant ship, and determines the dimensions, coefficients, displacement, freeboard, power and propeller requirements, and stability under various conditions of loading. In the drawing room he lays outboard and inboard profile, arrangement plans, etc., and fairs up a preliminary set of lines to meet the requirements 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.

13·50. Marine Engineering. Describes the design of marine engines and boilers with special reference to avoidance of trouble in operation at sea.

13·51. Marine Engineering. An introductory course in Marine Engineering; fuels, combustion, boilers, reciprocating engines, turbines, auxiliary machinery and power plant layouts. Numerous practical problems. Textbook: *Chapman, The Marine Power Plant.*

13·52. Marine Engineering. Consists of part of 13·54.

13·54. Marine Engineering. Includes the determination of stresses and the methods of proportioning the parts of reciprocating machinery. The vibration of ships, balancing of engines, inertia forces and other interesting problems of the marine engine designer are treated. Textbooks: *Marine Power Plant, Chapman. Notes on Marine Engineering. Reference book: Marine Engineering, Peabody.*

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. Computations and drawings are made for parts of a marine engine and a boiler. The design of riveted joints, simple machine parts, choice and advantage of different engineering materials are also discussed. Textbook: *Marine Engineer's Handbook; Sterling.*

13·62. Marine Engine Design. 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, engine balancing and similar marine engineering problems are also treated.

13·63, 13·64. Marine Engineering Design. The calculations for power plants of naval vessels, including boilers, main engines, auxiliaries, propellers and piping systems. The student makes a layout of the machinery arrangement for the warship design prepared in Courses 13·22, 13·23 and 13·24.

13·66. Marine Engineering Design. Calculations for the size of the boilers and auxiliaries of a merchant ship; layout of machinery arrangement and important piping systems; various actual machinery layouts discussed and compared.

13·70. Marine Steam Turbines. Following a brief preliminary résumé of nozzle and blade design, the dimensions of several turbines are computed and the effect of variation in steam conditions is considered. Descriptions of the turbines accompany these thermodynamic calculations. Mechanical features of turbine design such as shaft critical speed, disc wheel strength, and blade strength are discussed. A description of the marine helical reduction gear and turbine auxiliary equipment is also included.

13·72. Marine Diesel Engines. A detail study of Diesel engines and motorship auxiliaries; fuel injection, valve gears, reversing types of engines, Diesel fuels; Diesel-electric drive, the Still engine and calculations for auxiliaries for motorships.

13·81, 13·82. Ship Operation. The engineering and economic aspects of ship operation; 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, economical operation of propelling machinery and auxiliaries at sea and in port; tonnage measurements and maintenance; study of trade routes, cargo movements, and factors influencing ocean freight rates. 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 of ship's 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.

ELECTROCHEMICAL ENGINEERING. XIV

(See description under Physics)

AERONAUTICAL ENGINEERING

The course in aeronautical engineering is designed 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. Following the usual preliminary work in the subjects fundamental to all engineering, part of the time in the third year and most of that in the fourth is devoted to professional subjects, lectures being supplemented by drafting room practice and by laboratory work both in the methods of aeronautical research and in the operation and maintenance of airplanes in the field.

While a graduate in aeronautical engineering is especially prepared for work in the engineering department of a company manufacturing airplanes, the subjects taught are not so specialized as to go beyond the proper and necessary interest of any man entering any part of the aeronautical field. In particular, it furnishes a sound basic training for those desirous of associating themselves with enterprises engaged in the operation of aircraft, whether their primary concern is with the selection of equipment or its maintenance or with traffic management.

Students who are not regularly registered in Course XVI may be admitted to the professional subjects in the course, listed below, only by special permission.

Subjects 16·00 to 16·99 (see page 66)

16·00. Aerodynamics of Airplane Design. Aerodynamic theory as applied to airplane design, including calculations of performance and the study of stability and control. Textbook: *Warner, Airplane Design, Vol. I.*

16·01. Airplane Design. General theory of the design of airplanes, including calculations of stresses and performance and the study of stability and control. Textbooks: *Warner, Airplane Design, Vol. I; Niles, Airplane Design.*

16·03. Airplane Design. General theory of the design of airplanes, including calculations of stresses, and the proportioning of various parts as determined by structural, aerodynamic and practical considerations. Textbooks: *Warner, Airplane Design, Vol. I; Niles and Newell, Airplane Structures.*

16·04. Advanced Airplane Design. Special topics in stability and control and performance calculation, and advanced points in layout of airplanes for specific purposes are considered. Textbook: *Warner, Airplane Design, Vol. I.*

16·06. Advanced Airplane Structures. Examination of new methods in structural analysis and original work on analyses of greater refinement than those ordinarily made. Particular attention is paid to the applications of the generalized three-moment equation, the method of least work and the method of calculating deflections. Textbook: *Niles and Newell, Airplane Structures.*

16·08. Airplane Design Problems. 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.

16·11, 16·12. Airplane Design Practice. Identical with 16·13 but given in two terms. Textbook: *Niles, Airplane Design.*

16·13. Airplane Design Practice. Actual practice in design. Each student carries through the design of a training airplane.

16·14. Airplane Design Practice. A continuation of 16·13 with a more complete study of detail design and with more opportunity for the display of initiative by the student.

16·15. Airplane Design Practice. Actual practice in design for the special needs of naval officers in XIII-A and XVI.

16·16. Airplane Design Practice. A continuation of 16·15, for the special needs of naval officers in XIII-A.

16·21. Airship Theory. A study of the theory of aerostatics and aerodynamics as applied to lighter-than-air craft, including discussion of the properties of aerostatic gases and of the stability and control of airships.

16·22. Airship Design. Theory and practice of the design and construction of airships, including stress calculations. Includes both classroom work and design practice. Textbooks: *Blakemore & Pagon, Pressure Airships; Burgess, Airship Design.*

16·30. Aerial Propellers. Theory and practice of propeller design including the study of propeller stresses. Classroom work is supplemented by actual design practice.

16·35. Aircraft Instruments. Discussion of the use of instruments in the navigation of aircraft, with analysis of the theoretical and practical problems entering into their design. (Not given in 1929–30.)

16·41. History of Aeronautics. History of the airplane and airship, with special reference to the technical development.

16·43. Commercial Aeronautics. A general course in the commercial application of aircraft, taking up the study of passenger and mail lines, local operating companies, and special uses of flying equipment, with considerations of unit costs and revenues, equipment, insurance, regulation and organization.

16·44. Air Transportation. A continuation of commercial aeronautics, specializing in organized, scheduled airlines, taking up general transport and economic principles, and adapting them through detailed analyses to the problems of airplane and airship transportation.

16·48. Aircraft Armament. A general discussion of the types of machine gun, aircraft cannon and bomb releasing gears used on airplanes, together with a general treatment of the theory of sighting and operation of aircraft armament, and in particular of the special equipment necessitated by the difference between the conditions of aerial and ground operation. Open only to officers of the United States Army, Navy and Marine Corps.

16·51. Airplane Laboratory. Devoted to actual work on the assembly, disassembly, alignment, and adjustment and minor repair of airplanes, and to lectures of an introductory nature on the types and general features of typical airplanes.

16·54. Airplane Construction. Lectures discussing the methods used in constructing airplanes, either experimentally or in large production, the tools and other equipment needed, and the estimation of costs.

16·62. Aeronautical Laboratory. 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. 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. Conduct of Aeronautical Research. A continuation of 16·63, devoted chiefly to the design of equipment, the discussion of general research methods, and the planning of the methods of attack on specific new problems.

16·69. Aeronautical Seminar. Intended primarily for students conducting theses in aeronautics. Consists of a series of meetings with discussions of current research work by graduate students and members of the wind tunnel staff.

16·72. Propellers and Airships. A brief discussion of the theories of design of aerial propellers and their application and of the design and construction of various types of lighter-than-air craft. Intended primarily to give students who are prospective airplane specialists a broadened knowledge of the aeronautical field as a whole.

16·76. Aeronautics. Airplane design and the general principles of flight.

16·78. Aeronautics. A comprehensive course containing material on airship design, aerial propeller design and theory, and aeronautical laboratory methods. Intended to be supplementary to 16·76.

16·82. Aeronautical Power Plants. The design and construction of modern aeronautical engines is taken up from the point of view of the airplane designer and operator. Textbook: *Aircraft Power Plants, Jones, Insley, Caldwell and Kohr.*

16·83. Airplane Engine Design. Devoted to a thorough study of the fundamentals of the high speed internal combustion engine and its application to aircraft propulsion. Laboratory work is so planned as to illustrate the principles discussed in the classroom. Textbook: *Engines of High Output by H. R. Ricardo.*

16·84. Airplane Engine Design. Covers the design of the airplane engine and its parts from the theoretical and practical standpoint. The classroom discussion is supplemented by drafting-room practice in which the student carries through the design of a complete aircraft engine.

16·85. Airplane Engine Design Practice. Drafting-room exercises covering certain fundamental problems in aircraft engine design.

16·88. Aeronautical Engine Laboratory. Study of aeronautical engines, laboratory test equipment, and test procedure. Performance tests run on aero engines using different type dynamometers and test equipment. Textbooks: *The Testing of High Speed Internal Combustion Engines, by Judge; S. A. E. Data Sheets and Test Forms.*

16·911, 16·912. Synoptic Meteorology. 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. Decoding and plotting of the daily weather reports broadcast from the Arlington radio station, analysis of weather maps and practice forecasting for selected areas. Also the evaluation of pressure-temperature graphs from upper air soundings.

16·931, 16·932. Dynamic Meteorology. The application of hydrodynamical and thermodynamical methods to the study of the atmosphere in rest and in motion. Although for the sake of practice various disassociated problems will be solved, the course aims to give a quantitative presentation of the general circulation of the atmosphere, based on Margules' conceptions of the source of the kinetic energy of the extra tropical cyclone.

16·941, 16·942. Meteorological Seminar. Twice weekly reviews and discussions of recent meteorological contributions published in current periodicals.

BUILDING CONSTRUCTION

The subject of "Building Construction," included in the schedule for the second, third and fourth years, is an intensive and detailed study of the assembly of the materials of building. Instruction will be given simultaneously with the development of the structure and, in so far as possible, the student will apply the scientific and professional training of the other parts of the Course to the problem in hand.

Subjects 17·00 to 17·99 (see page 66)

17·11. Architectural Forms and Details. Includes instruction, by means of lectures and drawings, in architectural forms, including the five Orders and the characteristic details of the various architectural styles, together with a general review of Architectural History for the purpose of acquainting the student with the architect's language and point of view.

17·12. Architectural Forms and Details. A continuation of 17·11.

17·21. Building Construction. Problem I. Study of Wood Construction. The student draws the plans of a dwelling house, to scale, with principal dimensions indicated. A progressive detailed study is then made of the development of the structure and the assembly of the materials of building in their proper sequence, including excavations; concrete, rubble and block foundations; waterproofing; balloon, braced and veneered frames; stucco; lime and gypsum plaster and plastering, roof framing and roofing materials; chimney design; plumbing, heating, etc. Instruction is given by lectures and demonstration from models and samples, after which the student makes scale details of all the important structural features, embodying materials in general use in dwelling house construction, with an analysis of quantities and costs as applied to the specific problem in hand.

17·22. Building Construction. Problem I. Study of Wood Construction. A continuation of Problem I.

17·31. Building Construction. Problem II. Study of Timber Construction. The same procedure is followed as for Problem I, but with special reference to timber, its growth, properties, shrinkage and preservation; standard and semi-mill construction; the study of timber joints and splices; trusses; heavy timbering and bracing of excavations; wood and steel sheet piling; piles and pile driving; earth excavation, with steam shovel, crane and dragline; brick and brick work and details incidental to mill construction. Field inspections are made as opportunities offer.

17·32. Building Construction and Materials. Problem III. Study of Reinforced Concrete Construction. The same procedure is followed as for Problems I and II, but with special reference to concrete and its use in building, including cements, aggregates and concrete mixtures; steel reinforcements; forms in steel and wood; field methods, equipments and appliances; foundations, walls, floors and roofs; stone and stone work, metal windows and doors, roofing and sheet metal. A thorough study is also made of the physical and mechanical properties of the materials of building.

17·41. Building Construction. Problem IV. Study of Steel Construction. The same procedure is followed as for Problems I, II and III, but with special reference to steel construction, including the study of the manufacture and properties of steel, shop and erection practice, riveting, field methods, derricks, tools and appliances; floor structures and floor finishes; partitions; brick, stone and architectural terra cotta, marble and bronze; also rock excavation, explosives, caissons and pneumatic foundations. Special details relating to banks, theatres, hotels and office buildings.

17·42. Building Construction. Problem IV. Study of Steel Construction. A continuation of 17·41.

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.

DRAWING

The work of this division includes preparation in mechanical drawing and descriptive geometry which leads to the various courses in applied drawing offered by the professional departments.

The course in mechanical drawing is concerned largely with the technique and principles of graphical representation and includes as a basis for the work which follows, practice in accurate penciling, in the inking of instrumental construction and irregular curves, and in lettering and tracing. It also includes practice in making dimensioned sketches from simple machine parts, from which are laid out finished working drawings.

Special importance is attached to the study of descriptive geometry, both as embracing the principles of the graphical representation of objects and the solution of geometrical problems, and as a means of developing the imagination and the power to visualize. Illustrations of the practical application of its principles are afforded by the solution of problems taken from engineering and architectural practice.

Subjects D1 to D99 (see page 66)

D11. Mechanical Drawing. Instruction in the correct use of drafting instruments and materials. Drawings are made in pencil and in ink, on paper and on tracing cloth. Practice is given in lettering. Neatness and accuracy are required. Isometric and oblique projection are included. Textbook: *Mimeograph Notes.*

D12. Working Drawings. Gives the elementary instruction required for the courses in machine drawing. Includes the construction of conics and rolled curves, the making of dimensioned freehand sketches from machine parts and of accurate detail drawings from the sketches. Textbook: *Mimeograph Notes.*

D21. Descriptive Geometry. Short lectures and individual classroom instruction. Especial emphasis is placed upon the ability to visualize the problems and the processes of solution.

Includes a study of the fundamental conceptions of orthographic projection and fundamental problems on lines, planes and solids.

D22. Descriptive Geometry. A continuation of the work of the first term through the more complex phases of the science, including sections, developments, tangent lines and planes, and intersections of surfaces of revolution.

D23. Descriptive Geometry (College Class). Intensive work covering in one term the complete requirement in first year descriptive geometry, open to students transferring from other colleges with advanced standing. Students with failures in descriptive geometry will not be admitted. Textbook: *Kenison and Bradley, Descriptive Geometry.*

D31. Descriptive Geometry. A continuation of D22, providing additional practice and applications and covering in greater detail the study of tangent planes, intersection of surfaces of revolution. Includes some consideration of warped surfaces. Textbook: *Kenison and Bradley, Descriptive Geometry; Mimeograph Notes.*

D311. Descriptive Geometry (College Class). Covers the same ground as D31 and primarily intended for college transfer students of Course I who have taken the College Course (D23) of the first term.

ECONOMICS

In this Department is grouped the instruction given in general economics to students in all courses, and also the more specialized subjects provided for the course in Engineering Administration (XV). All courses, except $XIII_2$, XV and XVII, take political economy (Ec 31, 32) in the third year, and opportunity also is given to select certain general studies in the field of economics.

Students in Course XV begin political economy in the second year, but owing to the requirements of subsequent studies in business economics, devote but one term, instead of two, to this preliminary course.

The courses in Cost Accounting Ec51, Banking Ec37, Statistics Ec65, Corporate Organization Ec56, Corporate Finance and Investments Ec57, Business Management Ec70, 71 and 72, and Business Law Ec61 and 62 are designed particularly for students in Engineering Administration, and should not be applied for without permission of the Department.

Subjects Ec1 to Ec99 (see page 66)

Ec21. Political Economy. Less extensive in its scope than Political Economy Ec31, Ec32. More emphasis is placed upon fundamental principles, and less time devoted to such subjects as money, banking, trusts, labor problems, etc., which are covered by special subjects in Course XV.

Ec31, Ec32. 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. Special attention is given in Ec32 to fundamental business processes including principles of accounting, corporate organization and finance, credit and banking, labor problems and business management.

Ec35. Political Economy. Given for students in Course XIII-A. Covers Ec31 and part of Ec32.

Ec37. Banking. Credit instruments, credit documents, national banks, state banks, trust companies, savings banks, different kinds of loans, securities for loans, credit statements, the bank statement, the money market, relation of the treasury and crop movement to money market, clearing house, domestic and foreign exchange.

Ec45. Industrial Relations. Covers in general the same field as G21, though in somewhat abbreviated form. Special consideration is given to the history of the railroad brotherhoods and to the federal laws applicable to disputes in that industry as well as to its personnel problems.

Ec471, Ec472. Personnel Management. An intensive study of the principles and technique of personnel work, sometimes called human engineering. Particular attention will be given to the problems that arise in practice in recruiting, training and maintaining a labor force. Comparative studies of the different methods and practices in selection, including mental and trade tests; placement, promotion and transfer; education and training; job analysis and specifications; the measurement and control of turnover; regularization of employment; absenteeism and tardiness, and other specific problems will be undertaken. Other topics for investigation will include methods of wage payment; benefit plans, including pensions, insurance and assignment of stock; health and welfare work; housing; labor legislation, including safety supervision and workmen's compensation.

Ec50. Accounting. Systematic and logical recording of financial data is a requisite of modern business. The purpose is accomplished through the mechanism of double entry bookkeeping. But more important than the assembling of such data is analysis aiming toward useful generalizations and conclusions. Analysis of this sort is beneficial for management, stockholders and the general public. Instruction therefor deals with assets and liabilities, balance sheets, profit and loss statements, surplus, depreciation charges, reserves, financial ratios indicating trends and present conditions, and other kindred problems. In so far as possible, cases based upon actual corporation reports and records are studied.

Ec51. Cost Accounting. Methods of determining costs of materials, processes of labor and machines; the distribution of direct costs and overhead expenses; cost data to test management and to show the particular sources of profits or losses; shipping orders; inventories; recording and payment of wages. The development of standard costs as a basis for management and industrial control is emphasized.

Ec521, Ec522. Advanced Cost Accounting. Application of cost accounting principles to specific cases. Special attention given to the cost problems of the particular industries which the individual members of the class plan to enter. Study of some miscellaneous topics entering into the accounting of manufacturing corporations not necessarily directly connected with the computation or application of costs.

Ec53. Building Finance. Describes the financing of new building projects as well as the financing of the building constructor. The topics studied include the valuation of real estate, method of appraisal, depreciation, financing by first and second mortgages, mortgage companies, building and loan associations, construction loans, bank credit and the administration of finance. Special attention will be devoted to those aspects of building finance which are connected with the problem of securing new business for the building constructor.

Ec542. Public Utility Accounting and Analysis. The special accounting problems of gas and electric companies; a study of the figures needed by the operating management of the companies; comparison of the figures of the individual company with those of other companies; the reaction of cost and sales analysis on rates and rate forms; both problems and discussion will be based very largely on actual cases.

Ec551. Public Utility Finance. Lectures, readings and reports on the financial organization and operation of public utilities, with an analysis of their security issues. Attention is given to government control of financing, the analysis of public utility reports, and the market position of utility stocks and bonds. The operations of holding companies and finance companies and their relation to operating companies constitute an important part of the work. Students are advised to register for Ec591 and Ec592. (Not offered 1929–30.)

Ec552. Public Utility Regulation and Rates. The development and evolution of public utility regulation; the various methods of regulation contrasted and compared; the legal foundations of regulation, the legal duties imposed upon public utilities and their legal rights; rates, rate structures and rate control, with much attention to important rate cases; valuation of utility properties and a comparison of the different methods proposed for determining the rate base. These are the more important topics considered in the course. The work will consist of lecturers, assigned readings and reports. Students will devote some time to actual attendance at hearings before the Public Utility Commission. Students are adviced to register for Ec591 and Ec592. (Not offered 1929–30.)

Ec56. Corporate Organization. The organization and control of corporations with some attention to other forms of business. Consideration is given to procedure and problems of incorporation, relationships of the parties in the corporation, and combinations of corporations in our large industrials. Public utility corporations are studied briefly with the purpose of presenting the relations of public service corporations and the public.

Ec57. Corporate Finance and Investments. Covers 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 the methods of the exchanges, brokerage and speculation. Lecturers from investment houses assist in this branch of the subject.

Ec581, Ec582. Financial Administration of Industry. Deals primarily with financial problems of the ordinary sized establishments. The problems covered include: initial working, capital requirements, mortgaging the plant, choice of banking facilities, budgetary control, duties of the treasurer and procedure with relation to bankrupt debtors.

Ec591. Public Utility Management and Finance. Deals with the theoretical and practical phases of public utility management. The subject matter will include a brief study of corporate organization and management in general, followed by the application of the general principles of finance and management to public utility enterprises. Emphasis will be placed upon problems of capitalization, holding company organization and certain phases of accounting which bear upon the financial policies of these companies.

Ec592. Public Utility Management and Finance. A continuation of Ec591 including public relations, rate making, valuation and regulation by commissions. Some attention will be given to analysis of territory served. In addition to instruction by members of the Institute Faculty, a broad range of topics of direct concern to public utilities and to users and refiners of fuels will be covered by lectures by men of special achievement in their several fields.

Ec61, Ec62. Business Law. Deals with the general principles of contract law, special kinds of contracts; bills and notes; agency; corporation law; and partnerships.

Ec63. Business Law and Organization. A graduate study of business organization from both a legal standpoint 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.

Ec65. Statistics. Elementary instruction is given in the construction of statistical tables and charts, official sources of commercial and financial statistics of the United States, and the interpretation of such material. Some attention is given to the statistical methods of forecasting.

Ec661, Ec662. Statistical Methods. Study of the principles and methods used in more advanced statistical analysis. Some of the topics included are correlation of two variables, multiple and partial correlation, simple sampling and the basic theory of probability with special reference to business problems. Determination of historical trends and periodic fluctuations of economic time series will receive attention preparatory to the major problem of business forecasting.

Ec681, Ec682. Business Cycles. A study of recurrent periods of business prosperity and depression and of the theories offered to explain them. Students will examine the factors which must be considered and the statistical methods used in attempting forecasts of general business conditions and of the sales of particular enterprises.

Ec70, Ec71, Ec72. Business Management. Deals with problems of the production and distribution of manufactured goods. Among the more important topics considered are: Organization; plant location, layout and equipment; purchasing; intra-factory transportation; traffic; inspection; stores; design; time, motion and fatigue study; production control; office organization, layout and equipment; commercial research; marketing methods, sales promotion and advertising. As far as possible the practices of production and marketing are studied in parallel, thus emphasizing the development of similar principles of scientific management in both fields.

Ec74. Business Management. Deals with the business aspects of the building industry. The following topics are considered from an administrative viewpoint: organization, estimating, purchasing, contracts, insurance, sales promotion, control of equipment, control of materials, office control, regularization of work, research, coördination of sales, finance and construction programs, organization and management of small construction enterprises, cost accounting and the law of contracts.

Ec751, Ec752. Manufacturing Analysis. (See Graduate Bulletin).

Ec761, Ec762. Marketing of Manufactured Products. A study of the problems concerned in marketing the products of manufacturing industries with special reference to policies and methods. The basic factors of organization, operation and control are discussed. Readings in marketing methods are required as a foundation for a thesis on a specific practical marketing problem.

Ec781, Ec782. Standards of Measurement in Industrial Management. Deals with the selection of suitable standards of measurement for the evaluation of accomplishment and the control of the various functions of management, through the application of the engineering method. Special attention will be given to such topics as the evaluation of manufacturing operations, production and inventory control, economic processes, the choice of manufacturing equipment, the evaluation of performance or aptitude and management ratios. Classroom discussions will be based upon a study of specific problems and the results of original investigations.

Ec80. Ocean Shipping Administration. Deals with the types of ocean services and traffic agencies and their organizations; rate and traffic agreements; ocean shipping documents; ocean rates and regulation; marine insurance; and admiralty law. Its purpose is to acquaint the student with the more important aspects of the business administration of ocean shipping activities.

The following subjects are offered as general studies. For description see Division of General Studies, page 238.

G21. Industrial Relations. **G25. Investment Finance.**

ENGLISH AND HISTORY

The work in English is designed to arouse in the student an interest in the important problems of modern life, and through the interest thus stimulated to train him in oral and written expression. The instruction is given chiefly and in sections which offer frequent opportunity for class discussion and for oral presentation of topics prepared by students. The written work is for the most part in the form of reports, in which emphasis is put on the clearness and accuracy of expression which are essential in the work of a professional man.

The instruction given by the Department in literature and history is planned so that the student may acquire an understanding of the main currents of thought of the last one hundred and fifty years as they have expressed themselves in the events, the institutions, and the literature of that period. Significant works of literature which interpret phases of political, economic and social life are read and discussed concurrently with an historical study of the times. By this correlation of the work in literature and history — on which, as has already been indicated, the work in composition is based — it is hoped that the student may gain a broad and vital comprehension of the main forces working in life and society today.

Subjects E1 to E99 (see page 66)

E1. English (Entrance). For description see entrance requirements.

E11. English and History. Covers European History of the last hundred years and is conducted by recitations and conferences, with oral and written reports.

E12. English and History. A continuation of E11.

E21, E22. English and History. Includes the chief ideas of nineteenth century and contemporary thought, political, social and philosophical, handled in recitation and discussion groups, with required and collateral reading, lectures and written papers. An alternative course on "types of literature" is offered for men properly qualified.

E33. Report Writing. A study of the various types of engineering and business reports. Practice in the investigation of subjects, the arrangement of material, and its presentation in good report form. A secondary part of the subject is practice in the planning and writing of the more common types of business letters.

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 careful 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 as to its soundness and merits. This course consists almost entirely of group work.

