M.I.T. ANNUAL CATALOGUES AND BULLETINS
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# MASSACHUSETTS INSTITUTE OF TECHNOLOGY

# CATALOGUE

## ACADEMIC YEAR

## 1932-33

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

APRIL, 1932

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## CALENDAR FOR ACADEMIC YEAR 1932–1933

| | *1932* |
|---|---|
| Entrance Examinations at Technology Begin | Sept. 14 |
| College Year Begins | Sept. 26 |
| Columbus Day (Holiday) | Oct. 12 |
| Armistice Day (Holiday) | Nov. 11 |
| Thanksgiving Day (Holiday) | Nov. 24 |
| Christmas Vacation | Dec. 23–Jan. 2 (inclusive) |
| | *1933* |
| Last Exercise, First Term | Jan. 21 |
| Midyear Examination Period | Jan. 23–Feb. 4 (inclusive) |
| Second Term Begins (Registration Day) | Feb. 6 |
| Washington's Birthday (Holiday) | Feb. 22 |
| Spring Recess | April 19–23 (inclusive) |
| Last Exercise, Second Term | May 24 |
| Annual Examinations Begin | May 26 |
| Memorial Day (Holiday) | May 30 |
| Commencement Day | June 6 |
| Examinations, College Entrance Examination Board | June 19–24 |
| Summer Session 1933 Begins | June 5 |

## CALENDAR FOR ACADEMIC YEAR 1933–1934

| | *1933* |
|---|---|
| Entrance Examinations at Technology Begin | Sept. 13 |
| College Year Begins | Sept. 25 |
| Columbus Day (Holiday) | Oct. 12 |
| Armistice Day (Holiday) | Nov. 11 |
| Thanksgiving Day (Holiday) | Nov. 30 |
| Christmas Vacation | Dec. 22–Jan. 1 (inclusive) |
| | *1934* |
| Last Exercises, First Term | Jan. 20 |
| Midyear Examination Period | Jan. 22–Feb. 3 (inclusive) |
| Second Term Begins | Feb. 5 |
| Washington's Birthday (Holiday) | Feb. 22 |
| Spring Recess | April 18–21 (inclusive) |
| Last Exercise, Second Term | May 23 |
| Annual Examinations Begin | May 25 |
| Memorial Day (Holiday) | May 30 |
| Commencement Day | June 5 |
| Summer Session 1934 Begins | June 4 |

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[1] Address correspondence to Massachusetts Institute of Technology.

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*Professor of Topographical Engineering*

Charles Blaney Breed, S.B.
*Professor of Railway and Highway Transportation*

Harold Kilbreth Barrows, S.B.
*Professor of Hydraulic Engineering*

George Edmond Russell, S.B.
*Professor of Hydraulics*

George Leonard Hosmer
*Professor of Geodesy*

John Brazer Babcock, 3d, S.B.
*Professor of Railway Engineering*

John Wardwell Howard, S.B.
*Associate Professor of Topographical Engineering*

Walter Maxwell Fife, S.M.
*Associate Professor of Civil Engineering*

THOMAS RINGGOLD CAMP, S.M.
*Associate Professor of Sanitary Engineering*

WILLIAM ANDREW LIDDELL, S.B.
*Assistant Professor of Hydraulic Engineering*

EUGENE MIRABELLI, S.B.
*Assistant Professor of Structural Design*

KENNETH CASS REYNOLDS, S.M.
*Assistant Professor of Hydraulics*

GLENNON GILBOY, SC.D.
*Assistant Professor of Soil Mechanics*

**Special Lecturer**

JOHN AYER, S.B.

**Instructors**

JOHN DONALD MITSCH, S.B.
JOHN BENSON WILBUR, S.M.
FRANK LOUIS LINCOLN, B.S.
JOHN BUCKNAM DRISKO, S.B.
ISADORE SILVERMAN, S.M.

**Research Associates**

LEO JURGENSON, SC.D.
MILLS WENDLER BRAUNLICH, B.S.
EDWARD CHARLES ROCHE, S.B.

**Assistants**

RAYMOND GUSTAF ROLIN, S.B.
HUNTER ROUSE, S.B.
ALFRED THOMAS WAIDELICH, S.M.

**Research Assistants**

SIDNEY GUSSMAN ALBERT, C.E.
LEO CASAGRANDE, DIPL.ING.
CEDRIC HUGH MACDOUGALL, B.A. SC., S.M. (*Absent*)

**Representative of United States Bureau of Public Roads**

ARTHUR CASAGRANDE, DIPL.ING.

**Representative of American Society of Civil Engineers**

SPENCER JENNINGS BUCHANAN, S.M.

## ECONOMICS AND STATISTICS

DAVIS RICH DEWEY, PH.D., LL.D.
*Professor of Political Economy and Statistics*
*In charge of the Department*

CARROLL WARREN DOTEN, PH.B., A.M.
*Professor of Political Economy*

FLOYD ELMER ARMSTRONG, A.M.
*Professor of Political Economy*

DONALD SKEELE TUCKER, PH.D.
*Professor of Political Economy*

RALPH EVANS FREEMAN, M.A., B.LITT.
*Associate Professor of Economics*

OLIN INGRAHAM, PH.B., A.M.
*Assistant Professor of Economics*

**Special Lecturer**

LUTHER ROBERTS NASH, S.M.

**Instructor**

BRAINERD ALDEN THRESHER, S.B., A.M.

**Assistant**

MARION COOPER GILBERT, A.M.

## ELECTRICAL ENGINEERING

DUGALD CALEB JACKSON, B.S., C.E.
*Professor of Electric Power Production and Distribution*
*In charge of the Department*

FRANK ARTHUR LAWS, S.B.
*Professor of Electrical Measurements*

RALPH RESTIEAUX LAWRENCE, S.B.
*Professor of Electrical Machinery*

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

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

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

RALPH GORTON HUDSON, S.B.
*Professor of Electrical Engineering*

OTTO GUSTAV COLBIORNSEN DAHL, S.M.
*Professor of Electric Power Transmission*

ELIHU THOMSON, PH.D., SC.D., LL.D.
*Non-Resident Professor of Applied Electricity*

EDWARD LINDLEY BOWLES, S.M.
*Associate Professor of Electrical Communications*

CARLTON EVERETT TUCKER, S.B.
*Associate Professor of Electrical Engineering*

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

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

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

ARTHUR LITCHFIELD RUSSELL, S.B.
*Assistant Professor of Electrical Engineering*

JAYSON CLAIR BALSBAUGH, S.M.
*Assistant Professor of Electric Power Production and Distribution*

KARL LELAND WILDES, S.M.
*Assistant Professor of Electrical Engineering*

ERNST ADOLPH GUILLEMIN, PH.D.
*Assistant Professor of Electrical Engineering*

MURRAY FRANK GARDNER, S.M.
*Assistant Professor of Electrical Engineering*

JAMES LOVELL ENTWISTLE, S.M.
*Assistant Professor of Electric Transportation*

RICHARD DUDLEY FAY, A.B., S.B.
*Assistant Professor of Electrical Engineering*

RICHARD HENRY FRAZIER, S.B.
*Assistant Professor of Electrical Engineering*

HAROLD LOCKE HAZEN, S.M.
*Assistant Professor of Electrical Engineering*

PARRY H. MOON, S.M.
*Assistant Professor of Electrical Engineering*

### Instructors

ARAM BOYAJIAN, B.S., E.E. (*Non-Resident*)
LYMAN MINER DAWES, S.B.
OVID WALLACE ESHBACH, E.E., M.S. (*Non-Resident*)
JOHN BURGESS COLEMAN, S.M.
ROBERT ERNEST QUINLAN, S.M.
JAMES EDWARD MULLIGAN, B.S.
SAMUEL HAWKES CALDWELL, S.M.
HAROLD EUGENE EDGERTON, SC.D.
AUSTIN SIBLEY NORCROSS, S.M.
WILLIAM LAWRENCE SULLIVAN, S.M.
CHARLES KINGSLEY, JR., S.B.
EDWIN LAWRENCE ROSE, S.M. (*Absent*)

William Mott Hall, S.B.
Frank Malcolm Gager, S.M.
Truman Stretcher Gray, Sc.D.
Charles Justus Koch, S.M.
(*Non-Resident*)
Charles Benjamin Oler, M.S.
Wilmer Lanier Barrow, Sc.D.
Otto Walter H. O. Brune, Sc.D.
Carl John Ellsworth, S.M.
George Burnham Hoadley, B.S.
Frank Gregg Kear, E.E., S.M.
Hugh Merchant Nazor, B.S.
Carl Neitzert, B.S., M.A.
Thurston Dorr Owens, M.S.

### Assistants

Clifford Eugene Hentz
*Curator of Apparatus*

Robert Charles Meyer, B.S.

Elwood Worral Schafer
*Assistant Curator of Apparatus*

Robert John Ellis Whittier
*Curator of Apparatus*

### Research Assistants

Gordon Stanley Brown, S.B.

Sidney Eugene Caldwell, B.S.

Howard Allan Chinn, S.M.

Paul Stanley Hendricks
*Radio Operator*

Henry Garrett Houghton, Jr., S.M.

Ellis Adolph Johnson, S.M.

Allan John McLennan, 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.
*Professor of English*

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

William Anderson Crosby, A.M.
*Associate Professor of English*

Penfield Roberts, A.M.
*Associate Professor of English*

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

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

William Chace Greene, Ph.B., M.A.
*Assistant Professor of English*

### Instructors

Walter Washington Jamison, A.M.
Donald Malcolm Greer, Ph.D.
Carl Bridenbaugh, A.M.
Albert Arnold Lawrence, A.M.
Theodore Smith, A.M.
Robert Smith Woodbury, S.B.
Howard Russell Bartlett, B.S., A.M.
Paul Conant Eaton, S.B., A.M.
Frederick Gardiner Fassett, Jr., A.M.
Arthur Chace Watson, A.B.

## GEOLOGY

WALDERMAR 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*

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

WALTER HARRY NEWHOUSE, PH.D.
*Associate Professor of Economic Geology*

LOUIS BYRNE SLICHTER, PH.D.
*Associate Professor of Geophysics*

MARTIN JULIAN BUERGER, PH.D.
*Assistant Professor of Mineralogy and Petrography*

### Special Lecturers

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

JOSEPH AUGUSTINE CUSHMAN, PH.D.
*Micropaleontology*

### Instructors

ROBERT KINGSLAND DOTEN, S.M.
GERARD FRANCIS FLAHERTY, S.M.
LOUIS CRAWFORD RAYMOND, B.S.
JOHN SINCLAIR STEVENSON, B.A.SC.