E44. Committee Work. The development of coöperative thinking and cultivation of the "group spirit" by means of committee reports on vital and timely subjects, and acceptance or constructive amendment by the class of what each report recommends. Open only to I-A and VI-A.

E45. Business English. A study of the principles of effective, businesslike expression; and practice, both written and oral, in the expression of those principles. Leactures, recitations, business letters, oral and written reports. Open only to I-A and VI-A.

E46. Modern Forms of Literature. A brief study of the various types of contemporary novels, dramas and short stories with view to critical appreciation of these forms of literature. Lectures, discussion and written reports and criticisms. Open only to VI-A.

The following subjects are offered as **general** studies. For description see Division of General Studies, page 238.

G40. Contemporary Drama.
G41. Contemporary English Literature.
G42. Contemporary European Literature.
G43. American Literature.
G46. Public Speaking.
G47. Committee Reports.
G48. Appreciation of Music.
G49. Nineteenth Century Thought.
G50. Fine Arts in Modern Life.
G51. Biography in Science.
G52. Lincoln and the Period of the Civil War.
G55. French Revolution and Napoleon.
G59. Social Problems of Philosophy.

FUEL AND GAS ENGINEERING

This course is planned to afford properly prepared graduates in Engineering and allied fields of Science opportunity to obtain special theoretical and practical training in the processing and utilization of natural and manufactured fuels. Openings for men trained in this field are varied, but most particularly the demand for such men comes from the petroleum, steel, gas and electric power industries. The work consists of one academic year of study at the Institute followed by six months' fieldwork.

The scope of the work at the Institute is indicated in the list of subjects given below. In the fieldwork the theoretical side of fuel and gas engineering studied at the Institute is applied to the processes of gas manufacture and fuel utilization by plant studies and tests on full scale equipment in commercial operation. In general the thesis will be done during this period. The degree of Master of Science in Fuel and Gas Engineering will be awarded upon the satisfactory completion of the work, subject to the general rules for the Master's degree.

Subjects F1 to F99 (see page 66)

F1. Principles of Combustion. Part 1. Combustion calculations dealing with furnaces, kilns, retorts, gas producers and oil-cracking still-settings. The calculation of excess air, volume of air and flue gas, heat and material balances, etc., is thoroughly and quantitatively considered. **Part II.** Study of the principles and laws governing the combustion of coals, fuel oil, natural and manufactured gas. The methods and equipment employed in industrial fuel utilization are described and studied.

F2. Development and Use of Power. Study of gas, electric and steam power and the selection of power equipment for typical conditions met in practice. The different types of steam turbines, the principles and economics of gas and oil engines, the simultaneous production of power and process steam are considered. Intended to give the student a broad vision of the entire field of power development in addition to the more important detailed methods of power application and the limitations and possibilities of the various generating methods.

F3. Furnace and Retort Design. Study of principles and calculations of furnace and retort design and construction, dealing with rates of heat transfer, flow of gases in furnaces and retorts, and construction details. The quantitative design and layout of two or three furnaces, retorts or still-settings will be carried out.

F4. Gas Engine Laboratory. Based on a series of laboratory tests on various types of gasoline and Diesel engines during which the effect of different fuels, carburetion and other variables on operating performance is studied.

F5. Natural Fuels. A study of the origin, composition, classification, production, preparation and refining of the primary natural fuels, especially bituminous and anthracite coal, petroleum and natural gas.

F6. Principles of Fuel and Gas Engineering I. A quantitative study of (1) the measurement and calculations of pressure drop of gases and liquids flowing through pipes, ducts, etc.; (2) the flow of heat in coolers, condensers, heat interchangers, furnace walls; (3) crushing, grinding and sizing of solids. Consists of lectures, problems and conferences.

F7. Principles of Fuel and Gas Engineering II. Continuation of Fuel and Gas Engineering I, dealing with gas scrubbing and absorption, distillation and humidification. These principles will be applied to quantitative study of the unit processes of gas manufacture, petroleum refining and coal carbonization, as well as to the operation of the equipment involved. Studies in economic balance form a part of this subject.

F8. Properties of Materials. Includes a study of the chemical and physical properties of common materials of boiler and furnace construction, such as refractories, insulation, metals and alloys at high temperatures. The corrosion of metals in general and specifically condensers, boilers, stills, heat interchangers, etc., are taken up in addition to allied topics such as water softening.

F9. Manufactured Fuels. Takes up the chemistry, properties, equipment and the factors involved in the manufacture of producer gas, water gas, complete and low temperature gasification of coal, the production of oil gas, etc.

FIELD WORK AND THESIS

The field work consists of plant studies and tests of full-size equipment in commercial operation. The same general methods now in use at the field stations of the School of Chemical Engineering Practice are employed. The field stations are located at Buffalo, Boston, Bayonne and Rochester. At these stations the work is wholly educational and under the direct supervision of the Institute's faculty. In general, training is given in the application of acquired principles to industrial practice.

F10. Field Work and Thesis — Boston and Rochester Stations. The manufacture and purification of coal and water gas is studied at the plants of the Cambridge Gas Light Company in Massachusetts and the Rochester Gas and Electric Company in New York. The great variety of equipment installed in these plants affords opportunity for work on several types of retorts and ovens, dry quenching of coke and numerous types of purification equipment, in addition to studies of gas producers, water gas generators and distribution systems.

Power plant operation is studied at the Edgar Station of the Edison Electric Illuminating Company of Boston which is one of the most modern power stations in the country. This plant was one of the first to adopt the use of high pressure boilers and turbines. The investigations at this station include studies on boilers, turbines, deaerators and feed water heaters. Part of the time at these stations will be devoted to research or investigation which will comprise the student's thesis.

F11. Field Work — Buffalo Station. At the Lackawanna plant of the Bethlehem Steel Company, the use of fuels for power generation, coking of coal, blast furnaces, open hearth and general metallurgical furnaces will be studied. Other equipment at this plant which is available for study includes three types of coke ovens, by product recovery apparatus, reheating furnaces and benzol distillation equipment. A portion of the work at Buffalo will be carried out at the plant of the Iroquois Gas Company where the manufacture of coal gas, blue water gas and high pressure gas distribution will be studied. The plant is equipped with new Woodhall-Duckham vertical retorts, one bench of which is especially designed to permit study of coal carbonization. This plant also affords an excellent opportunity for studying the problems incident to the use of mixed natural, coke oven, coal and water gas.

F12. Field Work — Bayonne Station. The work of this station comprises studies of various types of refining equipment and methods. The Bayonne Refinery of the Tide Water Oil Company is a complete unit for the processing of crude petroleum. An excellent opportunity is afforded for the investigation of the manifold problems involved in the distillation, cracking and purification of petroleum and its distillates. Tests of different types of stills, fractionating columns, cracking units and combustion equipment are carried out in order both to investigate the process and equipment used and to obtain data on heat transfer and similar functions necessary to the design of such equipment. This station is operated in coöperation with the School of Chemical Engineering Practice.

F13. Advanced Gas Engineering. The purpose of this subject is to afford men now engaged in the technical and operating branches of the manufactured gas industry an opportunity to review the subject and to familiarize themselves with recent advances in methods of operation, research and development. Given especially for engineers and chemists employed by New England Gas Companies but is open to others who may be qualified. The work will occupy the entire time during the two weeks.

F14. Applications of Gas to Industry. An intensive series of lectures, laboratory tests, problems and discussions on gas appliances, the purpose being to give the industrial gas engineer or salesman a sufficient review of the theory of combustion and allied subjects so that he will be more competent to select the proper appliances to meet a particular problem. Sponsored by the New England Gas Association and the American Gas Association and open only to their members.

F15. Constitution and Combustion of Fuels. The purpose of this subject is to afford graduates in engineering, physics or chemistry now engaged in industrial work an opportunity to become familiar with current practice in fuel utilization. Includes: (1) A study of the origin, composition, classification, production, preparation and refining of the primary natural fuels; (2) a study of the principles and laws governing the combustion of coal, fuel oil, natural and manufactured gas; (3) consideration of the methods and equipment employed in industrial fuel utilizations.

F20. Seminar in Advanced Furnace Design. 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.

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. Each student is free to elect from among the subjects listed below such as appeal to his particular personal tastes and interests. A considerable variety of subjects is offered, grouped for convenience under the headings: Social, Political, Economic and Business Subjects; Literature, English, History and Fine Arts; Science; Foreign Literature. The list may be modified or extended from year to year.

Students taking Choral Singing G58 who attend regularly throughout the academic year the rehearsals and concerts and meet the tests to the satisfaction of the director may receive credit for four units of general study.

SOCIAL, POLITICAL, ECONOMIC AND BUSINESS SUBJECTS

First Term	Second Term
G21. Industrial Relations.	**G3. International Law and American Foreign Policy.**
G31. Humanics.	**G5. Psychology.**
G59. Social Problems of Philosophy	**G31. Humanics.**
G98. Military History and Policy of the United States.	

SCIENCE

G1. History of Science.	**G2. History of Science.**
G62. Economic Geography.	**G66. Descriptive Astronomy.**
G71. Principles of Biology and Heredity.	**G75. Biological Reproduction.**
G60. Geology.	**G64. Organic Evolution.**
	G76. History of Philosophy.

FOREIGN LANGUAGES

G821. French.	**G831. French.**
G822. French.	**G832. French.**

LITERATURE, ENGLISH, HISTORY AND FINE ARTS

G41. Contemporary English Literature. (Not offered in 1929–30)	**G40. Contemporary Drama.**
G43. American Literature	**G42. Contemporary European Literature.** (Not offered in 1929–30)
G46. Public Speaking.	**G47. Committee Reports**
G48. Appreciation of Music.	**G50. Fine Arts in Modern Life.**
G49. Nineteenth Century Thought.	**G51. Biography in Science.**
G51. Biography in Science.	**G55. French Revolution and Napoleon.**
G52. Lincoln and the Period of the Civil War.	**G57. European Civilization and Art.**
G56. European Civilization and Art.	**G58. Choral Singing.**
G59. Social Problems of Philosophy.	

Subjects G1 to G99 (see page 66)

G1. History of Science. Thirty lectures or other exercises, dealing with the development and decline of Greek science; the transmission of science into western Europe; the science of the renaissance with emphasis mainly on mathematics and the sciences nearly related to it. Textbook: *Sedgwick and Tyler, A Short History of Science*, Chapters I-X.

G2. History of Science. Thirty lectures, or other exercises, dealing with the development of different fields of science. The subjects treated will vary somewhat from year to year, but include such topics as the transition from alchemy to chemistry, and the development of modern astronomical theory, of the theories of natural science and special topics from the history of engineering and industry. Textbook: *Sedgwick and Tyler, A Short History of Science*, Chapters XI-XVII.

G3. International Law and American Foreign Policy. The lectures will be designed to help one to an intelligent understanding of international relations as an American citizen. They will include topics grouped as follows: Great Writers on the Law of Nations, the Birth of International Law, States and Their Recognition, the Entry of America into the Family of Nations, the Monroe Doctrine, and Pan-Americanism; the Territorial Jurisdiction of a State, Ships on the High Seas and in Port, Diplomatic Protection of Citizens Abroad, and Extradition; the American Foreign Service, Treaties and the Procedure of Ratification in the United States; the Hague Conferences, the League of Nations and the Permanent Court of International Justice; Rules of Land, Sea and Air Warfare, Military Government in Occupied Territory, and the Rights and Duties of Neutral States in Time of War. There will be occasional class discussions of related problems. One report for the term will be required on a topic of current international interest based on outside reading and chosen by the student himself, with the approval of the instructor. A few selected reports will be presented orally in the class either separately or as part of a symposium pre-arranged by the instructor. Textbook: *Wilson and Tucker, International Law.*

G5. Psychology. General principles of psychology.

G21. Industrial Relations. Intended to familiarize the student with the more important problems which arise out of the relation of employer and employee under present conditions of industry. In addition to a consideration of the organizations and policies of the parties to the contract of employment, it deals with the principles and to some extent the technique of employment management or personnel work.

G25. Investment Finance. Considers briefly (1) the legal rights conferred upon the owners of securities of various types; (2) the basis for credit offered by issuing corporations of various kinds: government, railroad, public utility, industrial, etc.; (3) the stock exchanges, brokerage, speculation and the various kinds of business houses which deal in securities and investments.

G31. Humanics. A series of conversations and discussions regarding the great variety of conditions and human contacts which arise in the course of employment, together with desirable methods by which to meet such conditions when they occur. The need for the development of specific traits of character and habits will be emphasized as well as their bearing upon the chance for success or failure in business.

G40. Contemporary Drama. An untechnical discussion of notable living playwrights and their work here and abroad.

G41. Contemporary English Literature. Treats of a number of the most important English men of letters from 1890 to the present time. (Not offered in 1929–30.)

G42. Contemporary European Literature. An introductory study of some of the chief figures in European Literature of the last few decades and today. (Not offered in 1929–30.)

G43. American Literature. From the Civil War, with especial emphasis on the period since 1900.

G46. Public Speaking. The object is to set forth the principal matters of technique on which the art of speaking in public is based, and to provide training for the individual members of the class.

G47. Committee Reports. Training in the preparation and oral presentation of committee reports. These reports serve as a basis for class discussion.

G48. Appreciation of Music. No previous knowledge of music is needed for this subject. 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. Written work totalling 2,500 words, and two-hour examinations are required. Textbook: *Sigmund Spaeth, The Common Sense of Music.*

G49. English and History. Advanced work in reading and discussion of modern intellectual problems, based on Steeves' and Ristine's "Representative Essays in Modern Thought." Lectures, recitations for discussion and written papers.

G50. The Fine Arts in Modern Life. Aims to develop the habit and faculty of noticing visible beauty in contemporary art, in public monuments and museum collections, and more especially in one's personal environment, such as costume, furnishing and decoration of the home, books, pictures, magazines, the theatre. The history of art is studied with a brief text in order to make the appreciation of contemporary work more discriminating. Textbook: *Reinach, Apollo, the Story of Art (Scribner's); The Significance of the Fine Arts (Amer. Inst. of Archts.).*

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. Lincoln and the Period of the Civil War. Life of Abraham Lincoln and his relation to the times.

G55. French Revolution and Napoleon. Lectures, maps, pictures and some outside reading will be used to give the student a general idea of the most interesting features and episodes of French society just prior to the Revolution, of the Revolution itself, of the advent of Bonaparte, of the Empire and of Waterloo.

G56, G57. European Civilization and Art. Rise of civilization and of its westward expansion through the Mediterranean basin. The racial, economic, religious and political elements in this development are carefully traced, and upon the background thus gained the art of each successive epoch is studied and general aesthetic principles are discussed. As the students in Course IV have a specialized course in the history of architecture, attention is here particularly concentrated upon sculpture. The lectures are very fully illustrated by lantern slides, supplemented by collections of photographs and by reference to the original works and casts contained in the Boston Museum of Fine Arts. Textbook: *Breasted, Ancient Times.*

G58. Choral Singing.

G59. The Social Problems of Philosophy. Discusses in non-technical language some of the philosophical theories which underlie recent views of society and of the management of the personal life.

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. Textbook: *Shimer, Introduction to Earth History.*

G62. Economic Geography. A popular course in the relation of man to the world on which he lives. His physical environments such as soils, mountains, plains, rivers, lakes and oceans, and climate, and their effect on his development are first considered. The natural resources of the earth are then described in relation to their importance in the development of civilization — power (water, coal and petroleum), iron and other metals used in industry, gold and silver, cement materials, clays, fertilizers, salts and other non-metallic materials. The point-of-view of the importance of environment and resources to civilization is kept uppermost during the presentation of this course.

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. Textbook: *Shimer, Evolution and Man.*

G66. Descriptive Astronomy. A general survey (illustrated) of the facts and theories relative to the solar system and sidereal universe. Textbook: *Moulton's Introduction to Astronomy.*

G71. Principles of Biology and Heredity. Thirty lectures illustrated by demonstrations, charts and lantern slides. A cultural subject intended for students who have had little or no previous training in biology. Gives a broad view of the fundamental principles of the subject, including the properties of living matter, movement, nutrition, growth and reproduction; with a general account of form and structure of plants and animals and their classification. The questions of sex and heredity treated at length. Textbook: *Walter, Genetics, Revised Edition,* 1922.

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.

G821, G822. French. Practice in understanding spoken French, expression in French of scientific ideas, general and technical. Reading of texts on science and industry. Each term may be taken independently.

G831, G832. French. A brief survey of some period or school of French literature with the reading of some masterpieces. Such topics as the following are discussed: the literature of the Middle Ages; the Renaissance; classicism; the romantic movement; realism; naturalism; art for art's sake; impressionism and symbolism. Each term may be taken independently.

G98. 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 as are the political or other factors leading up to the events referred to except where a clear understanding of the situation requires it. Required of all students registered in any Advanced R. O. T. C. Unit. Ordinarily taken during the first term senior year, but may be taken during first term junior year. Textbook: *Condensed Military History of the United States, Cloke.*

GERMAN

The study of German at the Institute has two objects: that of enabling the student to make use of the language as an instrument in scientific research, and that of giving him general training and culture. It aims to give sufficient facility with modern texts to use them without the necessity of translating, and as much familiarity with the spoken language as the individual aptitude of the student and the time available permit. From the beginning as much of the classroom work as possible is carried on in the language taught. Occasional talks therein are also given and writing from dictation is frequently practiced.

A sound knowledge of grammar is attained by the careful analysis of parts of the texts read, and by oral and written illustrative exercises. To make these of value a good pronunciation is essential, and this is striven for through constant practice in the classroom. In addition to a deeper knowledge of the language and literature, the advanced courses aim to impart familiarity with the character, customs, traditions, spirit, history and development of the peoples and countries whose language is studied.

In the designation of subjects the grades of elementary and intermediate correspond, respectively, to the definitions of the Modern Language Association of America, Report of the Committee of Twelve. All other subjects are of advanced grade.

Subjects L1 to L49 (see page 66)

L11, L12. German, Elementary. Intended to prepare students to fulfill the entrance requirement in German. A study of grammatical forms, syntax and vocabulary, through composition exercises and rapid reading, forms the basis of the work.

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 studied. By the end of the course students should be able to read understandingly any ordinary newspaper or magazine article of a literary or popular scientific nature, to understand simple spoken German, and to express simple thoughts in German. As far as practicable the exercises are conducted in German.

L23, L24. German Literature. Readings and lectures adapted to the needs of aeronautical students.

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.

L331, L332. German, Advanced. Readings in scientific advanced German.

ROMANCE LANGUAGES

Several courses are offered in French and one in Spanish. Those in French are of Elementary, Intermediate and Advanced grade. In the Elementary and Intermediate courses a careful foundation is laid for reading, writing and speaking French. 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 for French sounds, 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 France. Occasional illustrated lectures are given to supplement the class exercises and stimulate interest. The advanced courses for students in Architecture are planned to give a more ready command of the language, an acquaintance with great examples of French literary art, and a familiarity with French architectural literature. The General Study courses offer the student an opportunity to carry his study of French beyond the Intermediate grade, increasing his practical command of the language, reading ability, and acquaintance with the greatest French writers.

The one-year elective course in Elementary Spanish is parallel to the course in Elementary French. It gives a training in pronunciation, essentials of grammar, and reading of varied matter. On its completion a student should be able to make intelligent contact with a Spanish-speaking country, be able to read Spanish correspondence and translate reading matter of moderate difficulty.

In all courses the foreign language is used as much as possible 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 Cp. 2; Elementary Spanish = Spanish Cp. 2; Intermediate French = French B or French Cp 3.

Subjects L50 to L99 (see page 66)

L51, L52. French, Elementary. Designed to give the necessary foundation for the study of the French language, literature, or for scientific studies; it will also enable 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. The last term will include the reading of some technical French.

L61, L62. French, Intermediate. Design 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 and translation of some standard modern authors, reading of scientific French.

L63, L64. French, Advanced. Planned to suit the needs of Course IV. Emphasis is laid upon good pronunciation, and the ability to express in French matters dealing with travel and architecture. Some of the reading matter will deal with architectural subjects. Textbooks: such books as *Shanks and Méras, French Composition: L'Art Grec et l'Art Romain* (*Grammaire des Styles*); *Hervieu, La Course du Flambeau; Loti, Pêcheur d'Islande; George Riat, Paris* (*Les Villes d'Art Célèbres*); *Foville, Pise et Lucques.*

L65, L66. French, Advanced. 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, chateaux, etc. Practice in writing French, in pronunciation and conversational phrases useful for travel is given. Textbooks: *Coindreau and Lowe, French Composition;* such reading matter as *Emile Gebhart, Florence; Besnard, Le Mont-Saint-Michel; La Renaissance Italienne,* and *La Renaissance Française* (*Grammaire des Styles*); *Hugo, Notre Dame de Paris; Demaison, La Cathédrale de Reims; Anatole France, Le Crime de Sylvestre Bonnard.*

L71, L72. French. Arranged for students of Aeronautical Engineering. Review of grammatical principles. Reading of scientific matter dealing with aeronautics, engines, electricity, etc.

L81, L82. Spanish, Elementary. Pronunciation, elementary grammar, easy reading matter, practice in conversational phrases useful for travel. Textbooks: such books as *Crawford, First Book in Spanish; Wilkins, Beginner's Spanish Reader; Hills and Reinhardt, Spanish Short Stories; Romera-Navarro, Historia de Espana; Carrión and Aza, Zaragüeta.*

The following subjects are offered as General Studies. For description see Division of General Studies, page 238.

G821, G822. French.

G831, G832. French.

MATHEMATICS

Great importance is attached to the study of mathematics, both as a means of general education and as a necessary basis for further instruction in engineering and other subjects. Students in most of the regular courses study mathematics throughout the first two years, beginning with a combined course in elementary calculus and analytic geometry extending through the first year. The second year work is devoted mainly to integral calculus and elementary differential equations with systematic study of applications. From the outset, care is taken to present both underlying principles and a great variety of concrete applications, the latter connecting the mathematical instruction closely with the professional studies. The instruction is given mainly by recitations in small sections, the number of the students in a section being about twenty-five. Students having time and interest for the study of mathematics beyond the prescribed limits are given opportunity for more advanced work, and the Institute offers exceptional advantages for advanced and elective work in applied mathematics.

Undergraduates wishing to specialize in mathematics are enabled to do so by the provision for suitable electives in Course IX-C (page 111).

The department possesses an excellent library, with current journals, a mathematical laboratory with Monroe and Millionaire computing machines and a collection of models.

Subjects M1 to M99 (see page 66)

M1. Algebra, Entrance. For description see entrance requirements.

M3. Solid Geometry, Entrance. For description see entrance requirements.

M4. Trigonometry, Entrance. For description see entrance requirements.

M11. Calculus. An elementary presentation of the fundamental ideas of the calculus; differentiation and integration of the algebraic polynomial; 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. Textbook: *Woods and Bailey, Elementary Calculus.*

M12. Calculus. Differentiation and graphical representation of algebraic, 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. Textbook: *Woods and Bailey, Elementary Calculus.*

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 solid; 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. Textbook: *Woods and Bailey, Elementary Calculus.*

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. Textbook: *Phillips, Differential Equations.*

M23, M24. Higher Algebra and Geometry. Determinants, matrices, theory of equations, quadratic forms, conics and quadrics, curvilinear coördinates, elements of analytic geometry.

M26. Least Squares. A brief discussion of the general principles and the more common scientific and engineering applications of the method of least squares. Textbook: *Bartlett, Method of Least Squares.*

M31. Differential Equations of Electricity. 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.

M32. Elements of Analysis. Continuity and convergence, multiple integrals, partial derivitives, curvilinear integrals, variations, Fourier's series.

M36, M37. Advanced Calculus. 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 variation, elliptic integrals.

M41. Calculus, Applications of. Especially adapted to the needs of students in chemical engineering.

M43, M44. Theoretical Aeronautics. Open to third- and fourth-year students. The main topics covered are (*a*) The mechanics of the airplane, including vibrations, moment of momentum, moving axes, etc. (*b*) The mechanics of irrotational fluid motion and its application to lift and drag. (*c*) The stability of the airplane.

M451, M452. Fourier's Series and Integral Equations. The theory of Fourier's series, Bessel's functions and their application to the solution of such problems in physics as can be expressed by certain partial differential equations.

M46, M47. Advanced Wing Theory. Selected advanced topics in continuation of M44. Textbooks: *Joukowski, L'Aerodynamique; Prandtl, Applications of Modern Hydrodynamics to Aeronautics; Published by the National Advisory Committee for Aeronautics.*

M54. Mathematical Laboratory. 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. Textbook: *Lipka, Graphical and Mechanical Computation.*

M551, M552. Functions of a Real Variable. The first term is devoted to presenting 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.

In the second term, some existence theorems are proved, analytic functions are defined, the variation of an integral is briefly discussed, and applications are made to certain problems of mathematical physics involving linear differential and integral equations.

M561, M562. Functions of a Complex Variable. 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 and of the elliptic functions. Textbook: *Pierpont, Functions of a Complex Variable.*

M57. Theory of the Gyroscope. A mathematical discussion of the gyroscope, together with its application to torpedoes and stabilizers.

M571. Theory of the Gyroscope. Given to students taking Army Ordnance Course.

M60. Vector Analysis. Algebraic combinations of vectors, differentiation and integration of vector functions, Green's and Stokes' theorems, potential functions, applications to geometry and physics.

M62. Modern Algebra. Determinants, matrices, systems of linear equations, linear transformations, finite groups.

M631, M632. Differential Geometry. Introduction to differential geometry of curves and surfaces in ordinary space. Differential invariants. Generalization to n dimensional Riemannian manifolds with the aid of the Ricci calculus.

M651, M652, M653. Analytical Mechanics. The first term work consists of a discussion of elementary principles including vectors, velocity and acceleration, fundamental principles of dynamics, translation and rotation, work and energy, virtual work, d'Alembert's principle, rigid dynamics, generalized coördinates, Lagrange's equations, theory of vibration. The second term's work discusses Hamilton's equations and Hamilton's principle; contact transformations; the Hamilton-Jacobi theory. The third term's work is devoted to hydrodynamics; the general equations; irrotational motion; motion of a liquid in two dimensions; motion of a solid through a liquid; vortex motion; waves; viscosity. (Not given 1929-30.)

M70. History of Science. Same as G1 with 2 extra hours preparation.

M72. Differential Equations. (For students from the United States Army.) A review of calculus, including differentiation, differential properties of curves, rates, maxima and minima, integration, multiple integration, geometrical, mechanical and physical problems; differential equations of the first order, special types of second order equations, linear equations with constant coefficients and simultaneous linear equations. The application of the calculus and differential equations is made to various problems of mechanics, physics and engineering. Textbooks: *Wilson, Advanced Calculus; Phillips, Differential Equations.*

M731, M732. Rigid Dynamics. The fundamental principles of the mechanics of rigid bodies.

M75. Exterior Ballistics. The calculation of the trajectories of projectiles under standard conditions, and of the differential corrections for variations from standard conditions is discussed here. The method of Siacci-Ingalls and that of numerical integration are both treated. Applications to the construction of Range Tables are given. Textbook: *Introduction to Ballistics, A. A. Bennett*, prepared in the Technical Staff of the Ordnance Department.

M76. Theory of Probability. Permutations and combinations. Elementary principles of the theory of probabilities. Bernoulli's Theorem. Bayes' Theorem. Distributive functions and continuous variables. Averages. Curve fitting. Textbook: Th. C. Fry, *Probability and Its Engineering Uses.* (New York, Van Nostrand Co., 1928.)

M77. Vector Analysis. A treatment of the vector functions and operations required in theoretical work on electricity.

M781, M782. Advanced Geometry. Coördinate systems in plane, space and n dimensions. Properties of conics and quadrics. Projective geometry. Non-Euclidean geometry. N-dimensional geometry.

M791, M792. Theoretical and Applied Elasticity. Includes the fundamental mathematical theory of elasticity in three dimensions as applied to isotropic bodies; the elastic work of deformation; the stress equations of small motion and of equilibrium; Airy's stress function; Mohr's stress diagram; bending of bars, plates, shells and tubes; instability; vibration of elastic systems; modern theory of strength, plasticity. Discussion of the principles and methods used in obtaining approximate solutions of practical engineering problems; the principle of Saint-Venant, the principle of minimum energy, the principle of virtual velocities applied to elastic bodies, the method of elastic deflections, Ritz's method and the application of calculus of variation to problems in elasticity.

Application of the theory outlined above to problems of practical interest, illustrating the use of said principles and methods. Rigorous and approximate solution of the differential equations of the elastic surfaces and of various functions.

Reference books: *Saint-Venant, Elasticité des Corps Solides by Clebsch; Love, Theory of Elasticity; Foppl, Drang und Zwang; Timoshenko and Lessells, Applied Elasticity.*

M80. Methods of Teaching Junior High School Mathematics. Includes the observation of a demonstration class, showing actual teaching of a typical group of junior high school pupils.

M81. Methods of Teaching Senior High School Mathematics. A study of methods in teaching algebra, plane geometry, solid geometry, trigonometry, with special reference to the recommendation of the National Committee on mathematical requirements, and to the recently revised requirements of the College Entrance Examination Board.

M851, M852. Modern Mechanical Theories. This course represents a development of the mathematical features of the new extension of mechanics. It deals with the mechanics of special and gravitational relativity, the tensor calculus, the matrix and way forms of quantum mechanics. An attempt is made to develop the unifying principles underlying the various theories. Two hours a week will be devoted to lectures, the third to conferences in which the students will have the opportunity to present sections of the recent literature.

M90. Mathematical Reading. 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 primarily for graduate students and is open to undergraduates only by special permission.

The following subjects are offered as General Studies. For description see Division of General Studies, page 238.

G1. History of Science.

G2. History of Science.

G76. History of Philosophy.

MILITARY SCIENCE AND TACTICS

Six units of the senior division of the Reserve Officers' Training Corps are maintained.

The general object of the courses of instruction of the R. O. T. C. is to qualify students for positions of leadership in time of national emergency.

The complete course of instruction comprises four years: a basic course of two years, and an advanced course of two years.

The object of the basic course is to qualify the student to perform the duties of a non-commissioned officer of the branch in which he is trained.

The object of the advanced course is to qualify for a commission in the Officers' Reserve Corps a limited number of students who have completed the basic course and who have demonstrated exceptional qualities of leadership. Graduates of the four-year course, including the advanced camp, should be reasonably qualified to perform the duties of a second lieutenant of the branches in which they have been trained.

Basic Course

The first year of the basic course includes Infantry Drill, both close order and extended order, Military Courtesy and Discipline, Rifle Marksmanship, and a brief explanation of the National Defense Act.

The first half of the second year includes Map Reading and Military Sketching, the Principles of Field Fortification, Army Organization, and Communications. The second half of the second year is devoted to the instruction in the elements of one of the six branches maintaining units at this institution, *i.e.*, Coast Artillery Corps, Engineer Corps, Signal Corps, Ordnance Department, Air Corps, and Chemical Warfare Service.

All physically fit male students who are citizens of the United States under twenty-eight years of age, 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 completed one or two years of the basic course at some other institution will receive full credit upon presentation of evidence of satisfactory completion of the work.

Advanced Course

Having satisfactorily completed the two-year basic course in military training, a student may elect to pursue the advanced course of the Reserve Officers' Training Corps in one of the six units, depending upon his choice and the Institute course he is pursuing. With the approval of the Professor of Military Science and the professor in charge of his Institute course, he may sign a contract to pursue the advanced course during two academic years, including attendance at one six-weeks R. O. T. C. summer camp, normally held in June and July following the first year of the advanced course. The advanced course, once entered upon, becomes, in accordance with the terms of the establishment of the R. O. T. C. at the Institute, a prerequisite for graduation. Members of the advanced course receive commutation of subsistence (at present at the rate of 30 cents per day) from the time of entering upon the contract until the completion of the second academic year thereafter, including the intervening vacations. For the summer camp, all expenses, including food, clothes, and transportation to and from camp, are furnished by the Government. Upon graduation, members of the advanced R. O. T. C. are eligible to receive a Reserve commission in the United States Army. These Reserve commissions are for a period of five years, and are restricted so that the officer is subject to call only in case of an actual declaration of war, except for fifteen days service or training under certain conditions.

Students enrolling in the advanced course are furnished one uniform at a cost to the Government of $36, are paid $210 commutation of rations, and receive one six-weeks period of training at a military camp without any expense on their part. This is in effect a military scholarship open to all qualified students who are citizens of the United States, physically sound, who have made a satisfactory record in their basic military training, and display such physical, mental and moral qualifications as render them suitable candidates for commissions. The right is reserved to discharge from the advanced course any student who is guilty of misconduct, or whose work in any department of the Institute falls below standard, or who is found in any way unfit or unsuitable for the commission for which he is a candidate.

Subjects MS1 to MS99 (see page 66)

MS11. Military Science. (Required in all courses.) Consists of seven weeks of infantry drill, school of the soldier, squad and platoon; five weeks of lectures on elementary subjects of military training; and three weeks of instruction, both theoretical and practical, in infantry weapons and rifle marksmanship.

MS12. Military Science. (Required in all courses.) Consists of fifteen weeks of infantry drill and rifle gallery practice.

MS21. Military Science. (Required in all courses.) Consists of a six weeks' course in topography and map reading; five weeks of lectures on field fortification; and two weeks of lectures on signal communications; followed by two weeks devoted to one lecture on the particular duties of each of the units of the R. O. T. C. represented here. Opportunity is given the student to choose the unit in which he desires to continue his training during the following year. Those who do not report their choice of a unit before the beginning of the following term will be arbitrarily assigned to a unit.

MS221. Military Science. Coast Artillery. Consists of fifteen weeks devoted to elements of heavy artillery.

MS222. Military Science. Engineer Corps. Fifteen weeks devoted to instruction in the elements of engineer training.

MS223. Military Science. Signal Corps. Elementary instruction in the combat principles of infantry, cavalry and artillery; the organization of signal communication units; the tactics of signal communication in the infantry, cavalry and artillery signal corps communication equipment.

MS224. Military Science. Ordnance Department. Lectures on ordnance material.

MS225. Military Science. Air Corps. Fifteen weeks lecture course on air corps fundamentals, armament, aerial gunnery, theory of flight, aerial navigation, photography, parachutes and engineering fundamentals of the airplane.

MS226. Military Science. Chemical Warfare Service. Instruction both theoretical and practical for fifteen weeks in the chemical warfare service.

MS311. Military Science. Coast Artillery, Advanced. (R. O. T. C.) Five weeks devoted to instruction on fire control instruments; and ten weeks to the computation of firing data for heavy mobile artillery.

MS312. Military Science. Engineer Corps, Advanced. (R. O. T. C.) Consists of lectures for four weeks on organization and duties of engineers; three weeks on administration, supply and equipment; and eight weeks on musketry and combat principles.

MS313. Military Science. Signal Corps, Advanced. (R. O. T. C.) Theoretical and applicatory knowledge of all local and common battery telephone and telegraph equipment in use by the signal corps; signal communcation tactics in an infantry division. Military law.

MS314. Military Science. Ordnance Department, Advanced. (R.O.T.C.) Organization and duties of Ordnance Department.

MS321. Military Science. Coast Artillery, Advanced. (R. O. T. C.) Seven weeks' study of the dispersion and probability of fire; and eight weeks of observation and adjustment of fire.

MS322. Military Science, Engineer Corps, Advanced. (R. O. T. C.) Consists of lectures for eight weeks on general construction in war; and seven weeks on field and permanent fortifications.

MS323. Military Science. Signal Corps, Advanced. (R. O. T. C.) Various types of codes and ciphers, their uses and methods employed to build and break them down; instruction in International Morse Code; applicatory knowledge of all signal corps field radio sets.

MS324. Military Science Ordnance Department, Advanced. (R. O. T. C.) Ordnance service and ordnance development.

MS325. Military Science. Air Corps. Advanced. (R. O. T. C.) Fifteen weeks, course consisting of lectures and problems on airplane instruments, aerial navigation, bomb racks and sights, meteorology, duties of squadron officers and property accountability.

MS326. Military Science. Chemical Warfare Service, Advanced. (R. O. T. C.) Lectures for fifteen weeks on organization and duties of chemical warfare service. Personnel and matériel.

MS411. Military Science. Coast Artillery, Advanced. (R. O. T. C.) Lectures on coast artillery matériel, three weeks; organization and administration of the coast artillery corps, three weeks; camp sanitation and military hygiene, two weeks; gunners' instruction for anti-aircraft artillery, five weeks.

MS415. Military Science. Air Corps, Advanced. (R. O. T. C.) Fifteen weeks' course consisting of lectures and problems on military law, administration and supply, essentials of pursuit, attack, bombardment, and observation aviation and flying operations.

MS421. Military Science. Coast Artillery, Advanced. (R. O. T. C.) Lectures for fifteen weeks on the tactical employment of artillery, the various types of artillery, military law and motor transportation.

The following subject is offered as a General Study. For description, see Division of General Studies, page 238.

G98. Military History and Policy of the United States.

DEPARTMENT OF HYGIENE

The gymnasium of the Institute is located on the third floor of the Walker Memorial Building, fronting on the Esplanade, east of the educational buildings. This gymnasium 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 are the gift of 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. With the acquisition of this building the Walker Gymnasium is left free for the regular gymnastics for which it was designated.

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 physical examinations during the first month — one at Walker Memorial by the Physical Director, from which anthropometric charts are plotted, and 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 under the name of subjects indicate subjects required for preparation (those in parentheses may be taken simultaneously.)

To the right of the subjects are noted the Professional Courses, and the year and term in which the subjects are required.

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 ENGINEERING — 1·00–1·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
1·00	Surveying & Plot... *M4, D22* (Not open to 1st yr.)	I, XI	2	1	2	..	3	Robbins
1·001	Surveying........ *M4, D22* (Not open to 1st yr.)	XV$_1$	2	1	2	..	1	Robbins
1·01	Surveying & Plot... *M4, D22* (Not open to 1st yr.)	I, XI, XV$_1$	2	2	0	2	0	Robbins
1·02	Surveying & Plot. *M4, D22*	III$_3$, VI VI-A$_{2,3}$	3 2	S S	2 2	3 3	0 0	Hosmer
1·03	Surveying........ *M4, D22* (Not open to 1st yr.)	IX-B, XV$_2$ IV-A II, IV-A, XVII	2 3 2	2 2 1	1 1 1	1 1 1	0 0 0	Howard
1·04	Surveying........ *M4, D22* (Not open to 1st and 2d yr.)	(Elective)	3	S	2	20	2	Howard
1·041	Surveying *M4, D22*	I-A VII$_3$	2 3	S S	1 1	11 11	1 1	Howard
1·05	Plane Surveying... *1.00 or 1·001, 1·01* (Not open to 1st or 2d yr.)	I, XI, XV$_1$	3	S	1	5	1	Howard
1·06	Geod. & Top. Sur... *(1·05)*	I, XI, XV$_1$	3	S	1	6	0	Hosmer
1·07	Geodetic Surveying *1·13, 1·06*	(Elective)	4	S	0	10	0	Hosmer
1·10	Surveying........ *M4, D12, D22* (Not open to 1st or 2d yr.)	III$_{1,2}$ XII	3 4	S S	5 5	18 18	1 1	Eberhard
1·12	Astron. & Sph.Trig. *M4 (1·00)*	I	2	1	3	..	4	Hosmer
1·13	Geodesy.......... *M22, 1·12*	I	3	1	2	..	2	Hosmer
1·14	Geodesy Adv...... *1·13*	I	G(A)	2	2	..	4	Hosmer
1·15	Navigation *M4*	(Elective)	3	2	2	..	2	Hosmer
1·16	Aerial Surveying .. *1·06*	(Elective)	G	2	2	..	2	Hosmer
1·17	Sea & Aerial Nav. .	(Elective)	3	1	2	..	2	Howard
1·18	Map Read. & Top. Draw.......... *D22*	I, XI	2	1	0	2	0	Howard

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No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
1·20	Railway Fieldwork *(1·05) for I, XI, XV$_1$*	I, XI, XV$_1$	3	S	1	4	0	Babcock
	(1·041) for I-A	I-A	2	S	1	4	0	
1·21	Rail. & High. Eng.	I$_{1,2}$, I-A(B)	3	1	2	..	4	C. B. Breed
	M21, 1·20	I-A(A)	3	S	2	..	4	
1·211	Rail. & High. Eng. *M21, 1·20*	I$_3$, VII$_3$, XI, XV$_1$	3	1	1	..	3	C. B. Breed
1·22	Rail. & High. Eng.	I, VII$_3$, XI, XV$_1$	3	2	2	..	2	C. B. Breed
	1·21 or 1·211	I-A(B)	3	S	2	..	2	
		I-A(A)	4	S	2	..	2	
1·23	Railway Drafting.. *1·20 (1·21 or 1·211)*	I$_{1,2}$	3	1	0	4	0	Babcock
1·231	Railway Drafting.. *(1·20)*	I-A	2	S	0	5	0	Babcock
1·24	Railway Drafting.. *1·23 (1·22)*	I$_{1,2}$	3	2	0	3	0	Babcock
1·25	Eng. Con. & Estim. *1·22, 2·20 or (2·20)*	I-A(A), I$_2$, XI, XV$_1$, Mil. Eng.	4	1	2	..	3	C. B. Breed
		I-A(B)	3	1	2	..	3	
1·26	Rail. Main.& Sig...	I$_2$a, I-A(A)	4	1	2	..	2	C. B. Breed
	(1·25)	I-A(B)	3	1	2	..	2	
1·27	Railway Trans. .... *1·26*	I$_2$a, I-A	4	2	2	..	4	C. B. Breed
1·28	Railway Design ... *1·24 (1·27)*	I$_2$a	4	2	0	5	0	C. B. Breed
1·281	Railway Design ...	I-A(A)	3	2	0	3	0	Babcock
	1·231	I-A(B)	4	S	0	3	0	
1·29	Railway Accounts .	I-A(A)	3	S	2	..	3	Babcock
		I-A(B)	4	S	2	..	3	
1·30	Dev. of Trans.....	I-A(A)(B) (Not offered 1929-30)	G	2	2	..	2	C. B. Breed
1·301	Rail. Trans., Adv. . *1·27, 1·28 or 1·281*	I	G(A)	1	2	..	4	C. B. Breed
1·302	Rail. Trans., Adv. . *1·301*	I	G(A)	2	2	..	4	C. B. Breed
1·311	Rail. Des., Adv.... *1·28, or 1·281 (1·301)*	I	G(A)	1	0	3	0	C. B. Breed
1·312	Rail. Design, Adv.. *1·311 (1·302)*	I	G(A)	2	0	3	0	C. B. Breed
1·35	Roads & Pave.....	I$_{1,2}$	4	1	2	..	1	C. B. Breed
	1·22 or 1·211	XI	3	1	2	..	1	
1·36	Test. High. Mat. .. *1·35, 2·37*	I$_2$b	4	2	0	1	1	C. B. Breed
1.37	Highway Trans.... *1·25 (1·36), 5·37*	I$_2$b	4	2	2	..	4	C. B. Breed
1·38	Highway Design .. *1·24 (1·37)*	I$_2$b	4	2	0	3	0	Babcock
1·39	Graphic Statics ... *8·02* (Not open to 1st yr.)	I	2	2	1	2	1	Mitsch
1·391	Graphic Statics ... *2·15*	XVII	3	1	1	2	1	Mitsch
1·40	Structures........ *2·20 or 2·211*	I, I-A(A), IV-A, VII$_3$, IX-B, XI, XV$_1$	3	2	3	..	5	Fife
		Mil. Eng., I-A(B)	4	S	3	..	5	
1·401	Structures........ *2·20 or 2·211*	XVI	3	2	3	..	5	Newell
1·41	Structures *1·40, 1·43*	I, IV-A, XI, XV$_1$, XVII, Mil. Eng.	4	1	4	..	8	Spofford
1·411	Th. of Structures..	I-A(A)	4	1	4	..	8	Spofford
	1·40, 1·43	I-A(B)	4	2	4	..	8	
1·42	Structures........ *1·41*	I, Mil. Eng.	4	2	4	..	8	Spofford
1·421	Structures........ *1·41*	XI, XV$_1$	4	2	2	..	4	Spofford

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
1·422	Structures *1·41*	IV-A, XVII	4	**2**	2	..	4	Spofford
1·43	Materials (*2·20*)	I, XV_1	3	**2**	1	..	2	Sutherland
1·44	Stat. Structures *2·20*	$III_{1,2}$	4	**2**	2	..	3	Fife
1·45	Structures *2·20 or equiv.*	II(O.D.), XIII-A	G	**1**	3	..	6	Fife
1·46	Structural Design *1·45*	XIII-A	G	**2**	0	2	0	Fife
1·461	Structural Design *1·45*	II(O.D.)	G	**2**	0	3	0	Fife
1·471	Struc. Th. & Des. *1·391, 2·20*	XVII	3	**2**	3	2	6	Sutherland
1·48	Foundations *1·40 or 1·44*	IV-A, XV_1 I, IV-A	4 3	**1** **1**	1 1	.. ..	1 1	Terzaghi
1·481	Found.& Soil Mech. (*1·41*)	XVII	4	**1**	4	..	4	Terzaghi
1·482	Found.& Soil Mech. *1·481*	XVII	4	**2**	3	..	5	Terzaghi
1·491	Soil Mechanics *2·20*	I	G(A)	**1**	3	..	6	Terzaghi
1·492	Soil Mechanics *1·491*	I	G(A)	**2**	3	..	6	Terzaghi
1·493	Soil Mechanics *2·20*	(Elective)	G	S	4	..	8	Gilboy
1·501	Bridge Design (*1·41*)	$I_{1,2}$	4	**1**	0	7	0	Mirabelli
1·502	Bridge Design *1·501 (1·42)*	$I_{1,2}$	4	**2**	0	5	0	Mirabelli
1·511	Bridge Design *1·40*	I_3	4	**1**	0	4	0	Mirabelli
1·512	Bridge Design *1·511 (1·421)*	I_3	4	**2**	0	6	0	Mirabelli
1·52	Structural Design (*1·421*)	XI	4	**2**	0	6	0	Mirabelli
1·53	Structural Design (*1·41*)	I-A(A) I-A(B)	4 4	**1** **2**	0 0	4 4	0 0	Mirabelli
1·54	Structural Design (*1·421*)	XV_1	4	**2**	0	6	0	Mirabelli
1·55	Struct. Des., Adv. (*1·562*)	I	G(A)	**2**	0	8	0	Sutherland
1·561	Structures, Adv. *1·42 or 1·421 or 1·422, 1·502 or 1·512 or 4·922*	I	G(A)	**1**	3	..	9	Spofford
1·562	Structures, Adv. *1·561*	I	G(A)	**2**	3	..	9	Spofford
1·57	Secondary Stresses (*1·41 or 16·01*)	I, XVI	G(A)	**2**	2	..	4	Fife
1·581	Reinf. Con. Design *1·42 or 1·421*	I Mil. Eng.	G(A) 4	**1** **1**	0 0	6 6	2 2	Sutherland
1·582	Reinf. Con. Design *1·581*	I	G(A)	**2**	2	..	4	Sutherland
1·60	Hydrog. Survey *M12 (1·05, 1·06)*	I, VII_3, XI, XV_1	3	S	1	4	0	Liddell
1·62	Hydraulics *2·15 or equiv.*	I, VII_3, IX-B, XI IV-A	3 4	**2** **2**	3 3	.. ..	5 5	G. E. Russell
1·63	Hydraulics *2·15 or equiv.*	$III_{1,2,3}$, $XIII_1$, XV_1 XVII II_{3a}	4 3 4	**1** **2** **2**	2 2 2	.. .. ..	3 3 3	G. E. Russell
1·64	Hydraulics *2·15 or equiv.*	I-A(B) I-A(A) II, VI, VI-A(A), XV_2 VI-A(B)	3 3 4 4	**1** **2** **1** **2**	3 3 3 3	.. ..	6 6 6 6	G. E. Russell
1·66	Hydraulics, Adv. *1·62 or equiv.* (Open to undergraduates only on petition.)	I	G(A)	**1**	1	..	4	G. E. Russell
1·70	Water Power Eng. *1·62*	I_3	4	**1**	3	2	3	Barrows

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
1·71	Water Power Eng.. *1·70, 1·41*	I_3	4	**2**	2	4	3	Barrows
1·731	Wat. Pr. Eng., Adv. *1·42, 1·71 (1·851)*	I	G(A)	**1**	3	..	6	Barrows
1·732	Wat. Pr. Eng., Adv. *1·731 (1·852)*	I	G(A)	**2**	3	..	6	Barrows
1·75	Hyd. & San. Eng. . *1·62*	I_1	4	**1**	4	..	5	R. G. Tyler
1·76	Hyd. & San. Eng. . *1·62*	I_1	4	**2**	4	..	5	R. G. Tyler
1·77	Sanitary Eng...... *1·62*	XI	4	**1**	4	..	5	R. G. Tyler
1·78	Sanitary Eng...... *1·62*	XI	4	**2**	3	..	4	R. G. Tyler
1·79	Hyd. & San. Eng. . *1·75*	I_1	4	**2**	0	2	0	R. G. Tyler
1·80	Sanitary Design... *(1·75 or 1·77)*	XI	4	**2**	0	6	0	R. G. Tyler
1·811	San. Eng., Adv.... *1·75 or 1·77*	XI	G(A)	**1**	2	..	4	R. G. Tyler
1·812	San. Eng., Adv.... *1·76 or 1·78*	XI	G(A)	**2**	2	..	4	R. G. Tyler
1·851	Wat. Pr. Des., Adv. *1·731*	I	G(A)	**1**	0	8	0	Barrows
1·852	Wat. Pr. Des., Adv. *1·851 (1·732)*	I	G(A)	**2**	0	8	0	Barrows
1·881	San. Des., Adv. ... *(1·811)*	XI	G(A)	**1**	0	6	0	R. G. Tyler
1·882	San. Des., Adv. ... *(1·182)*	XI	G(A)	**2**	0	6	0	R. G. Tyler
1·901	Rail. Oper. Prac. ..	I-A(A) (B)	3 3	**1** S	0 0	48 48	0 0	Babcock
1·902	Rail. Oper. Prac. ..	I-A(B) (A)	3 4	**2** S	0 0	48 48	0 0	Babcock
1·903	Rail. Oper. Prac. ..	I-A(A) (B)	4 4	**2** **1**	0 0	48 48	0 0	Babcock
1·904	Rail. Oper. Prac. ..	I-A(A) (B)	G G	**1** S	0 0	48 48	0 0	Babcock