## HYGIENE

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

HAROLD EDWARD LOBDELL
*Dean*

LOUIS WARD CROKE, M.D.
*Assistant Medical Director*

BENJAMIN ERNEST SIBLEY, M.D.
*Assistant to Medical Director*

HARLAND FRANCIS LANCASTER, M.D.
*Assistant to Medical Director*

HENRY PATRICK McCARTHY
*Director of Physical Training*

SANFRID KNUT JOHNSON
*Assistant in Physical Training*

JUSTIN MENNIS KEARNEY
*Student Assistant in Physical Training*

OSCAR FREDERICK HEDLUND
*Track Coach*

WILLIAM B. HAINES
*Crew Coach*

JOHN H. SUMMERS
*Squash Coach*

ROBERT BOWIE
*Track Field Coach*

## MATHEMATICS

FREDERICK SHENSTONE WOODS, PH.D.
*Professor of Mathematics*
*In charge of the Department*
*Chairman of the Faculty*

FREDERICK HAROLD BAILEY, A.M.
*Professor of Mathematics*

HENRY BAYARD PHILLIPS, PH.D.
*Professor of Mathematics*

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

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

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

GEORGE RUTLEDGE, PH.D.
*Associate Professor of Mathematics*

NORBERT WIENER, PH.D. (*Absent*)
*Associate Professor of Mathematics*

PHILIP FRANKLIN, PH.D.
*Associate Professor of Mathematics*

DIRK JAN STRUIK, PH.D.
*Associate Professor of Mathematics*

LEPINE HALL RICE, A.B.
*Assistant Professor of Mathematics*

JESSE DOUGLAS, PH.D.
*Assistant Professor of Mathematics*

RAYMOND DONALD DOUGLASS, PH.D.
*Assistant Professor of Mathematics*

SAMUEL DEMITRY ZELDIN, PH.D.
*Assistant Professor of Mathematics*

**Instructors**

NORMAN HANSEN BALL, S.B.
JAMES GRAHAM ESTES, B.A., M.S.
HORACE ALPHEUS GIDDINGS, B.S.
EDWARD MONROE JOSEPH PEASE, SC.M.
GEORGE PROCTOR WADSWORTH, S.M.

## MECHANICAL ENGINEERING

EDWARD FURBER MILLER, SC.D.
*Professor of Steam Engineering*
*In charge of the Department*
*Director of Engineering Laboratories*
*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*

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

EARLE BUCKINGHAM
*Professor of Engineering Standards and Measurements*

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

WILHELM SPANNHAKE, DIPL.ING.
*Professor of Hydraulics*

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

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

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

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

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*

HEINRICH HENCKY, D.ENG.
*Associate Professor of Mechanics*

WILLIAM HENRY JONES, S.B.
*Associate 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*

ARTHUR LAWRENCE TOWNSEND, S.B.
*Assistant Professor of Machine Design*

JOHN HARVEY ZIMMERMAN, S.M.
*Assistant Professor of Materials of Engineering*

EDWARD ROBINSON SCHWARZ, S.B.
*Assistant Professor of Textile Technology*

CARL LOUIS SVENSON, S.B.
*Assistant Professor of Heat Engineering*

JAMES RICHARD LAMBIRTH
*Assistant Professor of Mechanical Engineering*

**Special Lecturers**

ROBERT LOUIS BROWNE, B.S.
*Thermit Welding*

RAYMOND WILSON COOK
*Production*

FRED DAVIS
*Electric Arc Welding*

GEORGE JAEGER
*Oxy-Acetylene Welding*

CLIFFORD LORING MUZZEY, S.B.
*Production*

WILLIAM TAYLOR OBER
*Electric Butt and Spot Welding*

GEORGE ALGER PENNOCK, S.B.
*Production*

LEWIS DANIEL SPENCE
*Automatic Machinery*

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

**Instructors**

CHARLES EVERETT LITTLEFIELD
ROY GIBSON BURNHAM, S.B.
JEREMIAH FRANCIS O'NEILL
ARTHUR BROWN ENGLISH
CLAUDE HUGH CLARK
ROBERT BUTTERFIELD CHENEY
BIRTHRAM SHEPPARD
HERBERT CARLTON MOORE, S.B.
MARK WILLIAM LIBBEY, S.B.
ALVIN SLOANE, B.S.
ANDREW WYLES LAWSON
MIETH MAESER, A.B., S.M.
CHARLES ARTHUR BULFINCH
LAURENCE LAMONT DEFABRITIS, S.B.
CARL MAGNUS FRITHIOF PETERSON, S.B.
HOWARD STOCKWELL ROOT, S.M.

**Research Associate**

HENRY FRANCIS KING, S.M.

**Assistants**

HAROLD MUNROE BAKER, S.M.
KHITISH CHANDRA BISWAS
RALPH JOHN BOWLEY
HEMENWAY REGNOLD BULLOCK
MADISON MOTT CANNON, JR., S.B.
AUGUST LUDWIG HESSELSCHWERDT, JR., S.B.
CLIFFORD PROCTOR KITTREDGE, S.B. (*Absent*)
FREDERICK A. LADD, JR.
JOHN WOODBURY LANE, S.B.
ALBERT J. OAKES
*Gas Mechanic*
FRANCIS WINFIELD PERKINS
*Constructor of Apparatus*
WALTER WALERY SOROKA, S.B.
ROBERT WESTON VOSE, S.B.

## MILITARY SCIENCE AND TACTICS

SAMUEL CURTIS VESTAL, GRAD. U.S.N.A.
Colonel, Coast Artillery Corps (D.O.L.)
*Professor of Military Science and Tactics*
*In charge of the Department*

ROBERT ARTHUR, GRAD. U.S.M.A.
Lieutenant-Colonel, Coast Artillery Corps, D.O.L.
*Associate Professor of Military Science and Tactics*
*Executive Officer*

PETER HILL OTTOSEN, B.C.E.
Major, Coast Artillery Corps, D.O.L.
*Associate Professor of Military Science and Tactics*
*In charge of Coast Artillery Unit*

RICHARD HERBERT SOMERS, M.B.A. GRAD. U.S.M.A.
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*In charge of Ordnance Unit*

CHARLES EDWARD ATKINSON, S.B.
Captain, Coast Artillery Corps, D.O.L.
*Assistant Professor of Military Science and Tactics*
*With Coast Artillery 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*

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

CLARENCE LIONEL ADCOCK GRAD. U.S.M.A.
1st Lieutenant, Corps of Engineers D.O.L.
*Assistant Professor of Military Science and Tactics*
*In charge of Engineer Unit*

EDWARD CROSBY HARWOOD, C.E., M.C.E., M.B.A., GRAD. U.S.M.A.
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*Assistant Professor of Military Science and Tactics*
*With Engineer Unit*

GEORGE ANTHONY BICHER GRAD. U.S.M.A.
1st Lieutenant, Signal Corps, D.O.L.
*Assistant Professor of Military Science and Tactics*
*In charge of Signal Corps Unit*

### Instructors

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

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
Armorer
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 of Metallurgy*

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

Charles E. Locke, S.B.
*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.
*Associate Professor of Physical Metallurgy*

John Torrey Norton, S.B.
*Associate Professor of the Physics of Metals*

Igor Nicholas Zavarine, S.M.
*Assistant Professor of Physical Metallurgy*

Franklin LeRoy Foster, S.M.
*Assistant Professor of Mining*

James Weston Pratt, S.B.
*Assistant Professor of Physical Metallurgy*

John Palmer Walsted, Sc.D.
*Assistant Professor of Physical Metallurgy*

### Instructors

Rufus Cook Reed, S.B.
Robert Edwin Bannon, S.M.

### Assistants

Theodore Eliot Graves, A.B.
Donald Louis Herbert, S.B.
Leonard Whitman Johnston, S.B.

### Research Assistant

Harold Bartlett Litchman, S.B.

## MODERN LANGUAGES

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

Herman Rudolph Kurrelmeyer, Ph.D.
*Professor of German*

### Instructors

Francis Morton Currier, A.M.
Jaques Henri Pillionnel, A.M.
Richard Felix Koch, A.M.
Marshall Newton, A.M.
Werner Paul Friederich, A.M.

## 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, Eng.D.
*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.
*Professor of Ship Operation and Marine Engineering*

HENRY EASTIN ROSSELL, S.M., GRAD. U.S.N.A.
Commander (C.C.) U. S. N.
*Professor of Naval Construction*

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

AUBREY DONNITHORNE BEIDELMAN, S.B.
*Assistant Professor of Naval Architecture*

## PHYSICS

### (Including Electrochemical Engineering)

JOHN CLARKE SLATER, PH.D.
*Professor of Physics*
*In charge of the Department*
*Director of the Institute of Theoretical Physics*

HARRY MANLEY GOODWIN, PH.D.
*Professor of Physics and Electrochemistry*
*In charge of the Course in Electrochemical Engineering*
*Director of Research Laboratory of Electrochemistry*
*Dean of Graduate Students*

CHARLES LADD NORTON, S.B.
*Professor of Industrial Physics*
*Director of the Research Laboratory of Applied Physics*
*Director of Division of Industrial Coöperation*

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

NEWELL CALDWELL PAGE, S.B.
*Professor of Electricity*

MAURICE DEKAY THOMPSON, PH.D.
*Professor of Electrochemistry*

GORDON BALL WILKES, S.B.
*Professor of Industrial Physics*

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

ARTHUR COBB HARDY, M.A.
*Associate Professor of Optics and Photography*

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

ROBERT BIGHAM BRODE, PH.D.
*Visiting Associate Professor of Physics, from University of California*

DONALD CHARLES STOCKBARGER, SC.D.
*Assistant Professor of Physics*

HANS MÜLLER, D.SC.
*Assistant Professor of Physics*

JULIUS ADAMS STRATTON, D.SC.
*Assistant Professor of Physics*

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

BERTRAM EUGENE WARREN, SC.D.
*Assistant Professor of Physics*

NATHANIEL HERMAN FRANK, SC.D.
*Assistant Professor of Physics*

VICTOR GUILLEMIN, JR., PH.D.
*Assistant Professor of Physics*

PHILIP MCCORD MORSE, PH.D.
*Assistant Professor of Physics*

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

### Visiting Lecturers

PETER DEBYE, PH.D.
*Professor of Experimental Physics, University of Leipzig*

LINUS CARL PAULING, PH.D.
*Associate Professor of Theoretical Chemistry, California Institute of Technology*

### Instructors

OSCAR KENNETH BATES, S.M.
ALEXANDER LOXLEY MASSEY DINGEE, S.B.
GEORGE PARSONS SWIFT, S.M.
SHERWOOD FISKE BROWN, S.M.
TEMPLE CHAPMAN PATTON, S.B.
LYMAN BAKER JOHNSON, S.M.
THOMAS JOSEPH KILLIAN, PH.D. (*Absent*)
LAURENCE BURNS, S.B.
JAMES ELI FORBES, S.B.
RENE JOSEPH MARCOU, B.S.
FRED HIRAM PERRIN, S.M.
WILLIAM PHELPS ALLIS, SC.D.
CLARENCE EDWIN BENNETT, PH.D.
PAUL LAVERN COPELAND, PH.D.
NEWELL SHIFFER GINGRICH, PH.D.
OVERTON LUHR, PH.D.
HENRY MILES O'BRYAN, PH.D.
ERIK GUSTAF RUDBERG, D.SC. (*Absent*)
JOHN CARL GAUDE WULFF, D.SC.

### Research Associates

GEORGE ASHMUN MORTON, S.M.
JOSEPH CANON BOYCE, PH.D.
EDWARD STONESTREET LAMAR, A.M.
ROBERT JEMISON VAN DE GRAAFF, PH.D.

### Assistants

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HUBERT WERTS ALLEN, M.S.
HARRY ERIC ANDERSON
*Curator of Apparatus*
JONATHAN BISCOE, S.B.
EDMOND JOSEPH BROWN, M.S.
SAMUEL DAVID BRYDEN, JR., S.M.
EVERETT CROPPER
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NEILS HANSEN DALL
*Mechanician*
JAMES WOODRUFF FARMER, B.E.E.
ROBERT HENDERSON FLETCHER
*Curator of Apparatus*
OLIVER MILLER GEORGE, M.S.
ALDEN GROCE HANDY, S.B.
HARRY HILL
*Optical Worker*
SHIKAO IKEHARA, PH.D.
WALTER HARDY KALLENBACH
*Instrument Maker*
LIONEL DETLER PERCIVAL KING, B.S
JOHN MARK KOLLIGIAN, S.M.
DAVID GEORGE CROFT LUCK, S.B.
MILLARD FULLER MANNING, M.S.
CHARLES WALTER MARTEL, S.B.
WILLIAM RICKER PERRET, S.B.
RUDOLPH EMANUEL PETERSON, S.B.
ORRIN WESTON PINEO, S.B.
JAMES GREGOR POTTER, M.S.
HUGH CAMERON RESSLER
EDMOND MAURICE RICHARDS
*Mechanician*
KENNETH HOOPER ROBES, B.S.
*Mechanician*
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## 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 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 of Science, Master in Architecture, 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 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 of students 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.

**Administrative Organization.** In order most effectively to administer and to develop the educational and research work of the Institute, and also in order better to coördinate the work of those departments which are naturally similar in outlook, the work of the Institute is divided into the following groups: The School of Architecture, The School of Science, The School of Engineering, The Division of Humanities, and The Division of Industrial Coöperation.

In the three schools are grouped those departments of study which lead to degrees and which embody the primary educational objectives of the Institute. In the Division of Humanities are grouped those additional studies which are particularly selected on account of their supplemental value in giving a well rounded and balanced cultural attitude toward life. In the Division of Industrial Coöperation there are centered the organized activities of departments and individual members of the staff whose activities are devoted wholly or in part to the assistance of industry in solving its problems or developing new products and methods.

Although thus divided into these five groups for administrative purposes, the educational policies of the Institute remain under the control of the Faculty as a whole.

**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. 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 sixty-seven thousand volumes and receives regularly more than twelve hundred 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; periodicals for one week.

Seniors and others engaged on theses or other research may apply for a special card of admission to the bookstack.

Individual reference service, and aid in research problems and in the use of the catalogue, will be given at the two Reference Desks in the Central Library and in the larger branch libraries.

Boston Public Library cards are given to non-resident students on the presentation of applications endorsed by the Institute Librarian.

**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 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.

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 Bemis ('93), will accommodate eighty men, and is five stories high. Adjoining Bemis are two new halls constructed during the fall of 1927 — containing one hundred and thirty-six single rooms. One of these halls has been named Walcott ('01), the funds having been contributed by his class. The other hall has been named Goodale ('75).

Three new dormitory halls, to accommodate two hundred men, were ready for occupancy in September, 1930. This brings the total capacity of the dormitories to 625. These halls are named Munroe ('82), Hayden ('96) and Wood ('94).

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 1932–1933, a period of 38 weeks, is given below:

**For a Period of 38 Weeks**

| | |
|---|---|
| Tuition | $500 |
| Board | 380 |
| Room | 230 |
| Books and materials | 90 |
| | $1,200 |

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, 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 football field; 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 basketball 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. On the grounds west of Massachusetts Avenue are fields for soccer, lacrosse and baseball; also additional tennis 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 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 coaching the few men composing a single varsity team, but 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, basketball, 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 of the conduct of these various sports is being steadily improved.

**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 mportance.

## 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 4. 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 considered 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 considered 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. to 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 on Saturday afternoons beginning in March; those received at the end of the second term must be made up the following September. A student not taking an examination at the time stated forfeits the right to 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 8.30–9.30 and 10–12, and every afternoon 1–3 and 4–5 for the care of the sick, 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 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 male undergraduate student is required to report to the Medical Director for a complete physical examination during the first term of each academic year, and every male graduate student is required to report for such examination during his first term of residence as a graduate student at the Institute.

With a view to correcting certain physical defects a course in gymnastics is given by an instructor especially trained in this work. Students who are found to be markedly unfit physically 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
Corps of Engineers
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 professors in charge of their Institute courses, 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 of Students is the general consulting officer for all students, and coöperates with the President in matters touching discipline and general student relations. On request to 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 $500 per year and must be paid *in advance* as follows: $250 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 $166 for the Summer term and $167 for the two succeeding terms.

The sons of Regular Army, Navy and Marine Corps Officers who are admitted to the first-year class at the Institute, will pay one-half the regular tuition, upon the recommendation of the Scholarship Committee, the total number not to exceed ten each year. After the first year these students, if recommended by the Scholarship Committee, may continue at half tuition.

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

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

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

**Deposits to Cover Chemical 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 $4.00 per term per student ($8 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 | Athletics | $6.80 |
| Class Dues | .44 | 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.

## LOANS, SCHOLARSHIPS, FELLOWSHIPS AND PRIZES

### LOANS

Funds available for loans to assist undergraduate and graduate students to meet their tuition fees have existed for a number of years. The establishment of the Technology Loan Fund in June, 1930, markedly increased the Institute's resources from which such assistance can be rendered.

The regulations governing the administration of the Technology Loan Fund provide that it will be the general policy to make a loan only to a student who has completed at least one year of residence at the Institute with a good academic record. Only in *exceptional* cases will applications be considered from a student after one semester of residence and only in *very special and unusual* cases from entering students who have met, with high standing, all entrance requirements.

The maximum amount loaned to an individual in a single year may not exceed the tuition fee, less any scholarship grant, or other award, from Institute funds.

To receive favorable consideration an applicant must:

1. Be endorsed as to character and personality by: (*a*) an alumnus of the Institute from the community in which he has resided, or by some other citizen of standing in that community; (*b*) the Principal or Head Master of the high school or preparatory school, or the President or Dean of the college or university he has previously attended; (*c*) his Registration Officer or the Head of the Course in which he is enrolled.

2. Have passed with a standing satisfactory to the Board, the physical examination required annually of all Institute students.

3. Submit a statement of his financial needs and such other information as the Board may deem necessary, on the application form supplied by the Board, such application to have the approval of his parent or guardian.

A recipient of a loan will be required to sign promissory notes in $50 units up to the amount of his loan, each note carrying interest at two per cent per annum from the date of its issue to a date not exceeding two years after he leaves the Institute, and at five per cent per annum thereafter. Interest is to be paid semi-annually. Each note shall have a definite maturity, such maturities to be spaced at intervals of six months, beginning on or before the December thirty-first following the recipient's expected date of graduation, but payments may be anticipated.

Upon signing notes, the student will be supplied with copies thereof. After leaving the Institute he will be required to advise the Board annually, or at more frequent intervals, as to his whereabouts, the character of the work in which he is engaged, the remuneration he is receiving and his plans for the repayment of his obligations to this Fund.

## 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 $80,000.

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 students as possible by assigning, in general, amounts less than full tuition. Awards are made, except those designated below as open to freshmen, only to students who have completed at least a year of satisfactory work at the Institute.

In making assignments the ability of the student as indicated by his scholastic record is the primary consideration. However, account is also taken of the applicant's evidences of need for financial assistance, of his good character and of his general worthiness and professional promise.

Applications for undergraduate scholarship aid should, except as noted below, be made not later than February 15 on blanks to be obtained at Room 3–108. Applications by an entering student for the Cambridge Scholarships should be filed with the Head Master or Principal of the applicant's school not later than June 1 of the year in which he plans to enter the Institute.

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

**Associated General Contractors Scholarship** (1932). Established by the New England Branch of the Associated General Contractors. A scholarship, carrying a stipend of full tuition for the freshman year, is annually offered to an entering student who elects the Course in Building Construction. Awards will be based upon a competitive examination conducted by the Educational Committee of the New England Branch of the Associated General Contractors, in consultation with the Head of the Course in Building Construction. Special emphasis will be laid upon the character of the applicant and his personal and technical fitness. Applications should be addressed directly to Mr. L. C. Wason, Chairman of the Educational Committee, 80 Federal Street, Boston, Massachusetts. Holders of this scholarship are, upon graduation from the Institute's Course in Building Construction, guaranteed employment by the New England Branch of the Associated General Contractors for a term of three years from the date of said graduation.

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

**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."

**Bridgeport Scholarship** (1932). Established by the Institute through a bequest received by the will of Horace T. Smith of the Class of 1898, to be known as the Horace T. Smith Scholarship Fund. A scholarship, carrying a stipend of full tuition for the freshman year, is annually offered to a graduate of the High Schools of Bridgeport, Connecticut, recommended by the Superintendent of Schools, to whom application must be made not later than June 1 of the year in which the applicant plans to enter the Institute. Preference will be given to individuals who have, as of July 1, fulfilled all entrance requirements of the Institute, with the further stipulation that no individual will be eligible to receive a Bridgeport Scholarship until he has fulfilled all entrance requirements of the Institute.

**Harriet L. Brown 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 Cambridge Scholarships, which carry a stipend of full tuition, are confined to students who make application furnishing evidence of need. An award may be continued in the second, third and fourth years upon annual reapplication, providing the holder maintains a satisfactory scholastic record and continues to furnish evidence of need. Original application for a Cambridge Scholarship should be made through the Head Master, or Principal, of the applicant's school, and such application must be filed with the Head Master, or Principal, not later than June 1 of the year in which the applicant plans to enter the Institute. Awards will be by competition, based upon the entrance examination records as of July 1 of those applying, with the stipulation that no successful candidate will be entitled to benefit from an award unless he or she satisfies, prior to admission, all entrance requirements of the Institute.

**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.

**Fred L. and Florence L. Coburn Fund** (1932). By the will of Fred L. Coburn, the Institute received a bequest of $5,000, the income of which "shall be expended by said Trustees in giving aid and assistance to students of M. I. T. . . . preference being given by said Trustees to students residing in Somerville, Massachusetts."

**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."

**Dormitory Fund** (1903). Raised by miscellaneous subscriptions and formerly known as Students' Aid Fund.

**Thomas Messinger Drown Scholarships** (1928). By the will of Mary Frances Brown, 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."

**East Bridgewater Scholarship** (1932). Established by the Institute through a bequest received by the will of Horace T. Smith of the Class of 1898, to be known as the Horace T. Smith Scholarship Fund. A scholarship, carrying a stipend of full tuition for the freshman year, is annually offered to a graduate of the High School of East Bridgewater, Massachusetts, recommended by the Principal to whom application must be made not later than June 1 of the year in which the applicant plans to enter the Institute. Preference will be given to individuals who have, as of July 1, fulfilled all entrance requirements of the Institute, with the further stipulation that no individual will be eligible to receive an East Bridgewater Scholarship until he has fulfilled all entrance requirements of the Institute.

**Fall River Scholarships** (1932). Established by the Institute through a bequest received by the will of Elizabeth R. Stevens to be known as the Albert G. Boyden Fund. Three scholarships for the freshman year, one carrying a stipend of full tuition and two carrying stipends of half tuition, are annually offered to qualified applicants recommended by the Superintendent of Schools of Fall River, Massachusetts, to whom application must be made not later than June 1 of the year in which the applicant plans to enter the Institute. Preference will be given to individuals who have, as of July 1, fulfilled all entrance requirements of the

Institute, with a further stipulation that no individual will be eligible to receive a Fall River Scholarship until he has fulfilled all entrance requirements of the Institute.

**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."

**Freshmen Competitive Scholarships** (1931). A limited number of scholarships is granted to students entering the freshman class at the Institute by examination from secondary schools. These scholarships are for full or half tuition for the first year, and awards will be made by the Faculty Committee on Undergraduate Scholarships based upon the results of the regular entrance examinations. They are confined to students who make application to the Office of the Dean before July 1 of the year in which they plan to enter, and who have, prior to the time of application, satisfied all entrance requirements for admission to the Institute.

**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."

**James H. Haste Fund** (1930). By the will of James H. Haste of the Class of 1896 the Institute received a bequest, the income of which is "for the aid of deserving students . . . of insufficient means, said fund, together with any other sums which said institution may receive under this will, to be known as the James H. Haste Fund."

**Health Education Scholarships** (1928). Three 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 Master 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."