MECHANICAL ENGINEERING — 2·00–2·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·00	Mechanism *D11, M11*	II, VI, VI-A	2	1	4	..	6	Merrill
2·01	Mechanism *D11, M11*	I, $III_{1,2,3}$, X XIV, XV_3 I-A, IX-B, XIII, $XV_{1,2}$, XVI	2 2 2	2 S 1	2 2 2	.. .. ..	4 4 4	Merrill
2·021	Mech. & Mach. Dr. *D12, D22, M11*	III_4	3	S	0	10	0	James
2·03	Mechanisms *2·891*	II(A.O.)	4	1	2	4	2	Swett
2·04	Mech. Eng. Equip.	II	2	2	1	..	0	Taft
2·05	Mech. of Machines *2·00 or 2·01*	II	3	1	3	..	2	Swett
2·06	Mech. of Machines *2·00 or 2·01*	II(G.D.)(T.D.)	G	1	2	..	2	Swett
2·07	Auto. Machinery *(2·05 or 2·06), 2·20*	II(T.D.)	G	1	3	..	3	Swett
2·08	Auto. Machinery *2·07*	II(T.D.)	G	2	1	3		Swett
2·09	Des. of Auto. Mach. *2·05, 2·20, 2·850*	II	G(A)	2	0	12	0	Dole
2·10	Mech. Eng. Draw. *D22 (2·00)*	II	2	1	0	6	0	James
2·101	Mech. Eng. Draw. *D22 (2·00)*	$XIII_2$	2	1	0	4	0	James
2·102	Mech. Eng. Draw. *2·101 or 2·10*	XVI	2	2	0	4	0	James
2·11	Mech. Eng. Draw. *D22 (2·01)*	XV_2	3	S	0	5	0	James
2·12	Mech. Eng. & Mach. Draw. *D12, D22 (2·00)*	VI, XVI	2	1	1	6	0	James
2·121	Mech. Eng. & Mach. Draw. *D12, D22 (2·00 or 2·01)*	I-A, IX-B, $XIII_1$	2	1	1	5	0	James
2·122	Mech. Eng. & Mach. Draw. *D12, D22 (2·00 or 2·01)*	VI-A	2	1	1	4	0	James
2·13	Machine Drawing *D12*	II	2	2	1	5	0	James
2·131	Machine Drawing *D12*	VII_3, XI	2	1	0	5	0	James
2·14	Machine Drawing *D12*	III_3 XV_2	3 3	S 1	0 0	4 4	0 0	James
2·14T	Machine Drawing	XVI	3	2	0	3	0	James
2·15	Applied Mechanics *(M21, 8·02)*	I, II, IX-B, X, XI, XVI, XVII I-A, IV-A $III_{1,2,3}$	2 2 3	2 1 1	3 3 3	.. .. ..	6 6 6	Johnston
2·151	App. Mech. (Kin.) *2.16*	(Elective)	2	1 or 2	1	..	2	Johnston
2·16	App. Mechanics *(M21, 8·02)*	VI, VII_3, XIII, XV III_4, XIV VI-A	2 3 2	2 1 1	2 2 2	.. .. ..	4 4 4	Johnston
2·20	App. Mechanics *2·15 or 2·16*	I, I-A(B), II, VI, VI-A(B), VI-C, VII_3, IX-B, X, XI, XIII, XV, XVI, XVII IV-A III, XIV I-A(A), VI-A(A) Mil. Eng.	3 2 3 3 4	1 2 2 S S	3 3 3 3 3	.. ..	6 6 6 6 6	Johnston
2·21	App. Mechanics *2·20*	II Mil. Eng.	3 4	2 S	3 3	.. ..	5 5	Fuller

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2.211	App. Mechanics...	IV-A	3	1	3	..	6	Fuller
	2.20							
2.22	App. Mechanics...	VI, VI-A(A)	3	2	3	..	5	Fuller
	2.20	VI-A(B)	4	S	3	..	5	
2.221	App. Mechanics...	XIII$_1$, XV$_2$	3	2	3	..	6	Fuller
	2.20							
2.231	Mechanics........	IV	2	1	3	..	6	Fuller
	M12							
2.232	Mechanics	IV	2	2	3	..	6	Fuller
	2.231							
2.251	Dyn. of Mach.....	II, XVI	4	1	2	..	4	Riley
	2.15, 2.20	II(O.D.)(T.D.)	G	1	2	..	4	
2.252	Dyn. of Mach., Adv.	II(G.E. Co.)	G	1	2	..	5	Riley
	2.251 or equiv.							
2.254	Dynamics of Eng. .	II(A.E.)	G	1	2	..	4	Riley
	2.251	II, XVI	G(A)	1	2	..	4	
2.255	Dyn. of Aircraft Eng.	XVI	G(A)	1	2	..	2	Riley
	2.254 or equiv.							
2.26	Mech. of Eng.	II	4	2	3	..	6	Fuller
	2.21							
2.271	Th. of Elasticity ..	II(A.O.)	4	1	4	..	8	Fuller
	2.891							
2.272	Th. of Elasticity ..	II(A.O.)	4	2	2	..	4	Fuller
	2.271							
2.281	Adv. Mech. & Th. Elas...........	II	G(A)	1	3	..	9	Fuller
	2.26	II(O.D.)	G	1	3	..	9	
2.282	Adv. Mech. & Th. Elas............	II	G(A)	2	3	..	9	Fuller
	2.281	II(O.D.)	G	2	3	..	9	
2.283	Mechanics, Adv. ..	II(G.E. Co.)	G	1	1	..	3	Fuller
2.284	Th. of Elasticity ..	II(G.E. Co.)	G	2	3	..	8	Fuller
2.29	Interior Ballistics..	II(O.D.)	G	2	2	..	3	Johnston
	M22, 2.15							
2.30	Materials of Eng...	II, XIII$_1$	3	2	2	..	2	H.W.Hayward
	2.20	Mil. Eng.	4	1	2	..	2	
		I-A(A)	3	S	2	..	2	
		I-A(B)	4	S	2	..	2	
		XVI	3	1	2	..	2	
2.301	Materials of Eng...	II(T.D.)	G	1	1	..	2	H.W.Hayward
2.304	Materials of Eng...	IV-A	3	1	2	..	2	H.W.Hayward
	2.20 (or 2.20)							
2.305	Mater. & Test.....	II(G.E. Co.)	G	2	0	7	3	H.W.Hayward
	2.284, 2.36, 3.703							
2.31	Materials of Eng...	XIII$_2$	4	1	1	..	2	H.W.Hayward
	2.20	XV$_2$	3	2	1	..	2	
2.35	Testing Mat. Lab..	II, XVI	4	1	1	3	2	H.W.Hayward
	2.30							
2.36	Testing Mat. Lab..	IV-A, XIII$_1$, XVII	4	1	0	2	1	H.W.Hayward
	2.20	Mil. Eng.	4	2	0	2	1	
		XV$_1$, VI-A(A)	3	2	0	2	1	
		VI-A(B)	4	S	0	2	1	
2.362	Testing Mat. Lab. Conc......... ..	IV-A	4	1	0	3	2	H.W.Hayward
	2.304							
2.363	Testing Mat. Lab. Conc...........	(Elective)	4	S	0	2	0	Adams
		Mil. Eng.,	4	1	0	2	0	
2.37	Testing Mat. Lab..	I, I-A(A), XV$_1$ (1st 10 w.)	3	2	0	2	0	H.W.Hayward
		III (l. 5 w.)	3	2	0	2	0	
		I-A(B), XI (l. 5 w.)	3	1	0	2	0	
		X, XI (1st 10 w.)	4	2	0	2	0	
		XIII$_2$, XV$_3$ (l. 5 w.)	4	1	0	2	0	
2.38	Phys. Test. of Met.	(Elective)		S	0	2	0	Cowdrey
2.381	Adv. Test. & Exam. of Metals	(Elective)		S	1	6	3	H.W.Hayward

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·390	Reinf. Conc. Des. & Lab.	XVII	4	1	0	7	0	Peabody
2·391	Reinf. Con. Des. *2·211*	IV-A	4	1	2	5	0	Peabody
2·392	Reinf. Con. Des. *2·391*	IV-A	4	2	2	4	0	Peabody
2·393	Reinf. Con. Des., Adv. *2·392*	II	G(A)	1✦				Peabody
2·394	Concrete Research *2·362*	II	G(A)	1✦				Peabody
2·395	Conc. Bldgs. Des. & Spec. *2·20*	Mil. Eng.	4	2	2	..	4	Peabody
2·40	Eng. Thermodyn. *(M21), 8·04*	II, III_3, VI, VI-A(B) IX-B, XIII, XV, XVI	3	1	4	..	5	Berry
		II(T.D.)	G	1	4	..	5	
		VI-A(A)	3	S	4	..	5	
2·41	Boilers & Engines *8·04*	II, XV_2	3	1	2	..	2	Miller
2·42	Eng. Thermodyn. *2·40*	II, VI, VI-A(A), IX-B, XIII, XV, XVI	3	2	4	..	5	Berry
		II(T.D.)	G	2	4	..	5	
		VI-A(B)	4	S	4	..	5	
2·43	Refrigeration *2·40*	II	4	1	2	..	4	Berry
2·46	Heat Engineering *(M21), 8·04*	I-A(B)	3	1	4	..	7	Miller
		I, XI, I-A(A)	4	1	4	..	7	
		Mil. Eng.	4	S	4	..	7	
2·461	Heat Engineering	II(A.O.)	4	1	3	..	6	Miller
2·47	Heat Engineering *2·46*	I-A(B)	3	2	2	..	3	Miller
		I, I-A(A), XI	4	2	2	..	3	
		Mil. Eng.	4	S	2	..	3	
2·471	Heat Engineering *2·461*	II(A.O.)	4	2	3	..	4	Miller
2·48	Int. Com. Engines	XIII-A	4	2	1	..	2	Riley
2·49	Refrigeration *2·43*	II_4	4	2	3	..	5	Berry
2·491	Refrigeration *8·04*	VII_2	4	1	1	..	2	Gray
2·501	Refrigeration, Adv. *2·43*	II	G(A)	1	3	..	9	Berry
2·502	Heat Trans., Adv. *2·43*	II	G(A)	2	3	..	9	Berry
2·503	Heat Eng., Adv.	II(G.E. Co.)	G	1	3	..	8	Berry
2·51	Torpedoes *2·40*	II(T.D.)	G	2	2	..	4	Taft
2·58	Power Plant Design *2·41, 2·42*	II	4	2	0	4	0	Miller
2·581	Power Plants, Adv. *2·58 or equiv.*	II	G(A)	1	3	..	6	Holt
2·59	Mech. Eq. Bldg., H. & V. *M11, 8·04*	IV-A, XVII	4	2	4	..	3	Holt
2·601	Engineering Lab. *2·40 or 2·46*	II	4	1	0	4	4	Eames
2·602	Engineering Lab. *2·601*	$II_{0,2}$	4	2	0	4	4	Eames
2·603	Engineering Lab. *2·601*	$II_{1,3,4}$	4	2	0	2	2	Eames
2·611	Engineering Lab. *2·40 or 2·46*	III_3, XIII	3	2	0	2	1	Eames
		XVI	4	1	0	2	1	
2·612	Engineering Lab. *2·611*	XIII	4	1	0	2	2	Eames
2·614	Engineering Lab. *2·40 or 2·46*	XV_2	4	1	0	4	3	Eames
2·615	Engineering Lab. *2·601 or 2·614*	$XIII_1$, XV_2	4	2	0	2	2	Eames
2·62	Engineering Lab. *2·40 or 2·46*	IX-B, X	4	1	0	4	2	Eames
		XV_3	4	2	0	4	2	

✦Time specially arranged.

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·621	Engineering Lab. . . *2·40 or 2·46*	VI, VI-A(A)1, 2	4	1	0	3	2	Eames
		VI-A(B)1, 2	4	2	0	3	2	
2·63	Eng. & Hyd. Lab. . *2·40 or 2·46*	I1, 2, XI, XV1	4	2	0	2	2	Eames
		I-A(B)	4	S	0	2	2	
		I-A(A)	4	1	0	2	2	
2·631	Eng. & Hyd. Lab. . *2·40 or 2·46*	I3, Mil. Eng.	4	2	0	3	3	Eames
2·64	Refrigeration Lab. . *2·43 & 2·601*	II4	4	2	0	2	2	Eames
2·65	Power Lab. . . . . *2·461*	II(A.O.)	4	2	0	2	2	Eames
		Chem. War.	G	2	0	2	2	
2·651	Gas Engine Lab. . .	(Elective)		S	1	12	0	Fales
2·652	Int. Com. Engines. *2·601, 2·42*	(Elective)		S	2	5	0	Taylor
2·66	Automobile Lab. . . *2·601 (2·79)*	II1	4	2	0	2	2	Fales
2·661	Main. & Op. of Auto. Eq. . . . . . . *2·79*	II	G(A)	1	2	. .	2	Fales
		II(A.E.)	G	1	2	. .	2	
2·671	Engine Testing . . . . *2·66*	II(A.E.)	G	1	0	4	2	Fales
2·672	Motor Veh. Test. . . *2·801 & 2·671*	II	G(A)	2	1	4	3	Fales
		II(A.E.)	G	2	1	4	3	
2·681	Aero. Engine Lab. .	(Elective)	G	1	0	4	4	Fales
2·691	Aero. Engine Lab. . *2·601*	II(T.D.)	G	2	0	2	0	Fales
2·70	Machine Design . . . *D12, 2·20*	II	3	2	1	3	0	Townsend
2·71	Machine Design . . . *2·70*	IIo, 3, 4	4	1	2	4	0	Swett
		II(O.D.)	G	1	2	4	0	
2·711	Machine Design . . . *2·70*	II1, 2	4	1	2	2	0	Swett
2·712	Machine Design . . . *2·711*	II1	4	2	1	1	0	Swett
2·721	Machine Design . . . *2·20*	XV2	4	1	2	2	0	Swett
2·722	Machine Design . . . *2·721*	(Elective)	4	2	2	. .	2	Swett
2·731	Machine Design . . . *2·15, 2·20*	XVI	4	1	2	0	4	Swett
2·732	Machine Design . . . *2·731*	XVI	4	2	2	. .	4	Swett
2·741	Machine Des., Adv. *2·71 or 2·712*	II	G(A)	1	3	5	2	Haven
2·742	Machine Des., Adv. *2·741*	II	(GA)	2	3	5	2	Haven
2·743	Machine Des., Adv. *2·71*	II(G.E. Co.)	G	2	3	5	0	Haven
2·75	Machine Des., Adv. *2·71*	II(O.D.)	G	2	3	7	0	Haven
2·761	Machine Design . . .	II(T.D.)	G	1	2	4	2	Haven
2·762	Machine Design . . . *2·761*	II(T.D.)	G	2	2	4	2	Haven
2·77	Engine Design . . . . *2·251 ,2·711*	II2	4	2	2	4	2	Riley
2·781	Industrial Plants . . *2·21*	II	4	2	3	. .	3	Peabody
2·782	Industrial Plants . . *(2·781)*	IIo	4	2	0	4	0	Peabody
2·79	Gasoline Auto. . . . . *2·40 or 2·47*	II1	4	2	3	. .	3	Park
2·801	Automotive Eng. . . *2·79, 2·251*	II	G(A)	1	3	0	6	Park
		II(A.E.)	G	1	3	0	6	
2·802	Automotive Eng. . . *2·801*	II	G(A)	2	3	0	6	Park
		II(A.E.)	G	2	3	0	6	

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·811	Automotive Design *(2·801)*	II(A.E.)	G	1	0	8	0	Park
2·812	Automotive Design *(2·802)*	II(A.E.)	G	2	0	10	0	Park
2·850	Automatic Mach... *2·05, 2·21*	II$_3$a	4	2	2	..	2	Swett
2·851	Fire Protec. Eng...	II$_3$	4	2	2	..	2	Schwarz
2·852	Locomotive Eng... *2·20, 2·47*	I-A(B)	G	1	3	..	3	Dole
		I-A(A)	G	S	3	..	3	
2·853	Locomotive Eng... *2·251*	II$_6$ (Elective)	4	2	2	..	2	Dole
2·854	Mech. Eq. of Bldgs. *2·40 or 2·46*	II$_6$ (Elective), II$_3$a	4	2	2	..	2	Holt
2·855	Steam Tur. Eng. .. *2·42*	II$_6$ (Elective)	4	2	2	..	2	Taft
2·858	Inspection Meth... *2·951*	II (Elective)	4	2	2	..	2	Buckingham
2·87	Textile Eng. .... *2·05*	II$_3$	4	2	2	4	2	Haven
2·871	Textile Eng.	II$_3$a	4	2	6	..	0	Haven
2·872	Des. of Cot. Mach. *2·05, 2·71 or 2·711*	(Elective)	G	1	3	..	6	Haven
2·873	Des. of Wool Work. Mach. .... *2·05, 2·71 or 2·711*	(Elective)	G	2	3	..	6	Schwarz
2·874	Dyn. of Tex. Mach. *2·251*	(Elective)	G	1	2	..	2	Haven
2·875	Tex. Tech. Anal. .. *2·87*	(Elective)	G	1	2	..	3	Haven
2·876	Prin. of Fabric St.. *2·87*	(Elective)	G	1	2	..	4	Schwarz
2·88	Ordnance Eng. ..... *2·21 or 2·221*	II Ord.	4	2	3	2	3	Fuller
2·891	Mechanics *M72*	II(A.O.)	4	S	13	..	3	Fuller
2·892	Ordnance Problems *2·271*	II(A.O.)	4	2	2	6	0	Fuller
2·90	Forging	II, III$_4$	2	2	0	3	0	Lambirth
		XVI	3	S	0	3	0	
2·901	Forging	XIII$_1$	2	1	0	2	0	Lambirth
		XIII$_2$	3	1	0	2	0	
2·902	Forging	III$_3$, XIII$_1$	2	2	0	2	0	Lambirth
2·91	Foundry	II	2	1	0	3	0	O'Neill
		III$_4$	3	1	0	3	0	
2·911	Foundry	I-A, III$_3$, IV-A, XIII$_1$	2	2	0	2	0	O'Neill
		VI	2	1	0	2	0	
		XIII$_2$	3	2	0	2	0	
		XV$_2$, XVI	3	S	0	2	0	
2·921	Carpentry	XVII	3	1	0	2	0	O'Neill
2·92	Pattern Making... *2·91*	II	2	2	0	2	0	O'Neill
2·923	Pattern Making... *2·913*	XVI	3	S	3	..	0	O'Neill
2·941	Mach. Tool Lab. ..	VI	2	1	1	1	0	Littlefield
2·942	Mach. Tool Lab. .. *2·941*	VI	2	2	1	3	0	English
2·951	Mach. Tool Lab. ..	II, XIII$_1$	3	1	2	4	0	R. H. Smith
		XVI	3	S	2	4	0	
2·952	Mach. Tool Lab. .. *2·951*	II, XIII$_1$	3	2	1	3	0	R. H. Smith
2·96	Mach. Tool Lab. ..	I-A, IX-B	2	2	1	3	0	R. H. Smith
		XIV	2	1	1	3	0	
		III$_4$	3	2	1	3	0	
2·961	Mach. Tool Lab. ..	XIII$_2$	4	2	1	1	0	R. H. Smith
2·971	Mach. Tool Lab. ..	XV$_2$	2	1	1	2	0	R. H. Smith

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
2·972	Mach. Tool Lab. . . *2·971*	XV_2	3	S	1	2	0	R. H. Smith
2·98	Production Meth. . *2·952*	II	4	**2**	1	..	1	R. H. Smith
2·981	Manuf. Proc. . . . . . *2·952*	II	G(A)	**1**	3	..	3	R. H. Smith
		II(A.E.)	G	**1**	3	..	3	
2·99	Met. & Dim. Eng. . *2·951*	II	G(A)	**1**	3	..	6	Buckingham

MINING AND METALLURGY — 3·00–3·99
Including Petroleum Production

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
3·00	Int. to Min. & Met.	III	2	1	2	..	0	Hutchinson
3·01	Mining Methods . . *1·10, 8·04, 12·01*	III$_1$	3	1	5	..	3	Hutchinson
3·02	Mining Methods . . *3·01*	III$_1$	3	2	4	..	3	Hutchinson
3·03	Econ. of Mining . . . *3·02, or 3·05; 3·08; 3·21 or 3·23*	III$_{1,2}$	4	1	4	..	3	Hutchinson
3·04	Mining, Prin. of . . . *3·03*	III$_{1,2}$	4	2	3	..	4	Hutchinson
3·05	Mining, Elem. of . .	III$_{2,3,4}$, XIIa	3	1	2	..	2	Hutchinson
3·061	Mining, Eng., Adv. *3·04*	III$_1$	G(A)	1✦				Hutchinson
3·062	Mining Eng., Adv.. *3·04*	III$_1$	G(A)	2✦				Hutchinson
3·08	Mining Practice . . . *1·10*	III$_{1,2}$	3	S	0	3	0	Hutchinson
3·09	Mining Law . . . . . . *3·04*	III$_1$	G(A)	1	2	..	8	Hutchinson
3·101	Mine Valuation . . . *3·04, 3·08*	III$_1$	G(A)	1	3	..	8	Hutchinson
3·102	Mine Valuation . . . *3·101*	III$_1$	G(A)	2	3	..	8	Hutchinson
3·12	Econ. of Min., Adv. *3·04*	III$_1$	G(A)	2✦				Hutchinson
3·13	Geophys. Pros. El. . *M22, 8·04*	III$_{1,2}$	4	1	1	2	1	Foster
3·14	Geophys.,Th.& Ap. *3·13*	III$_1$	G(A)	2✦				Foster
3·21	Ore Dressing . . . . . . *12·01 (3·22)*	III$_1$	3	2	3	..	2	Locke
3·22	Ore Dressing Lab. . *3·31, 5·13 (3·21)*	III$_1$	3	2	1	4	2	Locke
3·23	Ore Dressing . . . . . . *12·01*	III$_{2,3}$, XIIa	3	2	1	2	2	Locke
3·241	Ore Dressing, Adv. *3·21, 3·22; or 3·23*	III$_1$	G(A)	1✦				Locke
3·242	Ore Dressing, Adv. *3·21, 3·22; or 3·23*	III$_1$	G(A)	2✦				Locke
3.251	Th. & Prac. of Flot. *3·21, 3·22; or 3·23*	III$_1$	G(A)	1	2	..	4	Locke
3.252	Th. & Prac. of Flot. *3·21, 3·22; or 3·23*	III$_1$	(G(A)	2	2	..	4	Locke
3·26	Ore Dress. Econ. . . *3·21, 3·22; or 3·23*	III$_1$	G(A)	1 or 2	2	..	4	Locke
3·271	Ore Dressing Des. . *3·21, 3·22; or 3·23*	III$_1$	G(A)	1	2	..	4	Locke
3·272	Ore Dressing Des. . *3·21, 3·22; or 3·23*	III$_1$	G(A)	2	2	..	4	Locke
3·31	Fire Assaying . . . . . *12·01, 5·12*	III$_{1,3}$	3	1	2	4	2	Bugbee
3·32	Fire As.& Met. Lab. *5·12*	(Elective)	4	1	2	2	2	Bugbee
3·331	Fire Assaying, Adv. *3·31, 5·12*	III$_{1,3}$	G(A)	1	6	7	0	Bugbee
3·332	Fire Assaying, Adv. *3·31, 5·12*	III$_{1,3}$	G(A)	2	6	7	0	Bugbee
3·41	Met.; Copper, Lead *3·60, 5·13, 12·01*	III$_{3,4}$	4	1	5	5	3	C. R. Hayward
3·411	Met.; Copper, Lead *3·60, 5·13, 12·01*	III$_{3,4}$	4	1	4	2	3	C. R. Hayward
3·412	Met.; Copper, Lead *5·13, 12·01*	III$_1$	4	1	3	2	3	C. R. Hayward
3·42	Met.; Gold & Silver *3·31, 3·23*	III$_3$	4	2	2	3	2	Bugbee
3·421	Met.; Gold & Silver *3·31, 3·23*	III$_1$	4	2	1	2	1	Bugbee
3·43	Met.; Iron & Steel . *3·60, 5·02*	III$_{3,4}$	4	1	7	..	3	Waterhouse
3·431	Met.; Iron & Steel . *3·60, 5·02*	III$_{3,4}$	4	1	3	..	3	Waterhouse

✦Time specially arranged.

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
3·432	Met.; Iron & Steel. *5·02*	III$_1$ III$_2$	4 3	1 1	2 2	.. ..	1 1	Waterhouse
3·44	Met.; Gen. Zinc & Min. Met. . . . . . . *3·411, 3·431*	III$_{3,4}$	4	2	4	..	3	C. R. Hayward
3·45	Met.; Heat Tr. Steel *3·431, 3·61, 3·12*	III$_3$	4	2	2	..	1	Waterhouse
3·46	Met. of Com. Met. *5·02*	XII	4	2	3	..	3	C. R. Hayward
3·501	Met.; Iron & Steel, Adv. . . . . *3·43*	III$_{3,4}$	G(A)	1✦				Waterhouse
3·502	Met.; Iron & Steel, Adv. . . . . *3·43*	III$_{3,4}$	G(A)	2✦				Waterhouse
3·511	Metal. Plant Design *3·41, 3·42, 3·43*	III$_3$	G(A)	1	13	..	0	Waterhouse
3·512	Met. Plant Design. *3·41, 3·42, 3·43*	III$_3$	G(A)	2	13	..	0	Waterhouse
3·521	Gen. Metal., Adv. . *3·44*	III$_3$	G(A)	1	3	..	6	C. R. Hayward
3·522	Gen. Metal., Adv. . . *3·44*	III$_3$	G(A)	2	3	..	6	C. R. Hayward
3·531	Non-Fer.Met., Adv. *3·41, 3·23, 3·44*	III$_{3,4}$	G(A)	1✦				C. R. Hayward
3·532	Non-Fer.Met.,Adv. *3·41, 3·42, 3·44*	III$_{3,4}$	G(A)	2✦				C. R. Hayward
3·541	Gold. & Silver Met., Adv. . . . . *3·42*	III$_3$	G(A)	1✦				Bugbee
3·542	Gold & Silver Met., Adv. . . . . *3·42*	III$_3$	G(A)	2✦				Bugbee
3·56	Metal. Plants . . . . . *3·41, 3·42, 3·43*	(Elective)	4	2	3	..	3	Waterhouse
3·60	Metal. Pl. Visits. . .	III$_{3,4}$	4	S	0	3	1	C. R. Hayward
3·61	Metallography . . . . *5·12, 8·04*	III$_3$	3	2	2	3	1	Williams
3·611	Metallography *5·12, 8·04*	XIV V III$_2$	4 4 3	2 1 2	2 2 2	2 2 2	1 1 1	Williams
3·615	Metallography . . . . (*3·701*)	II(T.D.)	G	1	1	2	2	Williams
3·621	Metallography . . . . *5·12, 8·04*	III$_4$	3	1	5	..	2	Williams
3·622	Metallography . . . . *3·621*	III$_4$	3	2	5	..	2	Williams
3·641	Phys. Metal. (Non-Fer.) . . . . *3·622*	III$_4$	4	1	7	..	2	Williams
3·642	Phys. Metal. (Fer.) *3.641*	III$_4$	4	2	5	..	2	Homerberg
3·651	Phys. Metal., Adv. *3·61 or 3·622*	III$_{3,4}$	G(A)	1✦				Williams
3·652	Phys. Metal., Adv. *3·61 or 3·622*	III$_{3,4}$	G(A)	2✦				Williams
3·653	Phys. Metallurgy . . *2·30*	II	G(A)	1	1	9	2	Williams
3·654	Phys. Metallurgy . . *3·653*	II	G(A)	2	1	9	2	Williams
3·655	Aircr. Met.& Met. . *16·54* (Open only GXVI)	XVI	G(A)	1	2	2	2	Williams C. R. Hayward
3·66	App. of Metallog. . . *3·61 or 3·611, 3·622*	III$_{3,4}$	G(A)	1 or 2	0	5	0	Homerberg
3·67	Physics of Metals. . *3·622, 3·61 or 3·611*	III$_4$	4	2	4	..	2	Williams
3·68	Microstruct. of Ores and Metals . . . . . *5·12, 8·02*	III$_{1,2}$	4	1	3	..	0	Williams Newhouse
3·70	Heat Treatment . . . *2·30*	II$_{1,2}$	4	1	0	2	0	Williams

✦Time specially arranged.