**New England C. M. T. C. Scholarship** (1931). This Scholarship was established by the Institute and carries a stipend of full tuition for the freshman year. It is awarded to a member of one of the Citizens' Military Training Camps of the First Corps Area, United States Army, selected from the "Whites" or the "Blues," based upon the reports and records transmitted to the Headquarters of the First Corps Area. Application must be made to the Commanding General of the First Corps Area not later than July 1 of the year in which the applicant plans to enter the Institute. The applicant must furnish evidence to the Commanding General that he has not sufficient funds to defray all expenses at the Institute together with such other information as may be requested. Preference will be given to individuals who, at the time of making application, have fulfilled all entrance requirements of the Institute with the further stipulation that no man will be eligible to receive the New England C. M. T. C. Scholarship until he has fulfilled all entrance requirements of the Institute.

**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."

**Sons and Daughters of New England Puritan Colony Scholarship Fund** (1931). Founded with a gift of $600 from the Sons and Daughters of New England Puritan Colony. Holders of this scholarship must be of New England ancestry.

**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 the College of William and Mary, 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 the College of William and Mary.

**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.

**Swansea Scholarships** (1932). Established by the Institute through a bequest received by the will of Elizabeth R. Stevens to be known as the Albert G. Boyden Fund. Three scholarships for the freshman year, one carrying a stipend of full tuition and two carrying stipends of half tuition, are annually offered to qualified applicants recommended by the Superintendent of Schools of Swansea, Massachusetts, to whom application must be made not later than June 1 of the year in which the applicant plans to enter the Institute. Preference will be given to individuals who have, as of July 1, fulfilled all entrance requirements of the Institute, with a further stipulation that no successful applicant will be eligible to receive a Swansea Scholarship until he has fulfilled all entrance requirements of 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 course in Ship Operation of the Department of Naval Architecture and Marine Engineering. Applications should be made directly to the Head of the Department of Naval Architecture and Marine Engineering.

**Samuel E. Tinkham 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. Applications should be made directly to the Head of the Department of Geology.

**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."

## FELLOWSHIPS AND GRADUATE SCHOLARSHIPS

Fellowships and graduate scholarships amounting to approximately sixty thousand dollars will be available in 1932–33 to assist students in pursuing graduate work leading to the Master's and Doctor's degrees.

Applications for financial aid must be filed with the Secretary of the Committee of the Graduate School *on or before the first of March.* This rule applies to renewal of previous grants as well as to new applications. Late applications will receive consideration only if funds become available subsequent to the first allotment of awards.

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 except for Institute students an official transcript of the applicant's college record, and at least three letters from persons personally acquainted with his academic work. Both applications must be made on forms which may be obtained from the Secretary of the Committee of the Graduate School.

Awards to students who have not been in residence at least one semester will not exceed the amount of full tuition ($500 for the school year). Fellowships carrying stipends in excess of tuition are in general awarded only to students who have demonstrated their ability to carry on graduate study and research in residence.

In the award of graduate scholarships the committee considers first, the ability of the applicant 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 recipient of a scholarship grant is expected to complete the period of study for which the grant is made. In case he discontinues his work before the end of such period he will be expected to refund the amount received from the grant, unless released therefrom for satisfactory reasons by the Committee of the Graduate School.

## TRAVELING FELLOWSHIPS

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 the Graduate School in regard to special privileges offered by universities and technical schools of various countries in coöperation with the Institute of International Education.

Holders of Institute Traveling Fellowships are expected to present to the Dean of the Graduate School on or before 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.

## HONORARY FELLOWS

A student who is working for the degree of Doctor of Philosophy, Doctor of Science or Doctor of Public Health, either at the Institute or under an Institute grant at another institution, may, as a mark of distinction, be appointed a "Fellow" upon the recommendation of the Faculty. A certificate of appointment bearing the seal of the Institute and signature of the President and of the Secretary of the Corporation will be issued to each Fellow upon the approval of his appointment by the Corporation. The appointment being honorary carries no stipend.

### ENDOWMENT FUNDS APPLICABLE TO FELLOWSHIPS AND GRADUATE SCHOLARSHIPS 1932-1933

**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 $22,000 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 toward the Master's or Doctor's degrees, and for special Fellowships.

**Austin Research Fellowship** (1909). Carrying an award of $1,000 open to candidates for the Doctor's degrees 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; $24,000 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 $1,400.

**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 Fellowship is available for study abroad as well as for graduate work at the Institute of Technology. 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 $500.

**James Savage Fellowship** (1873). Founded by 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 $1,400.

**Frank Hall Thorp Fellowship in Industrial Chemistry** (1932). Established as a memorial to Professor Frank Hall Thorp, the income from $10,000 to be awarded on nomination by the Department of Chemical Engineering to a member of the graduate class of the Massachusetts Institute of Technology to enable him to pursue advanced study and research in the field of Industrial Chemistry.

**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 Russell Fund** (1904). Founded by Theodore E. Russell in memory of his brother Richard Lee Russell. 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 $165.

**Willard B. Perkins Fund** (1898). Founded by a bequest of Willard B. Perkins, of the Class of '72. The income, amounting to fifteen hundred dollars, available every fourth year for a traveling scholarship in Architecture. (Not available 1932–33.)

**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; $1,300 available.

## SPECIAL FELLOWSHIPS AND GRADUATE SCHOLARSHIPS 1932–1933

**Traveling Fellowship in Architecture.** For 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. Stipend $1,500.

**du Pont Fellowship.** Offered by the du Pont de Nemours Company; open to a graduate student in Chemistry or Chemical Engineering. Stipend $750.

**du Pont Fellowship.** Donated by the du Pont de Nemours Company; open to a graduate student in the Department of Physics or any branch of Engineering. Stipend $750.

**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. Approximately $1,300 available.

**Redfield Proctor Traveling Fellowship.** Offered by Redfield Proctor, for graduate study abroad in an English-speaking University, approved by the Dean of the Graduate School. Open to any graduate of the Massachusetts Institute of Technology, or in case there is no suitably qualified candidate among the graduates of the Institute, open to any graduate student who has been in residence for at least one year. Stipend $1,500.

**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 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, fifth and graduate years.

**The "Class of 1904" Prize.** The gift of the Class of 1904. Three prizes of five dollars each awarded to students in the third year class in Design for sketch problems.

**Fontainebleau Prize.** One scholarship of five hundred dollars, at the Fontainebleau School of Fine Arts. Awarded in either the fourth or fifth years.

**Freehand Drawing Prize.** Fifty dollars. Awarded to the student whose work is judged to be the best in a competition at the end of the year.

**Rotch Prizes.** The gift of Mr. Arthur Rotch. Two prizes of two hundred dollars awarded at the end of the fifth year to the regular and the special student having the best general records. The special student must have spent at least two years in residence to be eligible.

**Student Medal of the American Institute of Architects.** This medal is awarded on the recommendation of the Department to the member of the fifth-year 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 V and VI 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 or measured drawings 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.

**Traveling Fellowship.** Fifteen hundred dollars. To be devoted to travel and study abroad. 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 sixth year.

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 Memorial Prize.** A medal is given annually for a paper on an aeronautical subject.

The following annual prize is offered to students in the Department of Chemical Engineering:

**Hunneman Prize.** An award of fifty dollars to the most meritorious senior who has shown outstanding originality in his work in the regular course in Chemical Engineering. Established by William Cooper Hunneman in memory of his son, Roger DeFriez Hunneman, A.B. Harvard 1917, S.M. Massachusetts Institute of Technology 1923.

**Robert A. Boit Prizes.** By the will of Robert A. Boit the sum of $5,000 was left to the Institute, the interest of which is to be used in annual prizes, "to stimulate the interest in the best use of the English language." The prizes are awarded on the basis of the written work done in the course.

## 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 in small sections, 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 deferred until the graduate year; 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 knowledge. The system of instruction differs from the university plan of education in that cultural studies are closely correlated and interwoven with the professional work, while under the latter plan the two groups of studies are ordinarily pursued successively, in separate undergraduate and graduate schools. The Institute lays, moreover, especial emphasis on training in science and scientific methods, not only as an essential to professional success, but as an important element in culture and in life. Its courses differ from those of many colleges, in that electives are introduced to a much less extent, in the belief that better results are obtained by prescribing, after the student has selected the profession for which he desires to prepare himself, the principal studies which he is to pursue. He is given, however, the choice among groups of elective studies relating to different branches of his profession and between a variety of electives in the group of general studies.

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 are required to devote a specified amount of time to elective work in General Studies.

Special attention is 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.

Courses of study leading to the Bachelor's degree are offered in the several branches of science and engineering named on following page. (See pages 76 to 145 for course schedules.)

**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.

**Business and Engineering Administration,** Course XV, with options in Engineering and Chemistry.

**Chemical Engineering,** Course X, and Chemical Engineering Practice, X-B.

**Chemistry,** Course V.

**Civil Engineering,** Course I, with options. General (1), Transportation Engineering (2), Hydroelectric Engineering (3), and Geodesy and Seismology (4).

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

**Electrochemical Engineering,** Course XIV.

**General Science,** Course IX-A.

**General Engineering,** Course IX-B.

**Geology,** Course XII.

**Mathematics,** Course XVIII.

**Mechanical Engineering,** Course II.

**Mining Engineering and Metallurgy,** 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.

**Physics,** Course VIII.

**Sanitary Engineering,** Course XI.

**Ship Operation,** Course XIII-C.

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. A special course is offered for which the Certificate in Public Health is awarded.

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 Business and 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, 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 required of students in courses mentioned below 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 staff 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. A geodetic observatory is located in a separate building at a distance of about one-quarter of a mile from the main buildings, and near-by is a seismograph building built upon an outcropping ledge. The seismograph building is constructed in such a way as to protect the seismograph instrument from unnecessary temperature change. Sleeping quarters for students are provided in eight wooden barracks, each containing six double rooms. Sleeping quarters for the faculty members of the instructing staff are provided in a separate building. Another large wooden building provides drafting space for twenty-four students. 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, $VII_3$, XI, XV Option 1a and XVII, but students from other courses will be admitted. (See special camp circular.)

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 Oaks 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. (See special camp circular.)

**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 $15; deposit for board and incidental expenses, $20.

**Summer School in Petroleum Production.** Oil Field Visits 3·89, required of all students in Course III, Option 2, either between the second and third or between the third and fourth years, is given in the oil fields of western Pennsylvania. The fee is $15 and each student will pay his own expenses estimated at $30 for the trip.

**Summer School of Metallurgy.** Plant Visits 3·60, required of all students in Course III, Options 3 and 4, and any others planning to register for Metallurgy 3·41, 3·411, 3·43 or 3·431. A number of Metallurgical plants in eastern Pennsylvania and New Jersey are visited. The fee is $15 and each student will pay his own expenses estimated at $75 round trip from Boston.

**Summer School of Surveying.** Students in Courses III, Option 3, VI, VI-A and $XV_1c$ are required to take Surveying, 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 14 to 24 inclusive. Tuition fee $40. Each student will pay his own expenses, estimated at $30 for the trip.

## REQUIREMENTS FOR ADMISSION

**Admission to the First Year.** To be admitted as a first-year student the applicant must be of good character, must be seventeen years of age and must meet the entrance requirements as described below. (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.)

**I. Admission by Examination.** Students may take the College Entrance Examination Board examinations (offered in June), the Technology examinations (offered in September), or the New York State Regents examinations. Only records of 80 per cent, or better, will be accepted in the latter. Applicants planning to take the Regents examinations should notify the Director of Admissions.

1. Must pass examinations in:

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

   *Foreign Language — **One** of the combinations below (*a*, *b* or *c*) except as indicated in footnote:
   (*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.

* **Substitutions in Foreign Language.** The Institute prefers that a candidate fulfill the language requirements by presenting one of the complete groups (*a*), (*b*), or (*c*). Elementary French or Elementary German is required, but the remainder of the requirement may be met by offering one of the following subjects, provided a record of 80 per cent in the Regents, or of 60 per cent, or better, in the C. E. E. B. or Technology examination is obtained.

Elementary Spanish (College Board Cp. 2)
Elementary Italian (College Board Cp. 2)
Elementary Latin (College Board Cp. 2)

(If Latin is offered, a College Board or Regents examination should be taken, as no examination in Latin is given by the Institute.)

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

**II. Admission without Examinations.** Beginning with the class **entering in September, 1933,** the Institute will admit as an experiment a limited number of students without examinations under the plan described below. A small group will be admitted by this method in September, 1932.

The requirements which must be fulfilled to obtain admission without examinations are outlined below.

1. The student must have been graduated from a secondary school accredited by the Institute and have ranked in the upper fifth of his class.

   The upper fifth ranking should be based on the student's relative standing during his last two years of attendance and must be certified by the Principal or Head Master. This plan of admission will not apply unless the graduating class has a minimum of ten students.

2. The applicant must have completed the program of subjects required for admission as stated under I.
3. In addition to the above requirements, the applicant must present letters of recommendation from his principal and from two persons (not relatives) of recognized standing in his community who are acquainted with his personal qualities and ability.

   The Institute desires to admit only students whose qualities of character and intellect indicate their adaptability to an academic environment and who show promise of developing into useful and forceful citizens. Letters of recommendation should state the outstanding qualities of the prospective student.

The evidence of preparation as outlined above must be submitted before April 1 of the year in which the student plans to enter. Application forms may be obtained from the Director of Admissions, Massachusetts Institute of Technology.

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

**Time and Place of Entrance Examinations.** June examinations for admission to the first year class are held under the direction of the College Entrance Examination Board in all the principal cities of the United States, in Canada, London, Paris, Geneva and other foreign centers. 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 questions relating to admission or courses of study should be addressed to the Director of Admissions.

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

**C. E. E. B. Examinations, June 20–25, 1932.** 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, 1932, 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 |
| Geometry, Solid | Mathematics D |
| German (Elementary) | German Cp 2 |
| German (Intermediate) | German B |
| History | History A, B, C, or D.* |
| Physics | Physics |
| Plane Trigonometry | Mathematics E |

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

Electives: History A, B, C or D; 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 French or 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.

The Scholastic Aptitude Test is not required.

## Schedule of Examinations at Institute in September 1932

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

### Wednesday, September 14

| | |
|---|---|
| Algebra | 9.00 a.m. to 12.00 m. |
| *French (Elementary) | 2.00 p.m. to 5.00 p.m. |

### Thursday, September 15

| | |
|---|---|
| English | 9.00 a.m. to 12.00 m. |
| *German (Elementary) | 2.00 p.m. to 5.00 p.m. |

### Friday, September 16

| | |
|---|---|
| Trigonometry | 9.00 a.m. to 10.45 a.m. |
| Physics | 11.00 a.m. to 1.00 p.m. |
| *French (Intermediate) | 2.00 p.m. to 5.00 p.m. |
| *German (Intermediate) | 2.00 p.m. to 5.00 p.m. |

### Saturday, September 17

| | |
|---|---|
| Plane Geometry | 9.00 a.m. to 10.45 a.m. |
| Solid Geometry | 11.00 a.m. to 1.00 p.m. |
| History, United States or Ancient | 2.00 p.m. to 5.00 p.m. |

### Monday, September 19

| | |
|---|---|
| Chemistry | 9.00 a.m. to 11.00 a.m. |

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

**Schedule of Examinations at Institute in September 1933**

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

| | |
|---|---|
| **Wednesday, September 13** | |
| Algebra | 9.00 a.m. to 12.00 m. |
| *French (Elementary) | 2.00 p.m. to 5.00 p.m. |
| **Thursday, September 14** | |
| English | 9.00 a.m. to 12.00 m. |
| *German (Elementary) | 2.00 p.m. to 5.00 p.m. |
| **Friday, September 15** | |
| Trigonometry | 9.00 a.m. to 10.45 a.m. |
| Physics | 11.00 a.m. to 1.00 p.m. |
| *French (Intermediate) | 2.00 p.m. to 5.00 p.m. |
| *German (Intermediate) | 2.00 p.m. to 5.00 p.m. |
| **Saturday, September 16** | |
| Plane Geometry | 9.00 a.m. to 10.45 a.m. |
| Solid Geometry | 11.00 a.m. to 1.00 p.m. |
| History, United States or Ancient | 2.00 p.m. to 5.00 p.m. |
| **Monday, September 18** | |
| Chemistry | 9.00 a.m. to 11.00 a.m. |

**Entrance Examination Fee.** (See Page 41.)

**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 Director of Admissions for forms on which to make application, and 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

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

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.

*Forms on which to apply for admission may be obtained by writing to the Director of Admissions. Admission depends 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 lead to rejection, provided the school from which the student comes is unable to furnish such instruction.

The laboratory work should consist of 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 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; conditional sentences; 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.

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 those subjects. Mathematics beyond that required for entrance is essential as a basis for transfer. 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 Architecture, 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 Graduate School Bulletin.

**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.** Graduate students are given the opportunity of taking at Harvard University a limited number of courses under a coöperative agreement between Harvard University and the Massachusetts Institute of Technology, which provides that "Advanced courses other than courses prescribed in undergraduate programs or courses in research may, with the consent of the Instructor and the Dean or the Head of the Department in which the student wishes to work, be taken in either institution by students of the other without payment of fees."

A graduate student at the Institute desiring to take advantage of this privilege must present to the Dean of the Graduate School, from the chairman of his department committee, a request stating the catalogue number and title of the course desired, together with the name of the instructor giving it. The Dean will then give the student a letter of recommendation, to be presented in person, to the Dean of the Harvard Graduate School.

## 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 satisfactorily completed the prescribed subjects of his professional course or equivalent work.

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

All theses and records of work done in preparation of theses are the permanent property of the Institute, and must not be published, either wholly or in part, except by authorization of the heads of the respective departments. No degree will be conferred until all dues to the Institute are paid.

## GRADUATE COURSES

(For complete information regarding graduate work, see the bulletin on the Graduate School.)

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. Not less than two years must be devoted to advanced study or research for the Doctor's degree. Ordinarily at least three years will be found necessary to meet the requirements, but students pursuing their researches during the summer may be able to complete the work for the degree in less than this time.

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

The Institute offers courses in 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 Corps and Chemical Warfare. For information and course schedules, see pages 146 to 151.

# UNDERGRADUATE COURSE SCHEDULES FOR 1932–1933

## THE NUMBERING SYSTEM

Subjects are grouped and numbered according to the Department under which the instruction is given. A course is a program of study made up of subjects selected from the several Departments, and leads to a degree in a given field of science or engineering.

For description of subjects see pages 152–249.

| Department | Subject Numbers |
|---|---|
| Civil Engineering | 1.00 to 1.99 |
| Mechanical Engineering | 2.00 to 2.99 |
| Mining and Metallurgy | 3.00 to 3.99 |
| Architecture and Architectural Engineering | 4.00 to 4.99 |
| Chemistry | 5.00 to 5.99 |
| Electrical Engineering | 6.00 to 6.99 |
| Biology and Public Health | 7.00 to 7.99 |
| Physics | 8.00 to 8.99 |
| Chemical Engineering | 10.00 to 10.99 |
| Geology | 12.00 to 12.99 |
| Naval Architecture and Marine Engineering and Ship Operation | 13.00 to 13.99 |
| Aeronautical Engineering | 16.00 to 16.99 |
| Building Construction | 17.00 to 17.99 |
| Drawing | D1 to D99 |
| Economics and Business and Engineering Administration | Ec1 to Ec99 |
| English and History | E1 to E99 |
| General Studies | G1 to G99 |
| Languages | L1 to L99 |
| Mathematics | M1 to M99 |
| Military Science and Tactics | MS1 to MS99 |
| Hygiene | PT1 to PT2 |

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

## FIRST YEAR. All Courses (Except IV)

*First Term*

| | | |
|---|---|---|
| 5·01 | Chemistry, General | 7 – 4 |
| 8·01 | Physics | 6 – 5 |
| D11 | Drawing & Desc. Geom. | 6 – 1 |
| E11 | English | 2 – 4 |
| M11 | Calculus | 3 – 6 |
| MS11 | Military Science | 3 – 0 |
| PT1 | Physical Training | 1 – 0 |
| | Units of exercise and preparation: | 28 – 20 |

*Second Term*

| | | |
|---|---|---|
| 5·02 | Chemistry, General | 7 – 4 |
| 8·02 | Physics | 6 – 5 |
| D12 | Drawing & Desc. Geom. | 6 – 1 |
| E12 | English | 2 – 4 |
| M12 | Calculus | 3 – 6 |
| MS12 | Military Science | 3 – 0 |
| PT2 | Physical Training | 1 – 0 |
| | Units of exercise and preparation: | 28 – 20 |

## FIRST YEAR. COURSE IV

*First Term*

| | | |
|---|---|---|
| 4·06 | Graphics | 6 – 0 |
| 4·11 | Shades and Shadows | 3 – 0 |
| 4·12 | Perspective | 3 – 0 |
| 4·311 | Theory of Architecture | 1 – 0 |
| 4·411 | Architectural History | 3 – 3 |
| E11 | English | 2 – 4 |
| L63 | French | 3 – 6 |
| M11 | Calculus | 3 – 6 |
| MS11 | Military Science | 3 – 0 |
| PT1 | Physical Training | 1 – 0 |
| | Units of exercise and preparation: | 28 – 19 |

*Second Term*

| | | |
|---|---|---|
| 4·312 | Theory of Architecture | 1 – 0 |
| 4·412 | Architectural History | 3 – 3 |
| 4·712 | Design I | 12 – 0 |
| E12 | English | 2 – 4 |
| L64 | French | 3 – 6 |
| M12 | Calculus | 3 – 6 |
| MS12 | Military Science | 3 – 0 |
| PT2 | Physical Training | 1 – 0 |
| | Units of exercise and preparation: | 28 – 19 |

## SECOND YEAR

In the Second Year, Courses are divided into two Groups, Engineering and Chemistry. In the Engineering Group the following basic subjects are common to all courses. In individual courses the remaining units are given to introductory professional subjects.

*First Term*

| | | |
|---|---|---|
| 2·00 | Kinematics | 5 – 3 |
| 8·03 | Physics | 5 – 5 |
| E21 | English and History | 3 – 5 |
| M21 | Calculus | 3 – 6 |
| MS21 | Military Science | 3 – 0 |
| | Int. Prof. Subjects | 12 |
| | Total Units | 50 |

*Second Term*

| | | |
|---|---|---|
| 2·15 | Applied Mechanics | 3 – 5 |
| 8·04 | Physics | 6 – 4 |
| E22 | English and History | 3 – 5 |
| M22 | Differential Equations. (Omitted in XIII-C) | 3 – 6 |
| MS22 | Military Science | 3 – 0 |
| | Int. Prof. Subjects | 12 |
| | Total Units | 50 |

In the Chemistry Group the following basic subjects are common to all courses. In individual courses the remaining units are given to introductory professional subjects.