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
3·701	Heat Treatment... *(3·651)*	II(O.D.)(T.D.)	G	1	1	2	2	Williams
3·702	Heat Treatment... *3·70*	II(A.E.)	G	1	1	2	0	Williams
3·703	Heat Treatment...	II(Elective) (G.E. Co.)	G	2	1	2	0	Williams
3·71	Heat Treatment... *2·30, 2·37 or (2·37)*	I-A(B), II_G, (Elective) II Ord.	4	2	1	3	0	Williams
		I-A(A), III_4	3	2	1	3	0	
3·711	Heat Treatment... *2·30*	Mil. Eng.	4	2	0	2	0	Williams
3·72	Heat Treat. & Met. *3·702*	II, III_4	G(A)	2	1	3	2	Williams
		II(A.E.)	G	2	1	3	2	
3·731	Phys. Metallurgy..	II(O.D.)(T.D.)	G	1	1	..	2	Williams
3·732	Phys. Metallurgy.. *3·731*	II(O.D.)(T.D.)	G	2	1	7	2	Williams
3·81	Petrol. Eng., El.... *1·10, 8·04, 12·30*	III_2	3	1	5	..	3	Mann
3·82	Petrol. Eng., El.... *3·81*	III_2	3	2	5	..	3	Mann
3·84	Outline of Pet. Pd.	Elective	4	2	3	..	1	Mann
3·85	Pet. Prod. & Util. . *3·82*	III_2	4	1	2	..	1	Mann
3·86	Pet. Prod. & Util. . *3·85*	III_2	4	2	5	..	3	Mann
3·89	Oil Field Visits ... *1·10*	III_2	3	S	0	3	0	Mann
3·901	Oil & Gas Land Val. *3·86, 3·89*	III_2	G(A)	1	3	..	8	Mann
3·902	Oil & Gas Land Val. *3·901*	III_2	G(A)	2	3	..	8	Mann
3·911	Petrol. Eng., Adv.. *3·86*	III_2	G(A)	1✦				Mann
3·912	Petrol. Eng., Adv.. *3·86*	III_2	G(A)	2✦				Mann
3·921	Oil & Gas Law.... *3·86*	III_2	G(A)	1	2	..	4	Mann
3·922	Oil & Gas Law.... *3·86*	III_2	G(A)	2	2	..	4	Mann
3·93	Oil Well Waters... *3·86*	III_2	G(A)	2	2	..	2	Mann

✦Time specially arranged.

ARCHITECTURE — 4·00–4·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
4·021	Freehand Drawing.	IV	2	1	0	4	0	W. F. Brown
4·022	Freehand Drawing. *4·021*	IV	2	2	0	4	0	W. F. Brown
4·031	Freehand Drawing. *4·022*	IV	3	1	0	4	0	W. F. Brown
4·032	Freehand Drawing. *4·031*	IV	3	2	0	4	0	W. F. Brown
4·041	Freehand Drawing. *4·032*	IV	4	1	0	6	0	W. F. Brown
4·042	Freehand Drawing. *4·041*	IV	4	2	0	6	0	W. F. Brown
4·051	Free. Dr. & Dec. Des. *4·042*	IV	G(A)	1	0	6	0	W. F. Brown
4·052	Free. Dr. & Dec. Des. *4·051*	IV	G(A)	2	0	6	0	W. F. Brown
4·06	Graphics.........	IV	1	1	6	..	0	Beckwith
4·071	Modelling........ *4·722*	IV	3	1	0	3	0	Larsen
4·072	Modelling........ *4·071*	IV	3	2	0	3	0	Larsen
4·081	Color, Th. & Exer..	(Elective)	3	1	1	..	3	F. J. Robinson
4·082	Color, Th. & Exer..	(Elective)	3	2	1	..	3	F. J. Robinson
4·091	Color, Des. & App. *4·722*	IV	4	1	1	..	4	Hewlett
4·092	Color, Des. & App.	IV	4	2	1	..	4	Hewlett
4·11	Shades & Shadows. *4·06*	IV	1	1	0	3	0	Gardner
4·12	Perspective ...... *4·06 or (D311)*	IV	1	1	3	..	0	Beckwith
4·13	Perspective....... *D22*	IV-A	2	1	1	..	3	Lawrence
4·20	Office Practice .... *4·712, 4·212*	IV	2	S	7	..	0	Jenney
4·211	Office Practice .... *4·712*	IV	2	1	3	..	0	Jenney
4·212	Office Practice .... *4·211*	IV	2	2	3	..	0	Jenney
4·22	Office Practice	IV-A	3	1	6	..	0	Jenney
4·241	Prof. Relations....	IV, IV-A	4	1	1	..	1	Jenney
4·242	Prof. Relations.... *4·241*	IV, IV-A	4	2	1	..	1	Jenney
4·25	Estimating....... *4·212* or *4·22* and *4·812* or *4·912*. (Not offered to students below the 4th year)	IV-A	4	1	1	..	2	Jenrick
4·311	Theory of Arch....	IV	1	1	1	..	0	Beckwith
4·312	Theory of Arch.... *4·311*	IV	1	2	1	..	0	Beckwith
4·321	Theory of Arch.... *4·312*	IV	2	1	1	..	1	F. J. Robinson
4·322	Theory of Arch.... *4·321*	IV	2	2	1	..	1	F. J. Robinson
4·331	Theory of Arch.... *4·322*	IV	3	1	2	..	0	Gardner
4·332	Theory of Arch.... *4·331*	IV	3	2	2	..	0	Gardner
4·411	Architectural Hist..	IV	1	1	2	1	3	Putnam
4·412	Architectural Hist.. *4·411*	IV	1	2	2	1	3	Putnam
4·413	Architectural Hist..	IV-A	2	1	2	..	2	Putnam
4·414	Architectural Hist.. *4·413*	IV-A	2	2	2	..	2	Putnam
4·421	Architectural Hist.. *4·412*	IV	2	1	0	1	1	Putnam

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
4·422	Architectural Hist.. *4·421*	IV	2	**2**	0	1	1	Putnam
4·423	Architectural Hist..	IV-A	3	**1**	1	..	1	Putnam
4·424	Architectural Hist.. *4·423*	IV-A	3	**2**	1	..	1	Putnam
4·471	Euro. Civ. & Art .. *G57*	IV	4	**1**	3	..	4	Sumner
4·472	Euro. Civ. & Art .. *4·471*	IV	4	**2**	3	..	4	Sumner
4·481	Euro. Civ. & Art .. *4·472*	IV	G(A)	**1**	2	..	4	Sumner
4·482	Euro. Civ. & Art .. *4·481*	IV	G(A)	**2**	2	..	4	Sumner
4·49	Hist. of Renais.Art *4·421*	IV	4	**2**	1	..	1	Walker
4·52	Philosophy of Arch.	IV	4	**2**	1	..	0	Walker
4·61	Town Planning....	IV	4	**1**	2	..	3	T. Adams
4·712	Design I..........	IV	1	**2**	0	12	0	Beckwith
4·721	Design II......... *4·712*	IV	2	**1**	0	11	0	F. J. Robinson
4·722	Design II......... *4·721*	IV	2	**2**	0	11	0	F. J. Robinson
4·731	Design III........ *4·722*	IV	3	**1**	0	13	0	Gardner
4·732	Design III........ *4·731*	IV	3	**2**	0	15	0	Gardner
4·741	Design IV........ *4·732*	IV	4	**1**	0	23	0	Cash
4·742	Design IV........ *4·741*	IV	4	**2**	0	25	0	Cash
4·751	Design V......... *4·742*	IV	G(A)	**1**	0	36	0	Carlu
4·752	Design V......... *4·751*	IV	G(A)	**2**	0	36	0	Carlu
4·78	Planning Principles *4·411, 4·412*	IV-A	3	**2**	4	..	7	Emerson
4·80	Building Construct.	IV IV-A	3 2	**1** **1**	1 1	.. ..	1 1	P. W. Norton
4·811	Construct. Design . *2·17, 2·18*	IV	3	**1**	7	..	0	P. W. Norton
4·812	Construct. Design . *4·811*	IV	3	**2**	7	..	0	P. W. Norton
4·90	Structural Drawing *D22*	IV-A	2	**2**	1	2	0	P. W. Norton
4·911	Structural Anal.... *2·20*	IV-A	3	**1**	6	..	0	W.H.Lawrence
4·912	Structural Anal.... *4·911*	IV-A	3	**2**	8	..	0	W.H.Lawrence
4·921	Structural Design.. *4·912, 1·40, 4·90*	IV-A	4	**1**	7	..	0	W.H.Lawrence
4·922	Structural Design.. ***4·921***	IV-A	4	**2**	5	..	0	W.H.Lawrence

CHEMISTRY — 5·00–5·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
5·00	Chem., Entrance ..			S	3	3	5	Blanchard
5·01	Chemistry, Elem... *5·00*	All courses except IV	1	1	4	4	5	H. M. Smith
5·02	Chemistry, Elem... *5·01*	All courses except IV	1	2	4	4	5	J. W. Phelan
5·04	Chemistry, Elem...	A.O.	4	S	3	..	3	Schumb
5·05	Atom. St., Elem. ..	(Elective)		2	1	..	1	Blanchard
5·061	Inorg. Chemistry.. *5·13 or 5·131*	V Chem. War.	4 G	1 1	2 2	.. ..	3 3	Schumb
5·062	Inorg. Chem. ...... *5·061*	V Chem. War.	4 G	2 1	2 2	.. ..	3 3	Schumb
5·07	Inorg. Chem., Adv. *5·062*	V	G(A)	1	2	..	3	Schumb
5·10	Qualitative Anal... *5·02*	V, X (Elective)	2 2	S 1	3 3	11 11	4 4	Hamilton
5·101	Qualitative Anal... *5·02*	XIV, XV$_3$ (Elective)	2 2	S 1	3 3	9 9	2 2	Hamilton
5·11	Qualitative Anal... *5·02*	III, VII$_3$, IX-A, XI, XII VII$_{1,2}$, VIII	2 2	1 S	2 2	5 5	2 2	Hamilton
5·12	Quantitative Anal.. *5·10, 5·101 or 5·11*	V, XIV, XV$_3$ III, IX-A, XI, XII VII$_{1,2}$	2 2 2	1 2 S	2 2 2	5 5 5	2 2 2	Hamilton
5·121	Quantitative Anal.. *5·10*	X	2	1	3	6	3	Hamilton
5·122	Quantitative Anal.. *5·11*	VII$_3$	2	2	3	7	3	Hamilton
5·13	Quantitative Anal.. *5·12*	III$_{1,3}$, XII V, XV$_3$	3 2	1 2	2 2	5 5	2 2	Hamilton
5·131	Quantitative Anal.. *5·121*	X	2	2	1	5	1	Hamilton
5·132	Quantitative Anal.. *5·12*	XIV	2	2	1	3	1	Hamilton
5·133	Chem. An. of Alloys *5·12*	III$_4$	3	1	2	5	2	Hamilton
5·141	Anal. Chemistry... *5·13*	V	3	1	3	..	2	Hamilton Gill
5·142	Anal. Chemistry... *5·141*	V	3	2	3	..	2	Hamilton
5·16	Anal. Chemistry... *5·131*	X-A	4	2	1	3	1	Hamilton
5·18	Qual. Anal., Adv... *5·10 or 5·101*	V	G(A)	1	1	8	1	Hall
5·20	Chem. of Wat. Sew. *5·12*	VII	3	2	1	3	1	Woodman
5·22	Water Sup. & Wastes Dis...... *5·12*	XI	4	1	0	2	1	Woodman
5·23	Sanitary Chem. .... *5·12*	XI	3	2	1	6	1	Woodman
5·25	Chemistry of Foods *5·12*	VII$_{1,2}$	3	1	1	4	1	Woodman
5·251	Chemistry of Foods *5·12*	(Elective)	4	1 or 2	1	2	1	Woodman
5·26	Food Analysis..... *5·12*	(Elective)	4	1 or 2	0	5	0	Woodman
5·30	Proximate Anal.... *5·12 or 5·121,* *5·41 or 5·413*	(Elective)	4	1 or 2	1	5	2	Gill
5·31	Gas Analysis...... *5·12*	III$_3$	2	2	1	1	0	Gill
5·33	Study of War Gases	V C. W. S.	3	2	1	..	1	Gill
5·35	Applied Chem..... *5·02*	XIII	4	2	1	..	2	Gill
5·37	Chem.of Road Mat. *5·02*	I$_2$b	4	1	1	3	0	Gill

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
5·38	Lub.&Fuel Oil Test.	(Elective)	4	1 or 2	1	2	1	Gill
5·381	Oil Tst.& Pet. Refin.	III₂	3	1	2	3	2	Gill
5·39	Special Methods... *5·12, 8·02*	(Elective)	3	1	0	2	1	Gill
5·41	Organic Chem. I .. *5·12, 8·04*	V, X A.O.	3 4	1 1	4 4	.. ..	3 3	Woodman Mulliken
5·411	Organic Chem. I .. *5·13, 8·03*	X C. W. S., V C. W. S.	3	1	4	..	3	Mulliken
5·412	Organic Chemistry. *5·02*	VII₁, ₂, VIII VII₃, XV₃	2 3	1 1	3 3	.. ..	2 2	Huntress
5·413	Organic Chemistry. *5·02*	IX-A, XIV	3	1	2	..	2	Huntress
5·414	Organic Chem. Lab. *5·12 (5·41 or 5·411)*	V A.O.	3 4	1 1	0 0	9 9	0 0	Mulliken
5·415	Organic Chem. Lab. *5·12 (5·411)*	V C. W. S.	3	1	0	9	0	Mulliken
5·416	Organic Chem. Lab. *5·121 (5·41 or 5·411)*	X	3	1	0	7	0	Mulliken
5·417	Organic Chem. Lab. *5·121 (5·411)*	X C.W.S.	3	1	0	7	0	Mulliken
5·418	Organic Chem. Lab. *5·412*	XV₃	3	2	0	6	0	Huntress
5·42	Organic Chem. I .. *5·41*	V, X A.O.	3 4	2 2	4 4	.. ..	2 2	Mulliken
5·421	Organic Chem. I .. *5·411*	V C. W. S., X C. W. S.	3	2	4	..	2	Mulliken
5·424	Organic Chem. Lab. *5·414*	V	3	2	0	13	0	Mulliken
5·425	Organic Chem. Lab. *5·415*	V C. W. S. Chem. War.	3 G	2 2	0 0	9 9	0 0	Mulliken
5·426	Organic Chem. Lab. *5·416*	X	3	2	0	3	0	Mulliken
5·427	Organic Chem. Lab. *5·417*	X C. W. S.	3	2	0	3	0	Mulliken
5·428	Organic Chem. Lab. *5·413*	VII₁, ₂	2	2	1	6	1	Huntress
5·429	Organic Chem. Lab. *5·413*	IX-A, XIV	3	2	0	5	0	Huntress
5·43	Powder & Explo. .. *5·42*	V C. W. S., II(A.O.), X Ord., X C. W. S. V Chem. War.	4 G(A) G	2 2 2	2 2 2	.. .. ..	2 2 2	Davis
5·431	Org.& Expl. Lab... *5·04, 5·41, 5·414*	A.O.	4	2	0	7	0	Davis
5·51T	Organic Chem. II.. *5·42*	V	G(A)	1	2	..	2	Norris
5·52T	Organic Chem. II . *5·42*	V	G(A)	2	2	..	2	Norris
5·53	Organic Chem. III. *5·42*	V	G(A)	1	3	..	6	Mulliken
5·54T	Organic Chem. IV. *5·42*	V	G(A)	1	3	..	3	Davis
5·55	Organic Qual. Anal. *5·42, 5·414*	V	G(A)	1	0	10	0	Mulliken
5·56	Tech. Org. Chem. . *5·412 or 5·413*	V	G(A)	2	2	..	2	Underwood
5·57T	Chemistry of Dyes. *5·42*	V	G(A)	2	2	..	2	Mulliken
5·581T	Org. Lab., Adv..... *5·414, 5·424*	V	G(A)	1	0	4	1	Morton
5·582T	Org. Lab., Adv. ... *5·41' 5·424 5·414, 5·424*	V	G(A)	2	0	4	1	Morton
5·59	Recent Adv. in Org. Chem.......... *5·42*	V (Not offered in 1929–30)	G(A)	2	1	..	1	Huntress
5·61T	Phys. Chem. I .... *M 21, 8·03, 5·13 or 5·131*	V, X	3	1	4	1	5	Sherrill

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep	Instructor in Charge
5·62T	Phys. Chem. II . . . *5·61T*	V, X	3	2	4	1	5	Sherrill
5·63	Phys. Chem. III. . . *5·62T*	V	4	1	3	1	4	Sherrill
5·64T	Phys. Chem. IV . . . *5·63T*	V	4	2	3	. .	4	Sherrill
5·681	Phys. Chem. Elem. *M21, 8·04, 5·13*	XV$_3$	3	1	2	. .	4	Millard
		III$_3$, XIIb	4	1	2	. .	4	
5·683	Phys. Chem., Elem. *5·02, 8·04*	II	3	1	2	. .	2	Millard
		Mil. Eng., XVI	4	1	2	. .	2	
		II (T.D.)	G	1	2	. .	2	
5·684	Phys. Chem., Elem.	VII$_{1, 2}$	3	1	3	. .	3	Gillespie
5·71T	Physical Chem. . . . *M21, 8·03, 5·13 or 5·131*	V	G(A)	1	4	. .	6	Sherrill
5·72T	Physical Chem. . . . *5·71T*	V	G(A)	2	4	. .	6	Sherrill
5·73	Free Energy . . . . . . *5·63 or 5·72T*	V	G(A)	1	2	. .	4	Sherrill
5·741	Kin. Th. of Gas, Liq. & Sol.	V	G(A)	1	2	. .	4	Keyes
5·742	Kin. Th. of Gas, Liq. & Sol. . . . . . *5·741*	V	G(A)	2	2	. .	4	Keyes
5·75T	Thermodynamics . .	V	G(A)	2	2	. .	2	Keyes
		II (T. D.)	G	2	2	. .	2	
5·76	Thermodyn.& Chem. *5·61T and 5·62T*	V	G(A)	1	3	. .	6	Gillespie
5·77	Thermodyn.& Chem. *5·76*	V	G(A)	2	2	. .	4	Beattie
5·78T	Quantum Th. Ap. . *5·63*	V	G(A)	1	2	. .	4	Beattie
5·79T	Th. of Solutions . . . *5·76*	V	G(A)	2	2	. .	4	Scatchard
5·81T	Chem. Literature I *L12 and L52 or L22*	V	3	1	3	. .	2	Hall
5·82T	Chem. Literature II *5·81T, 5·42, 5·61T*	V	3	2	1	. .	1	Huntress
5·83T	History of Chem. . . *5·41 or 5·413*	V	4	2	2	. .	2	Davis
5·842	Optical Methods . . *5·12, 8·02*	(Elective)	4	1 or 2	0	2	1	Woodman
5·843	Eng. Chemistry . . . *5·02*	(Elective)	4	1 or 2	2	. .	2	Gill
5·851	Meth. of Electrochem. An. *5·12*	V	G(A)	2	1	3	2	Hall
5·852	Org. Phys. Chem. . . *5·64T, 5·42*	V	G(A)	2	1	. .	1	Morton
5·853	Sub-Atomic Chem. . *5·41, or 5·413, 5·62T or 8·802*	V	G(A)	1	1	. .	2	Blanchard
5·854	Sub-Atomic Chem. *5·583*	V	G(A)	2	1	. .	2	Blanchard
5·855	Th. & App. of Cat. *5·413 or 5·412*	V	G(A)	2	2	. .	2	Underwood
5·90	Logic of Sci. Inq. . .	V	G(A)	1	1	. .	1	Davis
5·911	Journal Meet. in Inorg. Chem. . . .		G(A)	1	1	. .	1	Schumb
5·912	Journal Meet. in Inorg. Chem. . . .		G(A)	2	1	. .	1	Schumb
5·921	Journal Meet. in Org. Chem. . . . . . *5·42*	V	G(A)	1	1	. .	1	Norris
5·922	Journal Meet. in Org. Chem. . . . . . *5·42*	V	G(A)	2	1	. .	1	Norris
5·931	Journal Meet. in Phys. Chem.	V V	G(A)	1	1	. .	1	Scatchard
5·932	Journal Meet. in Phys. Chem.	V	G(A)	2	1	. .	1	Scatchard

No.	Subject with Prerequisites		Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
5·941	Research Conf..... *5·42, 5·63*	V		G(A)	**1**	1	..	1	Norris
5·942	Research Conf..... 5·42, 5·63	V		G(A)	**2**	1	..	1	Norris
5·96	Thesis Conf.......	V		4	**2**	1	..	1	Keyes
5·961	Thesis...........	V		4	**1**	0	15	0	Keyes
5·962	Thesis...........	V		4	**2**	0	15	0	Keyes
5·98	Research.........	V		G(A)	✦				Norris

✦Time arranged

ELECTRICAL ENGINEERING — 6·00–6·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
6·00	Elec. Eng. Prin.... *(M22) 8·03*	I-A, VI, VI-A	2	**2**	5	..	6	Barker
6·01	Elec. Eng. Prin.... *6·00*	VI, VI-C	3	**1**	3	..	4	Barker
		VI-A(A)	3	S	3	..	4	
		VI-A(B)	3	S	2	..	5	
6·02	Elec. Eng. Prin.... *6·00, 6·01*	VI, VI-C	3	**2**	5	..	6	R.R.Lawrence
		VI-A(B)	3	**1**	5	..	6	
6·021	Elec. Eng. Prin.... *6·00, 6·01*	VI-A(A)	3	**1**	2	..	4	R.R.Lawrence
6·023	Elec. Eng. Prin.... *6·021*	VI-A(A)	3	**2**	5	..	6	R.R.Lawrence
6·03	Elec. Eng. Prin.... *6·02*	VI, VI-C	4	**1**	6	..	8	R.R.Lawrence
6·031	Elec. Eng. Prin.... *6·02*	VI-A(B)	3	**2**	2	..	5	R.R.Lawrence
6·032	Elec. Eng. Prin.... *6·023 or 6·031*	VI-A(A)	4	S	2	..	5	R.R.Lawrence
		VI-A(B)$_3$	4	**1**	2	..	5	
		VI-A(B)$_{1,2}$	4	S	3	..	4	
6·04	Elec. Eng. Prin.... ***6·03***	VI	4	**2**	6	..	9	Woodruff
6·041	Elec. Eng. Prin.... *6·032*	VI-A(A)$_{1,2}$	4	**1**	3	..	5	Woodruff
		VI-A(B)$_{1,2}$	4	**1**	2	..	6	
6·042	Elec. Eng. Prin.... *6·041*	VI-A(A)$_{1,2}$	4	**2**	2	..	6	Woodruff
		VI-A(B)$_{1,2}$	4	**2**	3	..	5	
6·06	Elec. Eng. Prin.... *(M22) 8·03*	XIV	2	**2**	3	..	5	Barker
6·07	Elec. Eng. Prin.... *6·06*	XIV	3	**1**	4	..	6	Barker
6·08	Elec. Eng. Prin.... ***6·07***	XIV	3	**2**	4	..	6	Lyon
6·09	Elec. Eng. Prin.... *6·08*	XIV	4	**1**	4	..	6	Lyon
6·121	Elec. Eng. Prin.... *6·00, M22*	I-A(A)	3	S	2	..	4	Barker
		I-A(B)	4	S	2	..	4	
6·122	Elec. Eng. Prin.... *6·121*	I-A(A)	3	**1**	2	..	4	Barker
		I-A(B)	4	**1**	2	..	4	
6·123	Elec. Eng. Prin.... *6·122*	I-A(A)	3	**2**	3	..	5	Barker
		I-A(B)	4	**2**	3	..	5	
6·20	Power Trans. Eq... *6·03*	VI(Elective)	4	**2**	3	..	6	Woodruff
6·21	Ind. App. El. Power *6·03*	VI(Elective)	4	**2**	3	..	6	Dawes
6·221	Central Stations... *2·42*	VI(Elective)	4	**1**	3	..	6	Mulligan
6·222	Central Stations... *6·03*	VI(Elective)	4	**2**	3	..	6	Mulligan
6·23	Elec. Eq. Bldgs.... *8·04*	XVII	4	**2**	1	..	2	Hudson
		VI(Elective)	3, 4	**2**	1	..	2	
6·241	Electric Railways.. *6·01 (6·03)*	VI(Elective)	4	**1**	3	..	6	Entwistle
6·242	Electric Railways.. *6·241*	VI(Elective)	4	**2**	3	..	6	Entwistle
6·251	Elec. Mach. Des... *(6·03)*	VI(Elective)	4	**1**	3	..	6	Dwight
6·252	Elec. Mach. Des... *6·03*	VI(Elective)	4	**2**	3	..	6	Dwight
6·27	Illumination...... *8·02*	VI(Elective)	4	**1**	3	..	6	J. W. Barker
6·281	Prin. Wire Com.... *(6·03)*	VI(Elective)	4	**1**	3	..	6	C. E. Tucker
6·282	Prin. Radio Com... *6·02*	VI(Elective)	4	**2**	3	..	6	Barrow
6·29	Storage Batteries.. *6·00*	VI(Elective)	4	**1** or **2**	1	..	1	R.R.Lawrence
6·301	Elec. Com., Prin... *6·00*	VI-C	3	**1**	3	..	6	C. E. Tucker