*First Term*

| | | |
|---|---|---|
| *5·11 | Qualitative Analysis or | |
| *5·12 | Qualitative Analysis | 7 – 2 |
| 8·03 | Physics | 5 – 5 |
| E21 | English and History | 3 – 5 |
| M21 | Calculus | 3 – 6 |
| MS21 | Military Science | 3 – 0 |
| | Int. Prof. Subjects | 11 |
| | Total Units | 50 |

*Omitted in IX-A

*Second Term*

| | | |
|---|---|---|
| *5·12 or 5·13 | Quantitative Anal. | 7 – 2 |
| 8·04 | Physics | 6 – 4 |
| E22 | English and History | 3 – 5 |
| MS22 | Military Science | 3 – 0 |
| | Int. Prof. Subjects | 20 |
| | Total Units | 50 |

*Omitted in Courses VIII, XIV, XVIII

## I. CIVIL ENGINEERING

Civil engineering is the broadest in scope of the engineering professions, being the parent stem from which have diverged most of the other branches of engineering. It covers topographical engineering, including the making of geodetic and geological surveys, and surveys for engineering construction; transportation engineering, consisting of the building and operation of railroads, highways, canals, docks, harbors, airports, and other similar works; municipal engineering, including the construction of sewers, waterworks, roads, and streets; structural engineering, 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 classroom, 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 four 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 to air transportation, an option in hydroelectric engineering in which special consideration is given to the subject of water power development and an option in geodesy and seismology. The special work of the hydroelectric and the geodesy and seismology options begins in the third year, and that of the other options in the fourth year.

No student may register for the option in Geodesy and Seismology in the year 1932–33 without authorization by the Head of the Department of Civil and Sanitary Engineering.

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

# I. CIVIL ENGINEERING

**FIRST YEAR.** See page 76

## SECOND YEAR. All Options

*First Term*

| | | |
|---|---|---|
| 1·00 | Surveying | 2 –2 |
| 1·39 | Graphic Statics | 3 –1 |
| 2·00 | Applied Kinematics | 5 –3 |
| 8·03 | Physics | 5 –5 |
| E21 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 |
| MS21 | Military Science | 3 –0 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 26 –24 |

*Second Term*

| | | |
|---|---|---|
| 1·01 | Surveying and Top. Draw. | 4 –0 |
| 1·12 | Astronomy and Spher. Trig. | 3 –4 |
| 2·15 | Applied Mechanics | 3 –5 |
| 8·04 | Physics | 6 –4 |
| E22 | English and History | 3 –5 |
| M22 | Differential Equations | 3 –6 |
| MS22 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 25 –24 |

**Required during Summer 1932. At Camp Technology***

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

## THIRD YEAR

**Option 1. General**
**Option 2. Transportation Engineering**

*First Term*

| | | |
|---|---|---|
| 1·13 | Geodesy | 2 –2 |
| 1·21 | Railway and High. Eng. | 2 –4 |
| 1·23 | Engineering Drafting | 4 –0 |
| 1·43 | Materials | 1 –2 |
| 2·20 | Applied Mechanics | 3 –6 |
| 6·40 | Electrical Eng. Elem. | 4 –6 |
| 12·321 | Geology | 2 –1 |
| Ec31 | Political Economy | 3 –3 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 23 –26 |

*Second Term*

| | | |
|---|---|---|
| 1·22 | Railway and High. Eng. | 2 –2 |
| 1·24 | Engineering Drafting | 3 –0 |
| 1·35 | Roads and Pavements | 2 –1 |
| 1·40 | Structures | 3 –5 |
| 1·62 | Hydraulics | 3 –5 |
| 2·36 | Testing Materials | 2 –1 |
| 6·89 | Electrical Eng. Lab. | 2 –2 |
| 12·322 | Geology | 3 –3 |
| Ec32 | Political Economy | 3 –3 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 25–24 |

## THIRD YEAR

**Option 3. Hydroelectric Engineering**

*First Term*

| | | |
|---|---|---|
| 1·13 | Geodesy | 2 –2 |
| 1·211 | Railway and High Eng. | 1 –3 |
| 1·43 | Materials | 1 –2 |
| 2·20 | Applied Mechanics | 3 –6 |
| 6·40 | Electrical Eng., Elem. | 4 –6 |
| 12·321 | Geology | 2 –1 |
| Ec31 | Political Economy | 3 –3 |
| Ec50 | Accounting | 4 –2 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 22 –27 |

*Second Term*

| | | |
|---|---|---|
| 1·22 | Railway and High. Eng. | 2 –2 |
| 1·40 | Structures | 3 –5 |
| 1·62 | Hydraulics | 3 –5 |
| 2·36 | Testing Materials Lab. | 2 –1 |
| 6·44 | Elec. Trans. and Control. | 2 –4 |
| 6·89 | Electrical Eng. Lab. | 2 –2 |
| 12·322 | Geology | 3 –3 |
| Ec32 | Political Economy | 3 –3 |
| E33 | Report Writing | 2 –2 |
| | Units of exercise and preparation: | 22 –27 |

* See special camp circular.

# I. CIVIL ENGINEERING — *Continued*

## THIRD YEAR

### Option 4. Geodesy and Seismology

*First Term*

| | | |
|---|---|---|
| 1·13 | Geodesy | 2 –2 |
| 1·63 | Hydraulics | 2 –3 |
| 2·20 | Applied Mechanics | 3 –6 |
| 8·161 | Optics | 3 –6 |
| 8·162 | Optical Measurements | 3 –2 |
| 12·321 | Geology | 2 –1 |
| Ec31 | Political Economy | 3 –3 |
| | Language | 3 –5 |
| | Units of exercise and preparation: | 21 –28 |

*Second Term*

| | | |
|---|---|---|
| 1·40 | Structures | 3 –5 |
| 8·201 | Electricity & Electronics | 3 –5 |
| 8·202 | Electronic Lab | 3 –3 |
| 12·322 | Geology | 3 –3 |
| Ec32 | Political Economy | 3 –3 |
| | Language | 3 –5 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 20 –26 |

## FOURTH YEAR

### Option 1. General

*First Term*

| | | |
|---|---|---|
| 1·41 | Structures | 4 –8 |
| 1·48 | Foundations | 3 –4 |
| 1·501 | Bridge Design | 7 –0 |
| 1·75 | Hydraulic and San. Eng. | 4 –5 |
| 2·46 | Heat Engineering | 4 –7 |
| 12·37 | Field Geology | 1 –1 |
| | Units of exercise and preparation: | 23 –25 |

*Second Term*

| | | |
|---|---|---|
| 1·42 | Structures | 4 –8 |
| 1·502 | Bridge Design | 5 –0 |
| 1·65 | Hydraulic Machinery | 2 –2 |
| 1·76 | Sanitary Eng. | 2 –3 |
| 1·79 | Hydraulic & San. Design | 2 –0 |
| 2·47 | Heat Engineering | 2 –3 |
| 2·63 | Eng. and Hydraulic Lab. | 2 –2 |
| | Thesis | 7 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 48 |

## FOURTH YEAR

### Option 2. (a, b, and c). Transportation Engineering

*First Term*

| | | |
|---|---|---|
| 1·25 | Eng. Const. and Estim. | 2 –3 |
| 1·26 | (*a*) Railway Main. & Sig. | 2 –2 |
| 1·41 | Structures | 4 –8 |
| 1·48 | Foundations | 3 –4 |
| 1·501 | Bridge Design | 7 –0 |
| 2·46 | Heat Engineering | 4 –7 |
| 5·37 | (*b*) Chem. of Road Mat. | 4 –0 |
| 12·37 | Field Geology | 1 –1 |
| 16·76 | (*c*) Aeronautics | 3 –1 |
| | Units of exercise and preparation: (*a*) | 23 –25 |
| | (*b*) | 25 –23 |
| | (*c*) | 24 –24 |

*Second Term*

| | | |
|---|---|---|
| 1·27 | (*a*) Railway Trans. | 2 –4 |
| 1·28 | (*a*) Railway Design | 5 –0 |
| 1·36 | (*b*) Testing High. Mat. | 1 –1 |
| 1·37 | (*b*) Highway Trans. | 2 –4 |
| 1·38 | (*b*) Highway Design | 3 –0 |
| 1·42 | Structures | 4 –8 |
| 1·502 | (*a, b*) Bridge Design | 5 –0 |
| 1·510 | (*c*) Structural Design | 7 –0 |
| 2·47 | Heat Engineering | 2 –3 |
| 2·63 | Eng. and Hydraulic Lab. | 2 –2 |
| 16·44 | (*c*) Com. Oper. of Aircraft. | 3 –6 |
| | General Study | 2 –2 |
| | Thesis | 7 |
| | Units of exercise and preparation: | 48 |

## I. CIVIL ENGINEERING — *Continued*

### FOURTH YEAR

#### Option 3. Hydroelectric Engineering

*First Term*

| | | |
|---|---|---|
| 1·41 | Structures | 4 – 8 |
| 1·48 | Foundations | 3 – 4 |
| 1·511 | Bridge Design | 4 – 0 |
| 1·70 | Water Power Eng. | 5 – 3 |
| 2·46 | Heat Engineering | 4 – 7 |
| 12·37 | Field Geology | 1 – 1 |
| | General Study | 2 – 2 |
| | Units of exercise and preparation: | 23 – 25 |

*Second Term*

| | | |
|---|---|---|
| 1·42 | Structures | 4 – 8 |
| 1·512 | Bridge Design | 6 – 0 |
| 1·71 | Water Power Eng. | 6 – 3 |
| 2·47 | Heat Engineering | 2 – 3 |
| 2·631 | Eng. and Hydraulic Lab. | 3 – 3 |
| | Thesis | 6 |
| | General Study | 2 – 2 |
| | Units of exercise and preparation: | 48 |

### FOURTH YEAR

#### Option 4. Geodesy and Seismology

*First Term*

| | | |
|---|---|---|
| 1·131 | Geodesy | 3 – 6 |
| 1·135 | Seismology | 2 – 3 |
| 1·137 | Instrument Design | 3 – 3 |
| 1·41 | Structures | 4 – 8 |
| 8·07 | Precision of Measure | 1 – 1 |
| 12·37 | Field Geology | 1 – 1 |
| 12·86 | Seismology | 2 – 2 |
| M26 | Least Squares | 2 – 2 |
| | General Study | 2 – 2 |
| | Units of exercise and preparation: | 20 – 28 |

*Second Term*

| | | |
|---|---|---|
| 1·132 | (*a*) Geod., Astron. & Nav. | 3 – 6 |
| 1·133 | Geodetic Laboratory | 2 – 0 |
| 1·134 | Adjust. of Observations | 3 – 6 |
| 1·138 | Seismological Lab. | 4 – 0 |
| 1·421 | Structures | 2 – 4 |
| 12·87 | (*b*) Geophysics | 2 – 2 |
| | Elective | 6 |
| | General Study | 2 – 2 |
| | Thesis (*a*) | 8 |
| | (*b*) | 13 |
| | Units of exercise and preparation: | 48 |

## I-A. RAILROAD OPERATION*

### In Coöperation with the Boston and Maine Railroad

The Institute conducts 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, Traffic, etc.).

Students are subject to the usual requirements applying to the employees of the Railroad. 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.

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.

* No student will be admitted to this course who was not in attendance at the Institute in 1930-1931.