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
6·302	Elec. Com., Prin... *6·301 (6·02)*	VI-C	3	2	3	..	6	Bowles
6·311	Elec. Com., Prin... *6·02*	VI-A(A)₃, VI-C	4	1	3	..	5	Bowles
		VI-A(B)₃	4	S	3	..	5	
6·312	Elec. Com. Prin... *6·311*	VI-A(A)₃, VI-C, VI-A(B)₃	4	2	3	..	5	Guillemin
6·330	Elec. Com. Lab.... *(6·311)*	VI-A(A)₃	4	1	0	4	4	Barrow
		VI-A(B)₃	4	2	0	4	4	
6·331	Elec. Com. Lab.... *(6·311)*	VI-C	4	1	0	5	6	Barrow
6·332	Elec. Com. Lab.... *6·331*	VI-C	4	2	0	3	4	Barrow
6·40	Elec. Eng. Elem.... *8·04*	I, XI, XV₁, XVII	3	1	4	..	6	Hudson
		II, IX-B, XV₂	3	2	4	..	6	
		III, X, XIII, XV₃, XVI, Mil. Eng.	4	1	4	..	6	
6·41	Elec. Eng. Elem.... *8·04*	X-B	4	1	3	..	5	Hudson
6·42	Elec. Eng. Elem....	II(A.O.)	4	1	5	..	5	Hudson
6·43	Gen. & Dist. Elec. Energy.......... *6·40*	XV₂	4	2	4	..	6	Balsbaugh
6·44	Elec. Trans. & Con. *6·40*	I₃	4	1	2	..	4	Mulligan
6·451	Alt. Cur. & A. C. Machinery.......	XIII-A	4	1	2	..	4	R.R.Lawrence
6·452	Alt. Cur. & A. C. Machinery....... *6·451*	XIII-A	4	2	2	..	4	R.R.Lawrence
6·46	Ind. App. Elec. Pr. *6·03*	II(O.D.)	G	2	3	..	2	Dawes
		Mil. Eng.	4	2	3	..	2	
6·501	Elec. Eng. Seminar	VI, VI-A	G(A)	1	2	..	6	Bush
6·502	Elec. Eng. Seminar	VI, VI-A	G(A)	2	2	..	6	Bush
6·511	Elec. Circuits...... *6·04, M31*	VI, VI-A	G(A)	1	3	..	7	Dah
6·512	Elec. Circuits...... *6·511*	VI, VI-A	G(A)	2	3	..	7	Dahl
6·513	Elec. Circuits...... *6·512*	VI, VI-A	G(A)	2	3	..	7	Dahl
6·521	Alt.Cur.Machinery *6·04, M31*	VI, VI-A	G(A)	1	3	..	7	Lyon
6·522	Alt. Cur. Machinery *6·04, M31*	VI, VI-A	G(A)	2	3	..	7	Lyon
6·531	Org. & Adm. Pub. Service Co....... *6·04, Ec32*	VI, VI-A (Not offered 1929-30)	G(A)	1	3	..	7	Jackson
6·532	Org. & Adm. Pub. Service Co....... *6·04, Ec32*	VI, VI-A (Not offered 1929-30)	G(A)	2	3	..	7	Jackson
6·541	Power Gen. Stations *6·03, Ec32*	VI, VI-A	G(A)	1	3	..	6	Mulligan
6·542	Power Gen. Stations *6·03, Ec32*	VI, VI-A	G(A)	2	3	..	6	Mulligan
6·551	Railroad Elec. Trac. *6·03, Ec32*	VI, VI-A	G(A)	1	3	..	6	Entwistle
6·552	Railroad Elec. Trac. *6·551*	VI, VI-A	G(A)	2	3	..	6	Entwistle
6·561	Elec. Com. Prin.... *6·312*	VI, VI-A	G(A)	1	3	3	4	Bowles
6·562	Elec. Com. Prin.... *6·312*	VI, VI-A	G(A)	2	3	3	4	Bowles
6·57	Illumination....... *6·27*	VI, VI-A	G(A)	1 or 2	3	..	6	Moon
6·58	Op. Circuit Anal... *6·04 or 6·312, M31*	VI, VI-A	G(A)	1	3	..	7	M.F.Gardner
6·651	Elec. Power Dist... *6·604*	VI, VI-A	G(A)	1	3	..	6	Balsbaugh
6·652	Elec. Power Dist... *6·604*	VI, VI-A	G(A)	2	3	..	6	Balsbaugh
6·661	Elec. Mach. Dev. Prin............ *6·03*	VI, VI-A	G(A)	1	3	..	7	Dwight

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
6·662	Elec. Mach. Div. Prin. *6·03*	VI, VI-A	G(A)	2	3	..	7	Dwight
6·70	Elec. Eng. Lab. *6·00 (6·01)*	VI, VI-C	3	1	3	4	4	Laws, C. E. Tucker
6·71	Elec. Eng. Lab. *6·70 (6·02)*	VI, VI-C	3	2	2	3	5	Laws, C. E. Tucker
6·72	Elec. Eng. Lab. *6·71 (6·03)*	VI, VI-C	4	1	1	3	4	C. E. Tucker
6·73	Elec. Testing *6·71, 6·04*	VI	G(A)	1✦				Laws
6·74	Elec. Eng. Lab. *6·03, 6·72*	VI	G(A)	1✦				C. E. Tucker
6·75	Elec. Eng. Lab. *(6·00)*	I-A, VI-A	2	2	1	1	2	Laws
6·76	Elec. Eng. Lab. *6·75 (6·01)*	VI-A(A)	3	S	2	2	3	C. E. Tucker
		VI-A(B)	3	1	2	2	3	
6·77	Elec. Eng. Lab. *(6·023) or 6·02*	VI-A(A)	3	2	1	2	2	Laws
		VI-A(B)	4	S	1	2	2	
6·78	Elec. Eng. Lab. *6·76, 6·032*	VI-A(A)$_{1,2}$	4	1	2	4	4	C. E. Tucker
		VI-A(B)$_{1,2}$	4	2	2	4	4	
6·781	Elec. Eng. Lab. *6·76, 6·032*	VI-A(A)$_3$	4	1	1	3	3	C. E. Tucker
		VI-A(B)$_3$	4	2	1	3	3	
6·79	Elec. Measure *6·40*	III$_4$	4	2	0	2	3	Laws
6·80	Elec. Eng. Lab.	VI(Elective)	4	1✦				Laws, C. E. Tucker
6·81	Elec. Eng. Lab. *(6·07)*	XIV	3	1	1	2	2	Laws, C. E. Tucker
6·82	Elec. Eng. Lab. *6·81 (6·08)*	XIV	3	2	1	2	2	Laws, C. E. Tucker
6·83	Elec. Eng. Lab. *6·82 (6·09)*	XIV	4	1	1	2	2	C. E. Tucker
6·84	Elec. Eng. Lab. *6·122*	I-A(A)	3	2	0	2	3	C. E. Tucker
		I-A(B)	4	2	0	2	3	
6·85	Elec. Eng. Lab. *6·40*	III$_{1,2,3}$, X, XV$_3$, XVI, Mil. Eng.	4	2	0	2	3	C. E. Tucker
		IX-B	4	1	0	2	3	
6·86	Elec. Eng. Lab. *6·40*	XI	3	2	0	1	2	C. E. Tucker
6·871	Elec. Eng. Lab. *(6·451)*	XIII-A	4	1	1	1	1	C. E. Tucker
6·872	Elec. Eng. Lab. *(6·452)*	XIII-A	4	2	1	1	2	C. E. Tucker
6·88	Elec. Eng. Lab. *6·42*	A.O.	4	2	1	3	6	Laws, C. E. Tucker
6·89	Elec. Eng. Lab. *6·40*	I, XV$_1$, XVII	3	2	0	2	2	C. E. Tucker
		II(O.D.)	G	1	0	2	2	
		II, XV$_2$	4	1	0	2	2	
		XIII$_1$	4	2	0	2	2	
						h. p. w.		
6·901	Man. Practice	VI-A(A)$_1$	3	1	0	48	0	Timbie
		VI-A(B)$_1$	3	S	0	48	0	
6·902	Man. Practice	VI-A(A)$_1$	4	S	0	48	0	Timbie
		VI-A(B)$_1$	3	2	0	48	0	
6·903	Man. Practice	VI-A(A)$_1$	4	2	0	48	0	Timbie
		VI-A(B)$_1$	4	1	0	48	0	
6·904	Man. Practice	VI-A(A)$_1$	G	1	0	48	0	Timbie
		VI-A(B)$_1$	G	S	0	48	0	
6·911	Pub. Util. Practice	VI-A(A)$_2$	3	1	0	48	0	Timbie
		VI-A(B)$_2$	3	S	0	48	0	
6·912	Pub. Util. Practice	VI-A(A)$_2$	4	S	0	48	0	Timbie
		VI-A(B)$_2$	3	2	0	48	0	
6·913	Pub. Util. Practice	VI-A(A)$_2$	4	2	0	48	0	Timbie
		VI-A(B)$_2$	4	1	0	48	0	

✦Time specially arranged.

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
					h. p. w.			
6·914	Pub. Util. Practice.	VI-A(A)$_2$	G	1	0	48	0	Timbie
		VI-A(B)$_2$	G	S	0	48	0	
6·921	Pub. Util. Practice.	VI-A(A)$_2$	3	1	0	48	0	Timbie
		VI-A(B)$_2$	3	S	0	48	0	
6·922	Pub. Util. Practice.	VI-A(A)$_2$	4	S	0	48	0	Timbie
		VI-A(B)$_2$	3	2	0	48	0	
6·923	Pub. Util. Practice.	VI-A(A)$_2$	4	2	0	48	0	Timbie
		VI-A(B)$_2$	4	1	0	48	0	
6·924	Pub. Util. Practice.	VI-A(A)$_2$	G	1	0	48	0	Timbie
		VI-A(B)$_2$	G	S	0	48	0	
6·931	Pub. Util. Practice.	VI-A(A)$_2$	3	1	0	48	0	Timbie
		VI-A(B)$_2$	3	S	0	48	0	
6·932	Pub. Util. Practice.	VI-A(A)$_2$	4	S	0	48	0	Timbie
		VI-A(B)$_2$	3	2	0	48	0	
6·933	Pub. Util. Practice.	VI-A(A)$_2$	4	2	0	48	0	Timbie
		VI-A(B)$_2$	4	1	0	48	0	
6·934	Pub. Util. Practice.	VI-A(A)$_2$	G	1	0	48	0	Timbie
		VI-A(B)$_2$	G	S	0	48	0	
6·941	Com. Practice.....	VI-A(A)$_3$	3	1	0	48	0	Timbie
		VI-A(B)$_3$	3	S	0	48	0	
6·942	Com. Practice.....	VI-A(A)$_3$	4	S	0	48	0	Timbie
		VI-A(B)$_3$	3	2	0	48	0	
6·943	Com. Practice.....	VI-A(A)$_3$	4	2	0	48	0	Timbie
		VI-A(B)$_3$	4	1	0	48	0	
6·944	Com. Practice.....	VI-A(A)$_3$	G	1	0	48	0	Timbie
		VI-A(B)$_3$	G	S	0	48	0	

BIOLOGY AND PUBLIC HEALTH — 7·00–7·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
7·01	General Biology...	VII	2	1	1	4	2	Turner
		XIIb	3	1	1	4	2	
7·011	Meth. Teach. Gen. Biol.	(Elective)		S	4	..	2	Miss MacRae
7·03	Theoret. Biology .. *7·103, 7·301*	VII	4	1	2	..	3	Turner
7·05	Micros. of Fibres ..	(Elective)	4	1	3	..	2	Jennison
7·06	Botany *(7·01)*	VII$_{1,2}$	2	1	2	3	2	Turner
7·07	Mycology *7·06*	VII$_{2}$	3	1	1	2	2	Proctor
		II$_{3}$a	4	1	1	2	2	
7·08	Parasitology *7·01, 7·11*	VII$_{1}$	4	2	2	..	4	Bigelow
7·09	Parasitology, Adv.. *7·08*	VII	G(A)	2	1	..	3	Bigelow
7·10	Zoölogy *7·01*	VII$_{1,2}$	2	2	1	4	2	Blake
		XIIb	3	2	1	3	2	
7·11	Anatomy & Histol. *7·01*	VII$_{1}$	3	1	2	6	5	Bigelow
7·12	Anatomy & Histol. *7·11*	VII$_{1}$	3	2	2	6	4	Bigelow
7·13	Cytology *7·03, 7·12*	VII	G(A)	1 or ✦ 2				Bigelow
7·14	Hist. of Biology... *7·01*	VII	G(A)	1	2	..	6	Bigelow
7·15	Essent. of Anatomy *7·10*	VII$_{2}$b	3	1	3	..	3	Blake
7·18	Tech.Asp.of Entom. *7·08*	VII	G(A)	1✦				Blake
7·20	Physiology *5·501, 7·11 or 7·15*	VII$_{1,2}$	3	2	3	3	5	Bunker
7·22	Pers. Hyg. & Nut..	VII	3	1	2	..	3	Bunker
7·23	App. Nutrition....	VII (Elective)	4	2	1	..	2	Turner
7·28	Biology & Bact....	IX-A	2	1	1	2	1	Proctor
		V	3	1	1	2	1	
7·281	Sanitary Biology ..	XI	3	1	3	4	3	Proctor
7·29	Biology & Bact....	XI	3	2	1	4	2	Proctor
7·291	Biology & Bact. ..	IX-A	2	2	1	2	1	Proctor
7·301	Bacteriology *7·01*	VII	3	1	2	4	4	Horwood
7·302	Bacteriology *7·301*	VII	3	2	2	4	3	Horwood
7·31	Bacteriology	Mil. Eng.	4	1	2	..	2	S. C. Prescott
7·321	Bacteriology, Adv.. *7·302, 7·80*	VII	G(A)	1	2	..	5	Bunker
7·322	Bacteriology, Adv.. *7·321*	VII	G(A)	2	2	..	5	Bunker
7·33	Plant Diseases .... *7·361*	VII$_{2}$b	3	2	1	..	2	Prescott
7·34	Limnological Field. *7·01, 5·122*	VII$_{3}$	3	S	0	5	0	Bunker
7·34T	Micros. of Waters . *7·01 or 7·28*	XI	4	1	0	1	1	Blake
7·35	Planktonology .... *7·34*	VII	G(A)	1✦				Blake
7·361	Indust. Microbiol. . *7·301*	VII$_{3}$	4	1	1	4	2	S.C. Prescott
7·362	Indust. Microbiol. . *7·361*	VII$_{3}$	4	2	1	3	2	S. C. Prescott
7·371	Indust. Microbiol. . *7·361 or 7·712*	VII	G(A)	1	1	4	4	S. C. Prescott
7·372	Indust. Microbiol. .	VII	G(A)	2✦				S. C. Prescott

✦Time specially arranged.

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
7·421	Food Fishes ...... *7·10*	VII$_2$ a	3	1	2	6	5	Bigelow
7·422	Food Fishes ...... *7·421*	VII$_2$a	3	**2**	2	4	2	Bigelow
7·43	Fish Culture...... *7·10*	VII$_2$a	3	**2**	2	..	2	Bigelow
7·441	Tech. of Fish. Prod. *7·302*	VII$_2$a	4	1	1	3	4	S. C. Prescott
7·442	Tech. of Fish. Prod. *7·441*	VII$_2$a	4	**2**	1	4	4	S. C. Prescott
7·50	Infection & Immun. *7·301*	VII$_1$	4	1	3	..	5	Slack
7·52	Industrial Hygiene *7·50*	VII$_1$	4	**2**	1	3	4	Turner
7·541	Pub. Health Adm.. *7·302*	VII$_1$	4	1	2	..	2	Turner
7·542	Pub. Health Adm.. *7·302*	VII$_1$	4	**2**	2	..	3	Turner
7·543	Public Health Inst.	(Elective)		S✦				S. C. Prescott
7·551	Public Health Lab. Meth........... *7·301*	VII$_1$	4	1	2	4	2	Slack
7·552	Public Health Lab. Meth........... *7·301*	VII$_1$	4	**2**	1	2	1	Slack
7·553	Public Health Lab. Meth...........	(Elective)		S	3	6	3	Slack
7·56	Pub. Health Surv.. *7·57*	VII$_1$	4	**2**	1	..	2	Horwood
7·57	Municipal San..... *7·301*	VII Mil. Eng.	3 4	**2** **2**	4 4	.. ..	4 3	Horwood
7·58	Vital Statistics....	VII$_1$	4	1	2	..	3	Horwood
7·601	Health Education . *7·01*	VII	G(A)	1	2	..	4	Turner
7·602	Health Education . *7·601*	VII	G(A)	**2**✦				Turner
7·603	Health Edu. Meth..	(Elective)		S	2	1	4	Turner
7·604	School Health Adm.	VII$_1$	4	**2**	1	..	1	Turner
7·605	Hyg.of Sch. Child..	(Elective)		S	3	..	4	Proctor
7·62	Health Surv. & Stat. *7·56*	VII	G(A)	1	3	..	6	Horwood
7·63	Pub. Health Field.. *7·542*	VII	G(A)	**2**	2	..	4	Turner
7·64	Pub. Health. Prob.. *7·542*	VII	G(A)	**2**	2	..	4	Turner
7·65	Health Hazards in Spec. Indus. .... *7·52*	VII	G(A)	**2**	1	..	5	S. C. Prescott Turner
7·66	Epidemiology..... *7·302, 7·50*	VII	G(A)	1	2	..	6	Horwood
7·67	Com. Disease Con. *7·542*	VII$_1$	G(A)	1✦				Place
7·68	Pathology........ *7·12, 7·551, 7·552*	VII$_1$	G(A)	**2**	1	2	4	Slack
7·701	Tech. of Food Sup. *(7·301)*	VII$_2$b	3	1	2	2	2	Proctor
7·702	Tech. of Food Sup. *(7·302)*	VII$_2$b	3	**2**	2	3	4	Proctor
7·711	Tech. of Food Prod. *7·701, 7·702*	VII$_2$b	4	1	2	2	4	S. C. Prescott
7·712	Tech. of Food Prod. *7·701, 7·702*	VII$_2$b	4	**2**	2	3	4	S. C. Prescott
7·80	Biochemistry ..... *5·412, 7·301*	VII	4	1	3	5	5	Bunker
7·81	Enzyme Chemistry *7·80*	VII	G(A)	**2**	1	3	5	Parker
7·90	Biological Lit...... *7·01, 7·06, 7·10*	VII$_1$	3	1	1	..	3	Prescott Bigelow
7·91	Biological Colloq...	VII	4	1	1	..	1	S. C. Prescott and Staff
7·92	Biological Colloq...	VII	4	**2**	1	..	1	S. C. Prescott
7·93	Biological Seminar. *7·11 or 7·301*	VII	G(A)	1 or ✦ **2**				Bigelow

✦Time specially arranged.

PHYSICS — 8·00–8·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
8·00	Physics Entrance . .			S	2	. .	5	Drisko
8·01	Physics (Mech.) . . . *8·00, M4*	All courses except IV	1	1	3	1	5	Drisko
8·012	Physics (Col. Class) *M11*		1	1	2	1	3	Drisko
8·02	Phys. (Mech. & Opt.) *8·01*	All courses except IV	1	2	3	1	5	Drisko
8·03	Physics (Elec.) . . . . *8·01, M12*	All courses except IV	2	1	3	1	5	Page
8·034	Physics (Col. Class) *M12*		2	1	2	1	3	Page
8·04	Physics (Elec. & Ht.) *8·03*	All courses except IV	2	2	3	1	5	Page
8·05	Sound, Sp. & Aud. . *8·04, M12*	VI-C, VIII	4	2	3	. .	6	Barss
8·06	Acoust., Ill. & Col. .	IV-A	3	1	1	. .	2	Barss
8·07	Precision of Meas. . *M22*	XIII-A VIII, XIV	G 4	1 1	1 1	. . . .	1 1	Goodwin
8·071	Phys. Meas. & Prec. *8·02, M12*	VIII	2	1	1	. .	1	Drisko
8·09	Acoustics	VIII	3	2	2	. .	3	Barss
8·10	Heat Measurements *8·04*	(Elective)	4	1	1	3	2	Wilkes
8·11	Heat Measurements *8·04*	IX-A, XIV	3	1	0	2	1	Wilkes
8·12	Heat Measurements *8·04*	III$_{3, 4}$	3	1	1	2	1	Wilkes
8·13	Heat Measurements *8·04*	(Elective)	4, G	2	1	4	1	Wilkes
8·14	Heat Meas. II . . . . *8·10, 8·11 or 8·12*	(Elective)	4, G	1✦				Wilkes
8·15	Photography . . . . . . *8·02*	VIII (Not offered 1929–30)	3	1	2	. .	1	Hardy
8·151	Photographic Lab. . *8·15*	(Elective)		2	0	3	2	Hardy
8·16	Optics, Seminar . . . *8·15, 8·172*	VIII	G(A)	2	2	. .	2	Hardy
8·172	Optics . . . . *8·02*	III$_4$, VIII II$_3$, a	3 4	1 1	3 3	. . . .	6 6	Hardy
8·18	Optical Measure. . . *(8·172)*	VIII	3	1	0	3	2	Hardy
8·191	Photomic. Th. Mic.	(Elective)	G	1	1	2	2	Hardy
8·193	Geom. Optic, Adv. . *8·172*	VIII	G(A)	1	2	. .	4	Hardy
8·194	Phys. Optics, Adv. . *8·172*	VIII	G(A)	2	2	. .	4	Hardy
8·20	Electricity . . . . *8·04, M22*	VIII	3	2	3	. .	6	Page
8·203	Electricity Lab. . . . *8·04, M22 (8·20)*	VIII	3	2	0	3	3	Page
8·21	El. Electron Th. & Elec. Apparatus . *8·04*	 VI-A(B)$_{1, 2}$ VI-A(A)$_{1, 2}$	 4 4	 2 1	 2 2	 2 2	 4 4	Knobel
8·212	Gaseous Conduct. . *8·03, 8·04*	VIII, VI	G(A)	2	3	. .	7	Knobel
8·22	Int. to Phys. Science	VIII	2	2	2	. .	3	Müller
8·221	Mech. & Hydrodyn.	VIII, IX-C	3	1	4	. .	8	Frank
8·222	Heat & Kinetic Th.	VIII, IX-C	3	2	4	. .	6	Sears
8·231	Physics II . . . . *8·222*	VIII, IX-C	4	1	4	. .	8	Sears
8·232	Physics II . . . . *8·231*	VIII, IX-C	4	2	4	. .	8	Sears

✦Time specially arranged.

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
8·241	Electromag. Th.... *M77*	VI-C	4	1	2	..	2	Vallarta
8·242	Electromag. Wave Prop.......... *8·241*	VI-C	4	2	2	..	3	Vallarta
8·25	Prac. Spectroscopy	VIII (Elective)	G	1	1	2	2	de Laszlo
8·26	Diel. & Mag. Mol. Prop.......... *8·232, 8·301*	VIII	G(A)	2	2	..	4	Müller
8·27	Desc.Atomic Theory	VIII (Not offered 1929–30)	4	1	2	..	4	Warren
8·29	Lattice Th. of the Solid State..... *8·232*	VIII	G(A)	1	2	..	4	Warren
8·301	Atomistic Theories. *M37, 8·222, 8·232*	VIII	G(A)	1	3	..	6	Frank
8·302	Atomistic Theories. *8·301*	VIII	G(A)	2	3	..	6	Müller
8·31	Celestial & Atomic Mechanics...... *M37, M651 or equiv.*	VIII	G(A)	2	2	..	6	Vallarta
8·321	Electromag. Theory *M77*	(Elective)	4	1	3	..	6	Vallarta
8·322	Int.Mod.Th.Phys..	(Elective)	4	2	3	..	6	Vallarta
8·33	X-Rays & Crystal Physics .... *8·04, M22*	XIV	4	1	2	1	1	J. T. Norton
8·36	Radiation Meas. Lab............ *8·04*	(Elective)	4	1 or 2	1	3	2	Stockbarger
8·361	Radiation Meas. Lab., Adv....... *8·36*	VIII	G(A)	1 or 2	0	5	0	Stockbarger
8·37	Gen.Theory of Rad. *8·301*	VIII (Not offered 1929–30)	G(A)	2	2	..	4	Frank
8·381	Th. of Relativity .. *M37, M632*	VIII	G(A)	1	2	..	6	Vallarta
8·382	Quantum Mech.... *M37, 8·302 or 8·31*	VIII	G(A)	2	2	..	6	Vallarta
8·431	Elas. & Photoelas. . *2·20, 2.21*	VIII	G(A)	1	2	..	4	Frost
8·432	Photoelasticity.... *8·431*	VIII	G(A)	2	2	4	1	Frost
8·44	Ap. of X-Rays and Photoelasticity.. *8·03, 8·04, 2·20, 2·21*	$II_{Gen.}$ (Elective) II(T.D.)	4 G	2 2	2 2	2 2	0 0	J. T. Norton Frost
8·46	Ind. Radiology.... *8·03, 8·04*	III_4	3	2	1	2	1	J. T. Norton
8·61	Ceramics......... *5·02, 8·04*	(Elective)	4	2	2	2	5	F. H. Norton
8·63	Fund.Ceramic Proc. *5·62T, 8·10 or 8·11, 8·61*	VIII	G(A)	1	3	4	4	F. H. Norton
8·64	Phys. Prop. Ceramic Pr. *8·63*	VIII	G(A)	2	2	3	4	F. H. Norton
8·70	Physics of Colloids	VIII	G(A)	1	2	..	4	Müller
8·801	Electrochem., Prin. *8·04, M22*	XIV XIIa	3 4	1 1	4 4	.. ..	6 6	Goodwin
8·802	Electrochem., Prin. *8·801*	XIV XIIa	3 4	2 2	3 3	.. ..	6 6	Goodwin
8·82	Electrochemistry .. *8·802*	XIV	4	1	2	..	3	Goodwin
8·83	Electrochem., Adv. *8·82*	VIII, XIV	G(A)	2	1	..	2	Knobel
8·84	Photochemistry ... *8·802*	VIII	G(A)	1	2	..	4	Stockbarger
8·851	App. Electrochem.. *8·82*	XIV	4	1	1	..	1	Thompson
8·852	App. Electrochem.. *8·851*	XIV	4	2	2	..	4	Thompson
8·86	Electrochem. Lab.. *(8·82)*	XIV	4	1	0	5	1	Stockbarger

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
8·871	App.Electroch.Lab. *(8·851)*	XIV	4	**1**	0	2	1	Thompson
8·872	App.Electroch.Lab. *8·871*	XIV	4	**2**	0	2	1	Thompson
8·89	Electric Furnaces.. *8·04, 5·02*	(Elective)	4	**1**	1	2	2	Thompson
8·90	Electroch., Elem... *8·04 and 5·02*	III3, 4	4	**2**	2	2	2	Thompson
8·93	Colloquium....... *8·82*	XIV	4	**2**	1	..	1	Goodwin
8·98	Glass Blowing.....	XIV(Elective)	4	**1**	0	1	0	Thompson
8·99	Phys. Instruments.	II (T.E.)	G	**2**	2	3	4	F. H. Norton

GENERAL SCIENCE — 9·00–9·99

No.	Subject	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
9·10	Industrial Psychology..	(Elective)		S	2	..	2	I. E. Bender
9·11	Educational Psychology............	(Elective)		S	2	..	4	C. L. Stone
9·12	Tests & Measurements in Education....	(Elective)		S	2	..	4	C. L. Stone
9·20	Meth. of Teaching General Science in Junior & Senior High Schools.........	(Elective)		S	2	..	4	J. R. Lunt
9·21	Meth. of Teach. Phys. in Senior High Schools	(Elective)		S	2	..	4	F. R. Miller
9·22	Meth. of Teach. Chem. in Senior High Schools.........	(Elective)		S	2	..	4	Schumb
9·23	General Science Lab.	(Elective)		S	0	3	3	J. R. Lunt
9·24	Prin. of Secondary Education......	(Elective)		S	2	..	4	W. F. Downey

CHEMICAL ENGINEERING — 10·00–10·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
10·11	Prob.of Chem.Eng. *5·02*	X	2	1	1	..	0	Lewis
10·15	Thesis Reports.... *10·26*	X	4	2	2	..	2	Lewis
10·191	Chem. Eng. Lit.... *L12, L52*	X(Elective)	2	1	2	..	2	C. S. Robinson
10·192	Chem. Eng. Lit.... *10·191*	X(Elective)	2	2	2	..	2	C. S. Robinson
10·20	Indust. Chemistry . *(5·42, 5·62T)*	X	3	2	5	..	5	Lewis
10·201	Indust. Chemistry. *(5·42 or 5·62T or 8·802)*	V, XV₃ XIV	3 4	2 2	4 4	.. ..	4 4	Lewis
10·202	Indust. Chemistry. *(5·42, 5·62T)*	V C.W.S., X C.W.S.	3	2	5	..	5	Lewis
10·21	Indust. Chemistry. *10·20*	X	4	1	2	..	2	Lewis
10·211	Indust. Chemistry. *10·201*	V Chem. War	4 G	1 1	3 3	.. ..	3 3	Lewis
10·212	Indust.Chemistry.. *10·201*	XV₃	4	1	2	..	1	Lewis
10·214	Indust. Chemistry. *10·20*	X C.W.S., V C.W.S.	4	1	2	..	2	Lewis
10·22	Indust. Chemistry. *10·20*	X-B	4	1	2	..	2	Lewis
10·224	Indust. Chemistry. *10·20*	X-B(Ord.), X-B C.W.S.	4	1	2	..	2	Lewis
10·25	Indust. Stoichiom.. *5·61T*	X Chem. War.	G(A) G	1 1	2 2	.. ..	3 3	Weber
10·26	Indust.Chem. Lab.. *(10·21)*	X, V(Elective)	4	1	2	3	1	C. S. Robinson
10·27	Indust. Chem. Lab. *(10·212)*	XV₃	4	1	2	3	1	C. S. Robinson
10·28	Chemical Eng. .... *M21, 8·04, 5·131*	X	3	1	3	..	6	Lewis
10·29	Chemical Eng. .... *10·28*	X	3	2	3	..	6	Lewis
10·30	Chem. Eng. Lab... *10·29*	X(In effect 1930–31)	4	1	..	3	3	Lewis
10·31	Chemical Eng..... *(10·21), 10·29*	X	4	1	5	..	5	C. S. Robinson
10·311	Chemical Eng..... *(10·21), 10·29*	X Ord., X C.W.S. Chem. War.	4 G	1 1	5 5	.. ..	5 5	C. S. Robinson
10·32	Chemical Eng..... *10·31*	X	4	2	4	..	4	C. S. Robinson
10·321	Chemical Eng..... *10·311*	X Ord., X C.W.S. Chem. War.	4 G	2 2	4 4	.. ..	4 4	C. S. Robinson
10·33	Chemical Eng..... *(10·21), 10·29*	X-B	4	1	7	..	9	Ryan
10·331	Chemical Eng..... *(10·21), 10·29*	X-B Ord., X-B C.W.S.	4	1	7	..	9	Ryan
10·34	Chemical Eng...... *10·33*	X-B	4	2	3	..	6	Ryan
10·341	Chemical Eng..... *10·331*	X-B Ord.	4	2	3	..	6	Ryan
10·35	Chemical Eng..... *(10·201)*	XV₃	3	2	3	..	4	Ryan
10·361	Chemical Eng..... *10·35*	XV₃	4	1	2	..	2	Ryan
10·362	Chemical Eng..... *10·361*	XV₃	4	2	3	..	4	Ryan
10·41	Distillation....... *(10·32)*	X, X-A	G(A)	2	2	..	6	McAdams
10·42	Drying........... *10·32*	X, X-A	G(A)	1	2	..	4	McAdams
10·43	Evaporation...... *10·31*	X,X-A	G(A)	2	2	..	4	McAdams
10·44	Combustion *10·31*	X-A	G(A)	1	2	..	4	Ryan
10·45	Mech. Separation.. *10·32*	X, X-A	G(A)	1	2	..	4	Weber
10·46	Extraction........ *(10·32)*	X, X-A	G(A)	2	3	..	6	McAdams

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
10·50	Heat Transmission. *10·31*	X, X-A	G(A)	2	2	..	4	McAdams
10·52	Chemical Eng. II..	X, X-A	G(A)	1	2	..	4	McAdams
10·53	Chem. Eng. Des... *10·81, 10·82, 10·83*	X-A	G(A)	1	3	..	3	Weber
10·54	Econ. Balance..... *(10·31)*	X, X-A	G(A)	1	3	..	9	McAdams
10·62	App. Chem.Therm. *5·62T*	X, X-A	G(A)	2	3	..	6	Lewis
10·63	App.Colloid Chem. *5·62T*	X, X-A	G(A)	2	3	..	6	Lewis
10·64	App.Col.Chem.Lab. *10·63*	X, X-A	G(A)	2	0	3	1	Lewis
10·65	App.Colloid Chem. *5·62T, 5·42*	X	G(A)	S	2	..	3	Hauser
10·67	App. Colloid Sem. . *(10·65)*	X	G(A)	S	3	..	1	Hauser
10·68	Corrosion......... *10·21 or (10·31)*	X, X-A	G(A)	1	2	..	2	Lewis
10·69	Leather..........	X, X-A	G(A)	2	2	..	2	Frölich
10.70	Sulphuric Acid.... *10·21*	X, X-A	G(A)	1	2	..	2	Phelan
10·71	Glass, Ceramics and Refractories .... *10·21*	X, X-A	G(A)	2	2	..	3	Lewis
10·72	Iron & Steel...... *10·21*	X, X-A	G(A)	1	2	..	4	Waterhouse
10·73	Starch & Cellulose. *10·21*	X, X-A	G(A)	1	2	..	2	Frölich
10·74	Petroleum........ *10·21*	X, X-A	G(A)	2	2	..	4	McAdams
10·75	High Pres.Proc. ... *(10·32)*	X, X-A	G(A)	2	2	..	4	Frölich
10·76	Nitrogen Fixation . *5·62T*	X, X-A	G(A)	1	2	..	3	Underwood
10·77	Rubber.......... *10·21*	X, X-A	G(A)	2	2	..	3	Lewis
10·78	Interphase React. . *5·62T*	X, X-A	G(A)	1	2	..	3	Fenske
10·79	Paints, Oils & Varn. *10·21*	X, X-A	G(A)	2	2	..	2	Gill
10·81	Sch. Ch. Eng. Prac. (Bangor Station) *10·32*	X-A	G(A)	1	..	11*	..	Ryan
10·82	Sch. Ch. Eng. Prac. (Boston Station) *10·32*	X-A	G(A)	1	..	11*	..	Ryan
10·83	Sch. Ch. Eng. Prac. (Buffalo Station) *10·32*	X-A	G(A)	1	..	11*	..	Ryan
10·84	Sch. Ch. Eng. Prac. (Bangor Station). *10·33*	X-B	4	2	..	11*	..	Ryan
10·85	Sch. Ch. Eng. Prac. (Boston Station) *10·33*	X-B	4	2	..	11*	..	Ryan
10·86	Sch. Ch. Eng. Prac. (Buffalo Station) *10·33*	X-B	4	2	..	11*	..	Ryan
10·87	Sch. Ch. Eng. Prac. (Bayonne Sta.) *10·32*	X-A	G(A)	1	..	11*	..	
10·90	Exp. Research	X	G(A)	..	✦	..	✦	Lewis
10·911	Research Conf.....	X	G(A)	1	1	..	1	Lewis
10·912	Research Conf.....	X	G(A)	2	1	..	1	Lewis
10·93	Automotive Fuels.. *10·21*	II(A. E.)	G	1	3	..	3	McAdams
		X, F&G Eng.	G(A)	1	3	..	3	
10·94	Org. & Meth. of Ind. Research.......	X	G(A)	1	1	..	2	Forrest
		Chem. War.	G	1	1	..	2	
10·991	Sem. in Chem.Eng. *10·32*	X, X-A	G(A)	1	1	..	0	Ryan
10·992	Sem. in Chem.Eng. *10·32*	X, X-A	G(A)	2	1	..	0	Ryan

✦Time specially arranged.
* Fieldwork 8 weeks, 44 hours per week.

GEOLOGY — 12·00–12·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep	Instructor in Charge
12·01	Mineralogy....... *5·02*	$III_{1,2,3}$, XII	2	**1**	1	7	2	Gillson
12·02	Mineralogy....... *12·01*	XII	2	**2**	1	4	1	Gillson
12·03	Mineralogy....... *5·02*	III_4, IX-A	3	**2**	1	2	1	Buerger
12·04	Mineralogy, Adv... *12·02, 12·211*	XII	G(A)	**1**	1	7	2	Gillson
12·05	Mineralogy, Adv... *12·02, 12·211*	XII	G(A)	**1**	0	5	1	Gillson
12·15	Petrography...... *12·02, 12·211*	XII	3	**2**	1	7	2	Gillson
12·161	Petrography, Adv.. *12·15*	XII	G(A)	**1**	1	7	2	Gillson
12·162	Petrography, Adv.. *12·161*	XII	G(A)	**2**	1	7	2	Gillson
12·20	Opt. Iden. of Crys. Compounds..... *8·02*	III_4	3	**2**	1	2	1	Buerger
		V	4	**2**	1	2	1	
12·211	Optical Crystallog.. *8·02*	XII	3	**1**	1	3	1	Buerger
12·212	Optical Crystallog.. *12·20 or 12·211*	XII	G(A)	**2**✦	..	..	..	Buerger
12·22	Optical Ceramics.. *12·20 or 12·211*	(Elective)	4	**2**	0	3	1	Buerger
12·25	Physical Crystallog. *8·04*	III_4	4	**1**	4	..	2	Buerger
12·30	Geology.......... *12·01 (12·03)*	$III_{1,2}$, XII	2	**2**	3	..	3	Morris
		IX-A	3	**2**	3	..	3	
12·31	Geology.......... *12·30*	$III_{1,2}$, XII	3	**1**	3	2	3	Shimer
		IX-A	4	**1**	3	2	3	
12·321	Geology..........	I, VII_3, XVII	3	**1**	2	..	1	Morris
		XI	4	**1**	2	..	1	
12·322	Geology.......... *12·321*	I	3	**2**	3	..	3	Morris Terzaghi
12·33	Field Geology..... *1·03, 12·01, 12.31*	$III_{1,2}$	4	**1**	0	3	1	Morris
		XII	4	**1**	0	3	2	
12·351	Geol. Survey., Adv. *12·33*	XII	G(A)	**1**	0	4	4	Morris
12·352	Geol. Survey., Adv. *12·351*	XII	G(A)	**2**	0	4	4	Morris
12·36	Geology, Field.... *12·30*	XII	4	S	0	8	0	Newhouse
12·37	Field Geology..... *12·322*	I	4	**1**	0	1	1	Morris
12·38	Physiography..... *12·31*	XII	4	**1**	1	2	1	Shimer
12·39	Field Geol. Meth. . *12·31*	(Elective)	3	**2**	0	3	1	Morris
12·40	Geology, Economic *12·01, 12·31*	$III_{1,2}$, XII	3	**2**	5	..	3	Newhouse
12·41	Econ. Geol. Lab. .. *12·40*	XII	4	**1**	0	6	2	Newhouse
12·42	App. Econ. Geol... *12·40*	XII	4	**2**	2	..	1	Newhouse
12·431	Ec.Geol.Lab.,Adv.. *12·41*	XII	G(A)	**1**	0	4	1	Lindgren
12·432	Ec.Geol.Lab.,Adv.. *12·41*	XII	G(A)	**2**	0	4	1	Lindgren
12·433	Ec.Geol.Sem.,Adv.. *12·40*	XII	G(A)	**1**	2	..	2	Lindgren
12·434	Ec.Geol.Sem.,Adv.. *12·40*	XII	G(A)	**2**	2	..	2	Lindgren
12·44	Ec. Geol. of Fuels.. *G60*	(Elective)	4, G	**2**	2	..	2	Newhouse
12·46	Econ. Geol. of Non-Metallic Deposits *12·40*	XII	4	**1**	2	1	3	Gillson

✦Time specially arranged.

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12·47	Econ. Geol. of Non-Metallic Deposits *12·46*	XII	G(A)	**2**	1	3	1	Gillson
12·48	Eng. Geol. & Hyd.. *12·31*	XII	4	**2**	3	..	2	Morris
12·49	Geol. of Materials .	IV-A	3	**1**	1	..	2	Morris
		IV-A	2	**2**	1	..	2	
12·50	Historical Geology . *12·31*	XII	3	**2**	2	1	2	Shimer
12·511	Paleontology...... *12·31*	XII	3	**1**	1	2	2	Shimer
12·512	Paleontology...... *12·511*	XII	3	**2**	0	1	1	Shimer
12·521	Paleontology, Adv. *12·512*	XII	G(A)	**1**	1	3	3	Shimer
12·522	Paleontology, Adv. *12·521*	XII	G(A)	**2**	1	3	3	Shimer
12·53	Index Fossils...... *12·512*	XII	G(A)	**2**	2	4	1	Shimer
12·54	Micropaleontology . *12·512*	XII	G(A)	**1**	3	..	2	Shimer
12·55	Organic Evol., Adv. *G64*	XII	G(A)	**2**	2	..	3	Shimer
12·581	Stratigraphy...... *12·50*	XII	G(A)	**1**	2	..	4	Shimer
12·582	Stratigraphy...... *12·15, 12·581*	XII	G(A)	**2**	2	..	4	Shimer
12·60	Struct. Geology ... *12·31*	XII	4	**1**	2	..	3	Morris
12·61	Diastro. & Vulcan.. *12·15, 12·31*	XII	4	**2**	2	..	3	Morris
12·631	Geol. Seminar, Adv. *12·31*	XII	G(A)	**1**	2	..	5	Shimer
12·632	Geol. Seminar, Adv. *12·31*	XII	G(A)	**2**	2	..	5	Lindgren and Staff
12·64	Geol. of N.America *12·50, 12·512*	XII	G(A)	**1**	2	..	4	Shimer
12·65	Geology of Europe . *12·64*	XII	G(A)	**2**	2	..	4	Shimer
12·66	Geology of Asia .. *12·64*	XII (Not offered 1929-30)	G(A)	**2**	2	..	4	Morris
12·80	Geol.Coal & Petrol. *12·31 or G60*	III₂, XII	4	**1**	4	..	3	Sp. Lecturer

NAVAL ARCHITECTURE AND MARINE ENGINEERING — 13·00–13·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
13·01	Naval Architecture *M12, 8·01*	XIII$_1$ XIII-A	3 4	**1** **1**	2 2	. . . .	2 2	Jack
13·011	Naval Architecture *8·01*	XIII$_2$	3	**1**	2	. .	2	Chapman
13·02	Naval Architecture *13·01*	XIII$_1$ XIII-A	3 4	**2** **2**	2 2	. . . .	2 2	Jack
13·021	Naval Architecture *13·011*	XIII$_2$	3	**2**	2	. .	2	Chapman
13·03	Naval Architecture *13·02*	XIII$_1$ XIII-A	4 G	**1** **1**	3 3	. . . .	3 3	Jack
13·11	Th. of Warship Des.	XIII-A	4	**1**	4	. .	6	Hovgaard Magoun
13·12	Th. of Warship Des.	XIII-A	4	**2**	4	. .	4	Hovgaard Magoun
13·13	Th. of Warship Des.	XIII-A	G	**1**	5	. .	8	Hovgaard Keith
13·14	Th. of Warship Des.	XIII-A	G	**2**	5	. .	6	Hovgaard Keith
13·21	Warship Design . . .	XIII-A	4	**1**	0	8	0	Hovgaard
13·22	Warship Design . . .	XIII-A	4	**2**	0	8	0	Hovgaard
13·23	Warship Design . . .	XIII-A	G	**1**	0	10	0	Hovgaard
13·24	Warship Design . . .	XIII-A	G	**2**	0	10	0	Hovgaard
13·31	Ship Construction .	XIII$_1$	2	**1**	2	. .	2	Owen
13·32	Ship Construction . *13·31*	XIII	2	**2**	2	. .	2	Jack
13·33	Ship Construction . *13·32*	XIII$_{1,2}$	3	**1**	2	. .	2	Jack
13·37	Merchant Shipbuild.	XIII-A	4	**2**	2	. .	2	Jack
13·38	Shipyard Organ. . . . *13·02, 13·32*	XIII$_1$	4	**2**	2	. .	1	Jack
13·39	Shipyard Practice .	XIII-A	4	**2**	2	. .	2	Jack Keith
13·41	Ship Drawing	XIII$_1$	2	**2**	0	7	0	Owen
13·411	Ship Drawing	XIII$_2$	2	**2**	0	5	0	Owen
13·42	Ship Design . . . . . . *13·41*	XIII$_1$	3	**1**	0	4	0	Owen
13·43	Ship Design . . . . . . *13·42*	XIII$_1$	3	**2**	0	3	0	Owen
13·45	Ship Design . . . . . . *13·43*	XIII$_1$	4	**1**	0	7	0	Owen
13·46	Ship Design . . . . . . *13·45*	XIII$_1$	4	**2**	0	3	0	Owen
13·47	Ship Design . . . . . . *13·021, 13·51*	XIII$_2$	4	**1**	0	6	0	Owen
13·48	Model Making	XIII-A	4	**2**	0	2	0	Owen
13·50	Marine Engineering	XIII$_{1,2}$	2	**1**	2	. .	1	Jack
13·51	Marine Engineering *2·40*	XIII	3	**2**	2	. .	2	Burtner
13·52	Marine Engineering *13·51*	XIII$_2$	4	**1**	1	. .	1	Jack
13·54	Marine Engineering *2·221, 2·40, 13·51*	XIII$_1$	4	**1**	3	. .	3	Burtner
13·58	Marine Engineering	XIII-A	4	**1**	2	. .	2	Chapman
13·61	Marine Eng. Design *2·20, 2·40, 13·51*	XIII$_1$	4	**1**	4	. .	0	Burtner
13·62	Marine Eng. Des. . *13·61*	XIII$_1$	4	**2**	5	. .	0	Burtner
13·63	Marine Eng. Des. .	XIII-A	4	**1**	0	3	0	Chapman
13·64	Marine Eng. Des. .	XIII-A	4	**2**	0	4	0	Chapman

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13·66	Marine Eng. Des.. *2·42, 13·51*	XIII$_2$	4	**2**	0	3	0	Burtner
13·70	Steam Turbines ... *2·42, 13·51*	XIII, XIII-A	4	**2**	2	..	3	Burtner
13·72	Marine Diesel Eng. *2·40*	XIII$_1$	4	**2**	2	..	3	Chapman
		XIII$_2$	3	**2**	2	..	3	
13·81	Ship Operation.... *13·021, 13·51*	XIII$_2$	4	**1**	3	..	4	Chapman
13·82	Ship Operation.... *13·81*	XIII$_2$	4	**2**	2	..	2	Chapman
13·83	Terminal Facilities.	XIII$_2$	3	**1**	3	..	2	Chapman

AERONAUTICAL ENGINEERING — 16·00–16·99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
16·00	Aerody.of Airp.Des. *M22, 16·51*	XVI	3	**2**	2	..	3	Chatfield
16·01	Airplane Design . . . *M22, 1·401 and 16·51*	(Elective)	4	**1**	5	..	6	Chatfield Newell
16·03	Airplane Design . . . *1·401 and 16·00*	XVI	4	**1**	4	..	4	Chatfield Newell
16·04	Airplane Des., Adv. *16·01 or 16·03, 16·12 or 16·13*	XVI	G(A)	**1**	3	..	6	Chatfield
16·06	Airplane St., Adv.. *16·01 or 16·03, 16·12 or 16·13*	XVI	G(A)	**1**	3	..	6	Newell
16·08	Airplane Des. Prob. *16·04, 16·06, 16·14*	XVI	G(A)	**2**	2	3	3	Chatfield
16·11	Airplane Des. Prac. *(16·01 or 16·03)*	XVI	4	**1**	0	2	0	Chatfield
16·12	Airplane Design . . . *16·11*	XVI	4	**2**	0	4	0	Chatfield
16·13	Airplane Des. Prac. *(16·01 or 16·03)*	(Elective)	4	**1**	0	6	0	Chatfield
16·14	Airplane Des. Prac. *16·01 or 16·03, 16·13*	(Elective)	G	**1**	0	8	0	Chatfield
16·15	Airplane Des. Prac. *(16·01 or 16·03)*	(Elective)	4	**1**	0	4	0	Chatfield
16·16	Airplane Des. Prac. *16·01 or 16·03, 16·15*	(Elective)	4	**2**	0	6	0	Chatfield
16·21	Airship Theory . . . . *M22, 16·72*	XVI	G(A)	**1**	2	..	3	Sayre
16·22	Airship Design . . . . *16·21*	XVI	G(A)	**2**	3	8	4	Sayre
16·30	Aerial Propellers . . . *16·01 or 16·03, 16·72*	XVI	G(A)	**2**	2	2	4	Sayre
16·35	Aircraft Instrum. . . *8·04*	(Elective) (Not offered 1929-30)	G	**1**	2	..	3	W. G. Brown
16·41	Hist. of Aeronaut. .	(Elective)	G	**1**	1	..	1	Sayre
16·43	Com. Aeronautics . *16·01 or 16·03; Ec21 or Ec31*	XVI	G(A)	**1**	2	..	4	Sayre
16·44	Air Transportation. *16·43*	XVI	G(A)	**2**	2	..	4	Sayre
16·48	Aircraft Armament	II(O.D.)	G	**2**	3	..	5	W. G. Brown
16·51	Airplane Lab.	XVI Air Corps Unit	3 3	**S** **1**	3 3	.. ..	1 1	Sayre
16·54	Airplane Const. . . . *16·01 or 16·03, 16·51*	XVI	4	**2**	2	..	1	W. G. Brown
16·62	Aeronautical Lab. . *M22, 8·04 (16·01 or 16·00)*	XVI	4	**2**	2	2	2	W. G. Brown
16·63	Aero. Lab. & Res. Methods . . . . *16·62*	(Elective)	G	**1**	2	2	2	W. G. Brown
16·68	Cond. of Aero.Res.. *16·63*	XVI	G(A)	**2**	2	..	4	W. G. Brown
16·69	Aeronaut. Seminar. *16·04, 16·06*	XVI	G(A)	**2**	1	..	1	Chatfield
16·72	Propell. & Airships. *16·01 or 16·03*	XVI	4	**2**	2	..	2	Sayre
16·76	Aeronautics . . . . *M22, 2·20*	II(Elective) XIII-A	4 G	**2** **1**	2 2	.. ..	2 4	Chatfield
16·78	Aeronautics . . . . *16·76*	XIII-A	G	**2**	3	..	5	Sayre
16·82	Aero. Power Plts. . . *2·30, 2·42, 2·251*	XVI, Air Corps Unit	4	**2**	2	..	2	Taylor
16·83	Airplane Eng. Des.. *2·732, 16·82*	XVI	G(A)	**1**	3	3	6	Taylor