# I-A. RAILROAD OPERATION

## FOURTH YEAR

| *Summer Term* 1932 | **At Railroad** | |
|---|---|---|
| 1·22 | Railway and High. Eng.... | 2 –2 |
| 1·902 | Railroad Oper. Prac...... | 48 h.p.w. |
| E45 | Business English......... | 1 –3 |

| *First Term* | **At M. I. T.** | |
|---|---|---|
| 1·25 | Eng. Const. and Estim.... | 2 –3 |
| 1·26 | Railway Maint. and Sig... | 2 –2 |
| 1·411 | Structures............... | 4 –8 |
| 1·53 | Structural Design......... | 4 –0 |
| 2·46 | Heat Engineering......... | 4 –7 |
| 2·63 | Eng. and Hyd. Lab....... | 2 –2 |
| Ec32 | Political Economy........ | 3 –3 |
| Ec45 | Industrial Relations...... | 2 –2 |

| *Second Term* | **At Railroad** | |
|---|---|---|
| 1·27 | Railway Transportation... | 2 –4 |
| 1·903 | Railroad Oper. Prac...... | 48 h.p.w. |
| 2·47 | Heat Engineering........ | 2 –3 |

## GRADUATE YEAR 1932–1933

| *Summer Term* 1932 | **At M. I. T.** | |
|---|---|---|
| 2·852 | Locomotive Eng.......... | 3 –3 |
| | Grad. Study and Research | 28 h.p.w. |

| *First Term* | **At Railroad** | |
|---|---|---|
| 1·904 | Rail. Operation Prac. | 48 h.p.w. |
| | Graduate Study......... | 14 |

| *Second Term* | **At M. I. T.** | |
|---|---|---|
| Ec63 | Business Law and Org..... | 3 –5 |
| G10 | Dev. of Transportation.... | 2 –2 |
| | Grad. Study and 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, applied kinematics 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.

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

# II. MECHANICAL ENGINEERING

FIRST YEAR. See page 76

## SECOND YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 1·02 | Surveying | 2 – 2 | 2·04 | Mech. Eng. Equipment | 3 – 3 |
| 2·00 | Applied Kinematics | 5 – 3 | 2·15 | Applied Mechanics | 3 – 5 |
| 2·10 | Mech. Eng. Draw. | 6 – 0 | 2·90 | Forge Shop | 3 – 0 |
| 2·91 | Foundry | 3 – 0 | 2·92 | Pattern Making | 3 – 0 |
| 8·03 | Physics | 5 – 5 | 8·04 | Physics | 6 – 4 |
| E21 | English and History | 3 – 5 | E22 | English and History | 3 – 5 |
| M21 | Calculus | 3 – 6 | M22 | Differential Equations | 3 – 6 |
| MS21 | Military Science | 3 – 0 | MS22 | Military Science | 3 – 0 |
| | Units of exercise and preparation: | 30 – 21 | | Units of exercise and preparation: | 27 – 23 |

### Required during Summer, 1932

2·13 Machine Drawing........ 8 – 0

## THIRD YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 2·05 | Mechanism of Machines | 3 – 2 | 2·21 | Applied Mechanics | 3 – 5 |
| 2·20 | Applied Mechanics | 3 – 6 | 2·42 | Eng. Thermodynamics | 4 – 5 |
| 2·30 | Materials of Engineering | 2 – 2 | 2·70 | Machine Design | 4 – 0 |
| 2·40 | Eng. Thermodynamics | 4 – 5 | 2·952 | Machine Tool Lab. | 4 – 0 |
| 2·41 | Boilers and Engines | 2 – 2 | 6·40 | Electrical Eng. Elem. | 4 – 6 |
| 2·951 | Machine Tool Lab. | 6 – 0 | 6·89 | Electrical Eng. Lab. | 2 – 2 |
| Ec31 | Political Economy | 3 – 3 | Ec32 | Political Economy | 3 – 3 |
| | General Study | 2 – 2 | | General Study | 2 – 2 |
| | Units of exercise and preparation: | 25 – 22 | | Units of exercise and preparation: | 26 – 23 |

## II. MECHANICAL ENGINEERING — *Continued*

### FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 1·64 | Hydraulics | 3 – 6 |
| 2·251 | Dynamics of Machines | 2 – 4 |
| 2·30 | Materials of Eng. | 2 – 2 |
| 2·35 | Testing Materials Lab. | 4 – 2 |
| 2·43 | Refrigeration | 2 – 4 |
| 2·601 | Engineering Lab. | 4 – 4 |
| 2·71 | Machine Design | 5 – 0 |
| 3·712 | Eng. Heat Treatment | 2 – 0 |
| | General Study | 2 – 2 |
| | Units of exercise and preparation: | 26 – 24 |

*Second Term*

| | | |
|---|---|---|
| 2·26 | Mechanics of Eng. | 3 – 6 |
| 2·58 | Power Plant Design | 4 – 0 |
| 2·781 | Industrial Plants | 3 – 3 |
| 2·98 | Production Methods | 1 – 1 |
| 2·602 | Engineering Laboratory | 3 – 3 |
| | General Study (G47) | 2 – 2 |
| | Professional Electives | 12 |
| | Thesis | 7 |
| | Units of exercise and preparation: | 50 |

**Professional Electives* — Second Term**

| | | |
|---|---|---|
| 2·79 | Gasoline Automobile | 4 – 4 |
| 2·66 | Automotive Laboratory | 2 – 2 |
| 2·49 | Refrigeration | 3 – 5 |
| 2·64 | Refrigeration Lab. | 2 – 2 |
| 2·77 | Engine Design | 6 – 2 |
| 2·87 | Textile Engineering | 6 – 2 |
| 2·851 | Fire Protection Eng. | 2 – 2 |
| 2·603 | Engineering Laboratory | 3 – 3 |
| 2·782 | Industrial Plant Design | 4 – 0 |
| 2·854 | Mech. Equip. of Bldgs. | 2 – 2 |
| 3·714 | Heat Treatment | 4 – 2 |
| 2·850 | Automatic Machinery | 2 – 2 |
| 2·853 | Locomotive Engineering | 2 – 2 |
| 2·855 | Steam Turbine Eng. | 2 – 2 |
| 2·983 | Production Design | 2 – 2 |
| 2·331 | Eng. Metals | 2 – 2 |

For Automotive work, Electives 2·79 and 2·66 are advised.
For Refrigeration, 2·49 and 2·64.
For Textiles, 2·87 and 2·851.
For Engine Design, 2·77 and 2·983 or 2·331.

* A professional elective will not be given unless there are at least seven applicants for the subject.

## II. MECHANICAL ENGINEERING — *Continued*

## ARMY ORDNANCE

### Summer Term (1932)

| | | |
|---|---|---|
| 2·271 | Theory of Elasticity...... | 5 –9 |
| 2·891 | Mechanics.............. | 3 –0 |
| 5·04 | Chemistry, Inorganic..... | 3 –3 |
| 5·412 | Organic Chemistry....... | 6 –3 |

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### FOURTH YEAR (1932–33)

*First Term*

| | | |
|---|---|---|
| 2·03 | Mechanisms............ | 8 –3 |
| 2·461 | Thermodynamics........ | 3 –6 |
| 5·413 | Organic Chemistry....... | 6 –0 |
| 6·42 | Electrical Eng. Elem...... | 5 –5 |
| 6·88 | Electrical Eng. Lab........ | 4 –6 |
| 10·38 | Chemical Engineering..... | 5 –2 |
| | Units of exercise and preparation: | 31 –22 |

## 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 of 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*

| | | |
|---|---|---|
| 2·872 | Design of Cotton Mach... | 3 –6 |
| 2·874 | Dynamics of Text. Mach.. | 2 –2 |
| 2·875 | Textile Tech. Analysis.... | 2 –3 |
| 2·876 | Prin. of Fabric Structure.. | 2 –4 |
| 3·651 | Physical Metallurgy...... | 10 –2 |
| | Textile Research......... | 14 |
| | Units of exercise and preparation: | 50 |

*Second Term*

| | | |
|---|---|---|
| 2·09 | Des. of Automatic Mach... | 12 –0 |
| 8·191 | Micro. Th. & Photomicro. | 3 –2 |
| 2·873 | Des. of Wool Work. Mach. | 3 –6 |
| | Elective................ | 9 |
| | Textile Research......... | 15 |
| | Units of exercise and preparation: | 50 |

### TORPEDO DESIGN, UNITED STATES NAVY — GRADUATE

*First Term*

| | | |
|---|---|---|
| 2·06 | Mechanism of Machines... | 2 –2 |
| 2·07 | Automatic Machinery..... | 3 –3 |
| 2·251 | Dynamics of Mach....... | 2 –4 |
| 2·40 | Eng. Thermodynamics.... | 4 –5 |
| 2·301 | Materials of Eng......... | 1 –2 |
| 3·713 | Heat Treatment......... | 3 –2 |
| 2·761 | Machine Design......... | 6 –2 |
| 3·615 | Metallography.......... | 3 –2 |
| 3·731 | Physical Metallurgy...... | 1 –2 |
| 5·683 | Physical Chemistry....... | 2 –2 |
| | Units of exercise and preparation: | 27 –26 |

*Second Term*

| | | |
|---|---|---|
| 2·08 | Automatic Machinery..... | 4 –4 |
| 2·256 | Dyn. of Rotation........ | 1 –2 |
| 2·42 | Eng. Thermodynamics.... | 4 –5 |
| 2·51 | Torpedoes.............. | 2 –4 |
| 2·691 | Auto. Engine Lab........ | 2 –0 |
| 2·762 | Machine Design......... | 6 –2 |
| 3·732 | Physical Metallurgy...... | 8 –2 |
| 5·75 | Thermodynamics......... | 2 –2 |
| 2·32 | App. of Photoelasticity.... | 4 –0 |
| | Units of exercise and preparation: | 33 –21 |

## III. MINING AND METALLURGY

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

**Option 4. Physical Metallurgy.** Designed to give special training in the structures, properties, uses and methods of testing of the ferrous and non-ferrous metals and alloys. Metallography, mechanical treatment and testing, heat treatment, X-Ray examination of metals and allied subjects are included. Training in production metallurgy is also given.

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 76**

### SECOND YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 3·00 | Int. to Mining & Metal. . | 2 –0 | 2·00 | Applied Kinematics. . . . . . | 5 –5 |
| 5·11 | Qualitative Analysis. . . . . | 7 –2 | 5·12 | Quantitative Analysis. . . . | 7 –2 |
| 8·03 | Physics. . . . . . . . . . . . . . . . | 5 –5 | 8·04 | Physics. . . . . . . . . . . . . . . . | 6 –4 |
| 12·01 | Mineralogy. . . . . . . . . . . . | 8 –2 | 12·30 | Geology. . . . . . . . . . . . . . . . | 4 –2 |
| E21 | English and History. . . . . | 3 –5 | E22 | English and History. . . . . | 3 –5 |
| M21 | Calculus. . . . . . . . . . . . . . . | 3 –6 | MS22 | Military Science. . . . . . . . | 3 –0 |
| MS21 | Military Science. . . . . . . . | 3 –0 | | General Study. . . . . . . . . . | 2 –2 |
| Units of exercise and preparation: | | 31 –20 | Units of exercise and preparation: | | 30 –18 |

**Required during Summer 1932. At Summer Mining Camp***

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

### THIRD YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 2·15 | Applied Mechanics. . . . . . . | 3 –5 | 2·20 | Applied Mechanics. . . . . . . | 3 –6 |
| 3·01 | Mining Methods. . . . . . . . . | 5 –4 | 3·02 | Mining Methods. . . . . . . . . | 5 –5 |
| 3·31 | Fire Assaying. . . . . . . . . . . | 6 –2 | 3·21 | Ore Dressing. . . . . . . . . . . . | 3 –2 |
| 5·13 | Quantitative Analysis. . . . . | 7 –2 | 3·22 | Ore Dressing Lab. . . . . . . . . | 5 –2 |
| 12·31 | Geology. . . . . . . . . . . . . . . . | 5 –3 | 12·40 | Economic Geology. . . . . . . | 4 –3 |
| Ec31 | Political Economy. . . . . . . . | 3 –3 | Ec32 | Political Economy. . . . . . . . | 3 –3 |
| Units of exercise and preparation: | | 29 –19 | | General Study. . . . . . . . . . . | 2 –2 |
| | | | Units of exercise and preparation: | | 25 –23 |

### FOURTH YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 2·36 | Testing Materials Lab. . . . | 2 –1 | 1·44 | Stationary Structures. . . . | 2 –3 |
| 3·03 | Economics of Mining. . . . | 4 –4 | 1·63 | Hydraulics. . . . . . . . . . . . . | 2 –3 |
| 3·13 | Geophysical Pros., Elem. . | 4 –0 | 3·04 | Principles of Mining. . . . . | 3 –4 |
| 3·412 | Metallurgy. . . . . . . . . . . . . | 5 –3 | 3·421 | Metallurgy. . . . . . . . . . . . . | 3 –1 |
| 3·432 | Metallurgy. . . . . . . . . . . . . | 2 –1 | 17·46 | Building Construction. . . . | 8 –0 |
| 6·40 | Electrical Eng., Elem. . . . . | 4 –6 | | Thesis. . . . . . . . . . . . . . . . . | 11 |
| 6·85 | Electrical Eng. Lab. . . . . . | 2 –3 | | General Study. . . . . . . . . . | 4 –4 |
| 12·33 | Field Geology. . . . . . . . . . | 3 –2 | Units of exercise and preparation: | | 48 |
| 12·47 | Microst. of Ores & Met. . | 3 –0 | | | |
| Units of exercise and preparation: | | 29 –20 | | | |

*See special camp circular.