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
16·84	Airplane Eng. Des.. *16·83, 16·85*	XVI	G(A)	**2**	2	8	2	Taylor
16·85	Airpl.Eng.Des.Prac. *(16·83)*	XVI	G(A)	**1**	0	4	0	Taylor
16·88	Aero. Engine Lab. . *2·42, 2·611*	XVI	4	**2**	0	3	0	Fales
16·911	Synoptic Meteor... *8·04, L22, G67 (16·921)*	(Elective)	G	**1**	2	..	2	Rossby
16·912	Synoptic Meteorol. *16·911 (16·922)*	(Elective)	G	**2**	2	..	2	Rossby
16·921	Meteorol. Lab..... *8·04, L22, G67 (16·911)*	(Elective)	G	**1**	0	16	0	Rossby
16·922	Meteorological Lab. *16·921 (16·912)*	(Elective)	G	**2**	0	16	0	Rossby
16·931	Dyn. Meteorology. *16·912, 16·922, M37*	XVI	G(A)	**1**	5	..	10	Rossby
16·932	Dyn. Meteorology. *16·931*	XVI	G(A)	**2**	5	..	10	Rossby
16·941	Meteorol. Seminar. *(16·931)*	XVI	G(A)	**1**	2	..	4	Rossby
16·942	Meteorol. Seminar. *(16·941, 16·932)*	XVI	G(A)	**2**	2	..	4	Rossby

BUILDING CONSTRUCTION

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
17·11	Arch. Forms & Det.	XVII	2	**1**	1	2	2	Voss
17·12	Arch. Forms & Det.	XVII	2	**2**	1	2	0	Voss
17·21	Building Const. *D12*	XVII	2	**1**	3	11	0	R. F. Tucker
17·22	Building Const.... *17·21*	XVII	2	**2**	3	6	0	R. F. Tucker
17·31	Building Const. .... *17·22*	XVII	3	**1**	3	9	0	R. F. Tucker
17·32	Bldg. Const. & Mat. *17·31*	XVII	3	**2**	3	6	0	R. F. Tucker
17·41	Building Const. .... *17·32*	XVII	4	**1**	3	8	0	Voss
17·42	Building Const. .... *17·41*	XVII	4	**2**	4	6	0	Voss
17·50	Job Management..	XVII	4	**2**	1	0	1	R. F. Tucker

DRAWING

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
D11	Mechanical Draw..	All courses except IV	1	**1**	0	3	0	Goodrich
D12	Working Drawings. *D11*	All courses except IV	1	**2**	0	3	0	Goodrich
D21	Desc. Geometry... *M2, M3*	All courses except IV	1	**1**	1	2	1	Kenison
D22	Desc. Geometry... *D21*	All courses except IV	1	**2**	1	2	1	Kenison
D23	Desc. Geometry... (College Class) *M2, M3*		1	**1**	3	..	4	Goodrich
D31	Desc. Geometry... *D22*	I	2	**1**	2	2	3	Bradley
D311	Desc. Geometry... (College Class) *D23*		1	**2**	2	..	5	Bradley

ECONOMICS

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
Ec21	Political Economy.	$XIII_2$, XV	2	1	3	..	5	Doten
	E12	XVII	3	1	3	..	5	
Ec31	Political Economy.	I, II, III, IV, IV-A,						
	E22	V, VI, VI-C, VII_3, VIII,						
		IX-A, IX-B, IX-C, X,						
		XI, XII, $XIII_1$,						
		XIV, XVI	3	1	3	..	3	Dewey
		VI-A	2	2	3	..	3	D. S. Tucker
		VII	2	1	3	..	3	
		I-A	3	2	3	..	3	
Ec32	Political Economy.	I, II, III, IV, IV-A,						
		V, VI, VI-C						
		VI-A(A), VII_3 VIII,						
		IX-A, IX-B, IX-C,						
		X, XI, XII, $XIII_1$,						Dewey
		XIV, XVI	3	2	3	..	3	D. S. Tucker
		VI-A(B)	3	1	3	..	3	
		I-A(A)	4	1	3	..	3	
		VII	2	2	3	..	3	
		I-A(B)	4	2	3	..	3	
Ec35	Political Economy.	XIII-A	4	1	3	..	5	Armstrong
	E12							
Ec37	Banking..........	XV	2	2	3	..	4	Dewey
	Ec21, Ec65	$XIII_2$	3	2	3	..	4	
Ec45	Indust. Relations..	I-A(B)	3	1	2	..	2	Doten
		I-A(A)	4	1	2	..	2	
Ec471	Personnel Manage.	XV	G(A)	1	2	..	6	Doten
	Ec21 or Ec31, G21							
Ec472	Personnel Manage.	XV	G(A)	2	2	..	6	Doten
	Ec471							
Ec50	Accounting.......	I_3	3	1	3	..	3	C. H. Porter
	E12	III_3, XVII	3	2	3	..	3	
		$XIII_2$, XV	2	2	3	..	3	
		$XIII_1$	4	2	3	..	3	
Ec51	Cost Accounting...	$XIII_2$, XV	4	1	4	..	4	C. H. Porter
	Ec50, Ec70							
Ec521	Cost Account., Adv.	XV	G(A)	1	1	..	3	C. H. Porter
	Ec51							
Ec522	Cost Account., Adv.	XV	G(A)	2	2	..	6	C. H. Porter
	Ec521							
Ec53	Building Finance..	XVII	4	1	3	..	6	D. S. Tucker
	Ec21							
Ec542	Pub.Util.Ac. & An..	XV	G(A)	2	2	..	4	C. H. Porter
	Ec21, Ec50, Ec57							
Ec551	Pub.Util.Finance..	XV(Not off. 1929-30)	G(A)	1	2	..	6	Armstrong
	Ec21, Ec50, Ec57							
Ec552	Public Util. Reg.							
	and Rates......	XV (Not off. 1929-30)	G(A)	2	2	..	6	Armstrong
	Ec551							
Ec56	Corporate Organ...	$XIII_2$, XV	3	1	3	..	6	Armstrong
	Ec21, Ec50							
Ec57	Corp. Fin. & Invest.	$XIII_2$, XV	3	2	3	..	6	Armstrong
	Ec56							
Ec581	Fin.Admin.of Ind. .	XV	G(A)	1	2	..	6	
	Ec50, Ec56 and							
	Ec57							
Ec582	Fin. Admin. of Ind.	XV	G(A)	2	2	..	6	
	Ec581							
Ec591	Pub.Util.Man.&Fin.	F. and G. Eng.	G(A)	1	2	..	4	Armstrong
	Gen. Econ.							
Ec592	Pub.Util.Man.&Fin.	F. and G. Eng.	G(A)	2	2	..	4	Armstrong
	Ec591							
Ec61	Business Law.....	XIII-A, $XIII_2$, XV	4	1	2	..	4	Hausserman
	Ec37, Ec57							
Ec62	Business Law.....	$XIII_2$, XV	4	2	2	..	4	Hausserman
	Ec61							
Ec63	Bus. Law & Org...	I-A, VI-A	G	2	3	..	5	Hausserman
	Ec21	VII_2	4	2	3	..	5	
Ec65	Statistics.........	XV	2	1	3	..	1	Dewey
	E12							

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
Ec661	Statistical Methods *Ec65, M21*	XV	G(A)	1	2	..	6	MacKinnon
Ec662	Statistical Methods *Ec661*	XV	G(A)	2	2	..	6	MacKinnon
Ec681	Business Cycles... *Ec32*	XV	G(A)	1	2	..	6	D. S. Tucker
Ec682	Business Cycles... *Ec681*	XV	G(A)	2	2	..	6	D. S. Tucker
Ec70	Business Manage. . *Ec56*	XV	3	2	3	..	3	Schell
Ec71	Business Manage. . *Ec70*	XV	4	1	4	..	6	Schell
Ec72	Business Manage. . *Ec71*	XV	4	2	4	..	5	Schell
Ec74	Contracting Man. .	XVII	3	2	3	..	6	Schell
Ec751	Manufact. Anal... *Ec72*	XV	G(A)	1	2	..	6	Schell
Ec752	Manufact. Anal... *Ec751*	XV	G(A)	2	2	..	6	Schell
Ec761	Mark.of Man.Prod. *Ec72 or equiv.*	XV	G(A)	1	2	..	6	
Ec762	Mark.of Man.Prod. *Ec761*	XV	G(A)	2	2	..	6	
Ec781	Stand. Meas. in Indust. Man. ...	XV	G(A)	1	2	..	6	Raymond
Ec782	Stand. Meas. in Indust. Man. ...	XV	G(A)	2	2	..	6	Raymond
Ec80	Ocean Ship. Adm. .	$XIII_3$	3	2	2	..	4	Fernstrom

ENGLISH AND HISTORY

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
E1	English (entrance).			S	2	..	5	Pearson
E11	English & History.	All courses	1	1	3	..	5	A. T. Robinson
E12	English & History.	All courses	1	2	3	..	5	A. T. Robinson
E21	English & History.	All courses	2	1	3	..	5	Rogers
E22	English & History.	All courses	2	2	3	..	5	Rogers
E33	Report Writing ...	$XIII_2$, XV_2 I_3, IV-A, $XV_{1,3}$	3 3	1 2	2 2	.. ..	2 2	W. Prescott
E41	Problem Analysis..	IV	3	1	2	..	2	D. M. Fuller
E42	Problem Analysis..	IV	3	2	2	..	2	W. A. Crosby
E44	Committee Work..	I-A(A), VI-A(A) I-A(B), VI-A(B)	3 4	1 1	2 2	.. ..	4 4	D. M. Fuller
E45	Business English ..	I-A(A), VI-A(A) I-A(B), VI-A(B)	4 3	S S	1 1	.. ..	3 3	A. T. Robinson
E46	Mod. Forms of Lit.	VI-A(A) VI-A(B)	4 3	2 2	2 2	.. ..	4 4	W. Prescott

FUEL AND GAS ENGINEERING — F1–F10

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
F1	Prin. of Combust. .	F. and G. Eng.	G(A)	1	2	..	4	Ryan
F2	Dev. & Use of Pwr..	F. and G. Eng.	G(A)	1	2	..	4	Riley
F3	Furn. & Ret. Des. .	F. and G. Eng.	G(A)	2	3	..	6	Hottel
F4	Gas Engine Lab. ..	(Elective)	G	1	0	3	0	Fales
F5	Natural Fuels.....	F. and G. Eng.	G(A)	1	2	..	4	Hottel
F6	Pr.F. & G. Eng. I..	(Elective)	G	1	5	..	5	C. S. Robinson
F7	Pr.F. & G. Eng. II. *F6*	F. and G. Eng.	G(A)	2	5	..	5	C. S. Robinson
F8	Prop. of Mat......	F. and G. Eng.	G(A)	2	2	..	2	Hottel
F9	Manufact. Fuels...	F. and G. Eng.	G(A)	2	2	..	4	Mangelsdorf
F10	Fieldwork & Thesis (Boston Station)	F. and G. Eng.	G(A)	1	..	16	..	Mangelsdorf
F11	Fieldwork........ (Buffalo Station)	F. and G. Eng.	G(A)	1	..	16	..	Mangelsdorf
F12	Fieldwork........ (Bayonne Station)	F. and G. Eng.	G(A)	1	..	16	..	Mangelsdorf
F13	Gas Eng., Adv.....	(Elective)		S				Mangelsdorf
F14	App. of Gas to Ind.	(Elective)		S				Wilkes
F15	Const.& Com.Fuels	(Elective)		S	3	..	5	Mangelsdorf
F20	Sem. Adv. Fur.Des.	F. and G. Eng.	G(A)	2	2	..	4	Hottel

GENERAL STUDIES — G1 - G99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
G1	History of Science. *M13*		3, 4	1	2	..	2	H. W. Tyler
G2	History of Science. *M13*		3, 4	2	2	..	2	H. W. Tyler
G3	Inter. Law & Am. Foreign Policy..		3, 4	1	2	..	2	Tryon
G5	Psychology.......		3, 4	2	2	..	2	Holmes Whittemore
G21	Ind. Relations.....		3, 4	2	3	..	5	Doten
	Ec70	XV, XIII$_1$ (Req.)	4	2	3	..	5	
G25	Invest. Finance...		3, 4	2	2	..	2	D. S. Tucker
G31	Humanics........		3, 4	1	2	..	2	Gow
G32	Humanics.........		3, 4	2	2	..	2	Gow
G40	Contemp. Drama..		3, 4	2	2	..	2	Rogers
G41	Contemp. Eng. Lit.	(Not off. in 1929-30)	3, 4	1	2	..	2	Rogers
G42	Contemp. Eur. Lit.	(Not off. in 1929-30)	3, 4	2	2	..	2	Rogers
G43	American Literature		3, 4	1	2	..	2	Rogers
G46	Public Speaking...		3, 4	1	2	..	2	Copithorne
G47	Committee Reports		3, 4	2	2	..	2	W. Prescott
G48	Appreciation of Music..........		3, 4	1	2	..	2	Roberts
G49	19th Cent. Thought		3, 4	1	3	..	5	W. Prescott
G50	Fine Arts in Modern Life		3, 4	2	2	..	2	H. L. Seaver
G51	Biography in Science		3, 4	2	3	..	5	Pearson
		VI,VI-C,VI-A(B) (Req.)	4	2	3	..	5	
		VI-A(A) Req.)	4	1	3	..	5	
G52	Lincoln & Period of Civil War......		3, 4	1	2	..	2	Pearson
G55	French Rev. and Napoleon.......		3, 4	2	2	..	2	Crosby
G56	Europ. Civ.& Art..		3, 4	1	3	..	4	Sumner
	E11	IV, IV-A (Req.)	3	1	3	..	4	
G57	Europ. Civ.& Art.		3, 4	2	3	..	4	Sumner
	G56	IV, IV-A (Req.)	3	2	3	..	4	
G58	Choral Singing		3, 4	Register both terms				Townsend
G59	Soc. Prob. of Phil..		3, 4	1	2	..	2	A.T. Robinson
G60	Geology..........	(Not open to students in I, III$_{1,3}$, IX-A, XI, XII, XVII)	3, 4	1	2	..	2	Shimer
		V	2	1	2	..	2	
G62	Economic Geog....		3, 4	1	2	..	2	Gillson
G64	Organic Evolution.		3, 4	2	2	..	2	Shimer
		IX-A, XII (Req.)	3	2	2	..	2	
G66	Desc. Astron......	(Not open to I)	3, 4	2	2	..	2	Goodwin
	8.04	IX-A (Req.)	4	2	2	..	2	
G71	Prin. of Biol.& Her.	(Not open to XI)	3, 4	1	2	..	2	Bigelow
G75	Biol. Reproduction		3, 4	2	2	..	2	Bunker
G76	Hist. of Philosophy *M12*		3, 4	2	2	..	2	Wiener
G821	French...........		3, 4	1	2	..	2	Langley
G822	French...........		3, 4	2	2	..	2	Langley
G831	French........... *L62*		3, 4	1	2	..	2	Langley
G832	French........... *L62*		3, 4	2	2	..	2	Langley
G98	Military Hist. & Policy of U. S...		3, 4	2	2	..	2	Cloke

GERMAN — L1 - L49

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
L11	German, Elem.	Elective		1	3	..	5	Vogel
L12	German, Elem. *L11*	Elective		2	3	..	5	Vogel
L21	German, Int. *L12 or ent. req.*	Elective		1	3	..	5	Vogel
L22	German, Int. *L21*	Elective		2	3	..	5	Vogel
L23	German Int. *L12*	XVI (Elective)		1	2	..	4	Vogel
L24	German, Int. *L23*	XVI (Elective)		2	2	..	4	Vogel
L31	German, Adv. *L21, L22*	Elective		1	3	..	5	Vogel
L32	German, Adv. *L31*	Elective		2	3	..	5	Vogel
L331	German, Adv.	Elective		1	2	..	4	Vogel
L332	German, Adv. L331	Elective		2	2	..	4	Vogel

ROMANCE LANGUAGES — L50 - L99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
L51	French, Elem.	Elective		1	3	..	5	Langley
L52	French, Elem. *L51*	Elective		2	3	..	5	Langley
L61	French, Int. *L52*	Elective		1	3	..	5	Langley
L62	French, Int. *L61*	Elective		2	3	..	5	Langley
L63	French, Adv. *L62*	IV	1	1	3	..	6	Langley
L64	French, Adv. *L63*	IV	1	2	3	..	6	Langley
L65	French, Adv. *L64*	IV	2	1	2	..	3	Langley
L66	French, Adv. *L65*	IV	2	2	2	..	3	Langley
L71	French *L52 or equiv.*	XVI (Elective)	3	1	2	..	4	Langley
L72	French *L71*	XVI (Elective)	3	2	2	..	4	Langley
L81	Spanish, Elem.	Elective		1	3	..	5	Langley
L82	Spanish, Elem. *L81*	Elective		2	3	..	5	Langley

MATHEMATICS — M1 – M99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
M1	Algebra (Ent.)....			S	2	..	5	Rice
M3	Solid Geom. (Ent.)			S	2	..	5	Franklin
M4	Trigonometry (Ent.)			S	2	..	5	Zeldin
M11	Calculus.......... *M1, M3, M4*	All courses	1	1	3	..	6	Bailey
M12	Calculus.......... *M11*	All courses	1	2	3	..	6	Rutledge
M21	Calculus.......... *M12*	All courses except IV	2	1	3	..	6	Bartlett
M22	Diff. Equations ... *M21*	Allexc.IV,VII$_{1,2}$, X,XV$_3$	2	2	3	..	6	H. B. Phillips
M23	Higher Algebra & Geometry....... *M12*	VIII	2, 3	1	2	..	4	Franklin
M24	Higher Algebra & Geometry....... *M23*	VIII	2, 3	2	2	..	4	Franklin
M26	Least Square...... *M22*	IX-C	4	1	2	..	2	Bartlett
M31	Mathematics...... *M22*	VI, VI-C, VI-A(B) VI-A(A)	3 3	1 2	2 2	.. ..	4 4	Franklin
M32	Elem. of Analysis.. *M22*	VIII, IX-C	3	1	3	..	6	
M36	Calculus, Adv. *M22*		G(A)	1	3	..	6	Woods
M37	Calculus, Adv..... *M36*		G(A)	2	3	..	6	Woods
M41	Calculus, App. of.. *M21*	X, X-B Chem. War.	4 G	1 1	3 3	.. ..	6 6	Hitchcock
M43	Theoret.Aeronaut.. *M21*	IX-C(Elective) XVI	4 3	1 1	3 3	.. ..	6 6	Moore
M44	Theoret. Aeronaut. *M43*	IX-C(Elective) XVI	4 3	2 2	3 3	.. ..	6 6	Moore
M451	Fourier's Series & Int. Equa.......	Math.	G	1	2	..	6	Wiener
M452	Fourier's Series & Int. Equa	Math.	G	2	2	..	6	Wiener
M46	Wing Th., Adv. ... *M44*	XVI, Math.	G(A)	1	3	..	6	Moore
M47	Wing Th., Adv. ... *M46*	XVI, Math.	G(A)	2	3	..	6	Moore
M54	Mathematical Lab. *M22*	Math.	4	2	3	..	9	Douglass
M551	Funct.of Real Vari. *M22*	Math.	G(A)	1	2	..	6	P. Franklin
M552	Funct.of Real Vari. *M22*	Math.	G(A)	2	2	..	6	P. Franklin
M561	Funct.of Comp.Vari. *M22*	Math.	G(A)	1	2	..	6	Rutledge
M562	Funct.of Comp.Var. *M561*	Math.	G(A)	2	2	..	3	Rutledge
M57	Th. of Gyroscope .. *M22*	II(O.D.)(T.D.) Math.	G G(A)	2 2	1 1	.. ..	2 2	H. B. Phillips
M571	Th. of Gyroscope.. *M22*	II(A.O.)	4	2	1	..	1	H. B. Phillips
M60	Vector Analysis ... *M22*	Math.	G(A)	1	2	..	6	Zeldin
M62	Modern Algebra... *M22*	Math.	G(A)	2	2	..	6	Rice
M631	Diff. Geometry.... *M22*	Math.	G(A)	1	2	..	6	Woods
M632	Diff. Geometry.... *M22*	Math.	G(A)	2	2	..	6	Woods
M651	Anal. Mechanics... *M22*	Math.	G(A)	1	3	..	6	P. Franklin
M652	Anal. Mechanics... *M651*	Math.	G(A)	2	3	..	6	P. Franklin

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep	Instructor in Charge
M653	Anal. Mechanics...	Math.	G(A)	**1**	3	..	6	P. Franklin
M70	Hist.(Math.)Science *M12*	Elective	4	**1**	2	..	4	H. W. Tyler
M72	Diff. Equations.... *M21*	II(A.O.)	4	**S**	13	..	0	H. B. Phillips
M731	Rigid Dynamics... *M22*	XIII-A	G	**1**	3	..	6	Moore
M732	Rigid Dynamics... *M731*	XIII-A	G	**2**	3	..	6	Moore
M75	Ext. Ballistics..... *M22*	II(O.D.)	G	**1**	2	..	4	P. Franklin
M76	Th. of Probability. *M21*	IX-C	G(A)	**2**	3	..	6	Struik
M77	Vector Analysis ... *M22*	VI-A$_{1,2}$ VIII, IX-B	3	**2**	3	..	5	H.B.Phillips
		VI-A(A)$_3$	4	**1**	3	..	5	
		VI-A(B)$_3$	4	**2**	3	..	5	
M781	Geometry, Adv.... *M22*	IX-C	G(A)	**1**	2	..	6	Struik
M782	Geometry, Adv....	IX-C	G(A)	**2**	2	..	6	Struik
M791	Th. & App. Elast. .	IX-C	G(A)	**1**	2	..	6	Hovgaard
M792	Th. & App. Elast. .	IX-C	G(A)	**2**	2	..	6	Hovgaard
M80	Meth. of Teach. Jr. High Sch. Math.			**S**	2	..	6	W. F. Downey
M81	Meth. of Teach. Sr. High Sch. Math.			**S**	2	..	6	W. F. Downey
M851	Mod. Mech. Th....	IX-C	G(A)	**1**	3	..	6	Wiener Struik
M852	Mod. Mech. Th....	IX-C	G(A)	**2**	3	..	6	Wiener Struik
M90	Math. Reading....		G(A)	**1 & 2**	✦	..	✦	Woods

✦Time specially arranged.

MILITARY SCIENCE — MS1–MS99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep	Instructor in Charge
MS11	Military Science...	All courses	1	**1**	2	1	0	Eddy
MS12	Military Science...	All courses	1	**2**	3	..	0	Eddy
MS21	Military Science...	All courses	2	**1**	3	..	0	A.T.W. Moore
MS221	Coast Artillery....	All courses	2	**2**	3	..	0	Winslow
MS222	Engineer Corps ...	All courses	2	**2**	3	..	0	A.T.W.Moore
MS223	Signal Corps......	All courses	2	**2**	3	..	0	Eyster
MS224	Ordnance Dept ...	All courses	2	**2**	3	..	0	Somers
MS225	Air Corps........	II, VI & XVI only	2	**2**	3	..	0	Frierson
MS226	Chem. War Ser...	V, X, XIV, XV$_3$, only	2	**2**	3	..	0	Kellogg
MS311	Coast Art., Adv... *MS221*	All courses except V	3	**1**	3	..	3	Winslow
MS312	Eng. Corps, Adv... *MS222*	All courses except V	3	**1**	3	..	3	A.T.W.Moore
MS313	Signal Corps, Adv. *MS223*	VI, VI-A, VI-C, VIII, IX-B, XIV	3	**1**	3	..	3	Eyster
MS314	Ord. Dept., Adv... *MS224*	II, III$_3$, VI-A, X, X-B, XV$_{2,3}$	3	**1**	1	..	1	Somers
MS321	Coast Art., Adv... *MS311*	All courses except V	3	**2**	3	..	3	Winslow
MS322	Eng. Corps, Adv... *MS312*	All courses except V	3	**2**	3	..	3	A.T.W.Moore
MS323	Signal Corps., Adv	VI, VI-A, VI-C, VII, IX-B, XIV	3	**2**	2	1	3	Eyster
MS324	Ord. Dept., Adv.. *MS314*	II, III$_3$, VI-A, X, X-B, XV$_{2,3}$	3	**2**	1	..	1	Somers
MS325	Air Corps, Adv...	II, VI & XVI only	3	**2**	3	..	3	Frierson
MS326	Chem. Warfare Service Adv.....	V, X, XIV, XV$_3$	3	**2**	3	..	3	Kellogg
MS411	Coast Art., Adv... *MS321*	All courses except V	4	**1**	2	..	2	Winslow
MS415	Air Corps, Adv... *MS325*	II, VI & XVI only	4	**1**	3	..	3	Frierson
MS421	Coast Art., Adv... *MS411*	All courses except V	4	**2**	2	..	2	Winslow

HYGIENE — PT1–PT99

No.	Subject with Prerequisites	Taken by	Yr.	Tm.	Rec. Lec.	Lab. Draw.	Prep.	Instructor in Charge
PT1	Physical Training	All courses	1	**1**(l. 10 w.)		1	0	McCarthy
PT2	Physical Training	All courses	1	**2**(1st 10 w.)		1	0	McCarthy

ALPHABETICAL LIST OF SUBJECTS

(With reference to pages containing description)

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