## III. MINING AND METALLURGY — *Continued*

### Option 2. Petroleum Production

**FIRST YEAR.** See page 76

### SECOND YEAR

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| 3·00 | Int. to Mining & Metal. . | 2 –0 | 2·00 | Applied Kinematics. . . . . . | 5 –3 |
| 5·11 | Qualitative Analysis. . . . . | 7 –2 | 5·12 | Quantitative Analysis. . . . | 7 –2 |
| 8·03 | Physics. . . . . . . . . . . . . . . . | 5 –5 | 8·04 | Physics. . . . . . . . . . . . . . . . | 6 –4 |
| 12·01 | Mineralogy. . . . . . . . . . . . . | 8 –2 | 12·30 | Geology. . . . . . . . . . . . . . . . | 4 –2 |
| E21 | English and History. . . . . | 3 –5 | E22 | English and History. . . . . | 3 –5 |
| M21 | Calculus. . . . . . . . . . . . . . . | 3 –6 | MS22 | Military Science. . . . . . . . | 3 –0 |
| MS21 | Military Science. . . . . . . . | 3 –0 | | General Study. . . . . . . . . . | 2 –2 |
| | Units of exercise and preparation: | 31 –20 | | Units of exercise and preparation: | 30 –18 |

**Required during Summer 1932. At Summer Mining Camp***

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

### THIRD YEAR

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| 2·15 | Applied Mechanics. . . . . . | 3 –5 | 2·20 | Applied Mechanics. . . . . . | 3 –6 |
| 3·05 | Mining, Elements of. . . . . | 2 –2 | 3·23 | Ore Dressing. . . . . . . . . . . | 3 –2 |
| 3·432 | Metal. of Iron & Steel. . . . | 2 –1 | 3·82 | Petroleum Eng., Elem. . . . | 5 –4 |
| 3·81 | Petroleum Eng. Elem. . . . | 5 –4 | 12·40 | Economic Geology. . . . . . | 4 –3 |
| 5·381 | Oil Text. & Petrol. Refin. . | 5 –2 | 12·80 | Geology of Coal & Petrol. . | 4 –3 |
| 12·31 | Geology. . . . . . . . . . . . . . . . | 5 –3 | Ec32 | Political Economy. . . . . . . | 3 –3 |
| Ec31 | Political Economy. . . . . . . | 3 –3 | | General Study. . . . . . . . . . | 2 –2 |
| | General Study. . . . . . . . . . | 2 –2 | | Units of exercise and preparation: | 24 –23 |
| | Units of exercise and preparation: | 27 –22 | | | |

### FOURTH YEAR

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| 2·36 | Testing Materials Lab. . . . | 2 –1 | 1·44 | Stationary Structures. . . . . | 2 –3 |
| 3·031 | Economics of Mining. . . . | 2 –2 | 1·63 | Hydraulics. . . . . . . . . . . . . . | 2 –3 |
| 3·13 | Geophysical Pros., Elem. . | 4 –0 | 3·04 | Mining, Principles of. . . . . | 3 –4 |
| 3·61 | Metallography. . . . . . . . . . | 4 –1 | 3·86 | Petroleum Production. . . . . | 3 –2 |
| 3·85 | Petroleum Production. . . . | 4 –2 | 17·46 | Building Construction. . . . | 8 –0 |
| 6·40 | Electrical Eng., Elem. . . . . | 4 –6 | | Thesis. . . . . . . . . . . . . . . . . . | 11 |
| 6·85 | Electrical Eng. Lab. . . . . . | 2 –3 | | Elective. . . . . . . . . . . . . . . . . | 3 |
| 12·33 | Field Geology. . . . . . . . . . . | 3 –2 | | General Study. . . . . . . . . . . | 2 –2 |
| 12·47 | Microst. of Ores & Met. . . | 3 –0 | | Units of exercise and preparation: | 48 |
| | Units of exercise and preparation: | 28 –17 | | | |

*See special camp circular.

## III. MINING AND METALLURGY — *Continued*

### Option 3. Metallurgy

**FIRST YEAR.** See page 76

### SECOND YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 3·00 | Int. to Mining & Metal | 2 –0 | 2·00 | Applied Kinematics | 5 –3 |
| 5·11 | Qualitative Analysis | 7 –2 | 2·91 | Foundry | 3 –0 |
| 8·03 | Physics | 5 –5 | 5·12 | Quantitative Anal. | 7 –2 |
| 12·01 | Mineralogy | 8 –2 | 8·04 | Physics | 6 –4 |
| E21 | English and History | 3 –5 | E22 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 | M22 | Differential Equations | 3 –6 |
| MS21 | Military Science | 3 –0 | MS22 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 31 –20 | | Units of exercise and preparation: | 30 –20 |

**Required during Summer 1932**

| | | |
|---|---|---|
| 1·02 | Surveying & Plotting | 2 –2 |
| 2·12 | Machine Drawing | 6 –0 |

### THIRD YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 2·15 | Applied Mechanics | 3 –5 | 2·20 | Applied Mechanics | [illegible] –6 |
| 2·40 | Eng. Thermodynamics | 4 –5 | 2·611 | Engineering Lab. | 2 –1 |
| 3·05 | Mining, Elements of | 2 –2 | 2·901 | Forging | 2 –0 |
| 3·31 | Fire Assaying | 6 –2 | 3·23 | Ore Dressing | 3 –2 |
| 5·13 | Quantitative Analysis | 7 –2 | 3·61 | Metallography | 4 –1 |
| 5·31 | Gas Analysis | 2 –0 | Ec32 | Political Economy | 3 –3 |
| 8·12 | Heat Measurements | 3 –1 | Ec50 | Accounting | 4 –2 |
| Ec31 | Political Economy | 3 –3 | | General Study | 4 –4 |
| | Units of exercise and preparation: | 30 –20 | | Elective | 4 |
| | | | | Units of exercise and preparation: | 48 |

**Required during Summer 1932**

| | | |
|---|---|---|
| 3·60 | Metallurgical Plant Visits | 3 –1 |

### FOURTH YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 2·36 | Testing Materials Lab. | 2 –1 | 1·63 | Hydraulics | 2 –3 |
| 3·41 | (*b*) Metallurgy | 10 –3 | 3·42 | Metallurgy | 5 –2 |
| 3·411 | (*a*) Metallurgy | 6 –3 | 3·44 | Metallurgy | 4 –3 |
| 3·43 | (*a*) Metallurgy | 7 –3 | 3·45 | Met. & Heat Tr. of Steel | 2 –1 |
| 3·431 | (*b*) Metallurgy | 3 –3 | 8·90 | Electrochemistry, Elem. | 4 –2 |
| 5·611 | Physical Chem. | 4 –4 | | Thesis | 12 |
| 6·40 | Electrical Eng., Elem. | 4 –6 | | General Study | 2 –2 |
| 6·85 | Electrical Eng. Lab. | 2 –3 | | Elective | 4 |
| | General Study | 2 –2 | | Units of exercise and preparation: | 48 |
| | Units of exercise and preparation: | 27 –22 | | | |

## III. MINING AND METALLURGY — *Continued*

### Option 4. Physical Metallurgy

**FIRST YEAR.** See page 76

### SECOND YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 3·00 | Int. to Mining & Metal | 2 –0 | 2·901 | Forging | 2 –0 |
| 5·11 | Qualitative Analysis | 7 –2 | 5·12 | Quantitative Analysis | 7 –2 |
| 8·03 | Physics | 5 –5 | 8·04 | Physics | 6 –4 |
| E21 | English and History | 3 –5 | E22 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 | M22 | Differential Equations | 3 –6 |
| MS21 | Military Science | 3 –0 | MS22 | Military Science | 3 –0 |
| | Language | 3 –5 | | Language | 3 –5 |
| Units of exercise and preparation: | | 26 –23 | Units of exercise and preparation: | | 27 –22 |

### THIRD YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 2·15 | Applied Mechanics | 3 –5 | 2·12 | Machine Drawing | 6 –0 |
| 3·62 | Metallography | 10 –4 | 2·20 | Applied Mechanics | 3 –6 |
| 5·13 | Quantitative Analysis | 7 –2 | 2·91 | Foundry | 3 –0 |
| 5·611 | Physical Chemistry | 4 –4 | 2·96 | Machine Tool Lab. | 3 –0 |
| 12·25 | Physical Crystallog. | 3 –2 | 3·656 | X-Ray Metallography | 3 –3 |
| Ec31 | Political Economy | 3 –3 | 3·71 | Heat Treatment | 4 –2 |
| Units of exercise and preparation: | | 30 –20 | Ec32 | Political Economy | 3 –3 |
| | | | | General Study | 4 –4 |
| | | | Units of exercise and preparation: | | 29 –18 |

**Required during Summer 1932**

3·60 Metallurgical Plant Visits . . 3 –1

### FOURTH YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 2·36 | Testing Materials Lab. | 2 –1 | 3·422 | Metallurgy | 2 –2 |
| 3·41 | (*b*) Metallurgy | 10 –3 | 3·44 | Metallurgy | 4 –3 |
| 3·411 | (*a*) Metallurgy | 6 –3 | 3·642 | Physical Metallurgy | 5 –2 |
| 3·43 | (*a*) Metallurgy | 7 –3 | 3·67 | Physics of Metals | 2 –4 |
| 3·431 | (*b*) Metallurgy | 3 –3 | 6·75 | Electrical Eng. Lab. | 2 –2 |
| 3·641 | Physical Metallurgy | 5 –2 | | Thesis | 13 |
| 6·40 | Electrical Eng., Elem. | 4 –6 | | Elective | 6 |
| 8·12 | Heat Measurements | 3 –1 | Units of exercise and preparation: | | 47 |
| | Elective | 7 | | | |
| Units of exercise and preparation: | | 50 | | | |

## 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 98; 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, the four-year course has been extended to five years, and leads to the degree of Bachelor in Architecture.

This new course affords the secondary 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 that has been performed elsewhere equivalent to the requirements of our schedule. 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 72). 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 individual 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 or 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 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 the Rotch Prizes, one Fontainebleau Scholarship and a Traveling Scholarship entitling the student to one 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 in Architecture.

## IV. ARCHITECTURE

### FIRST YEAR

*First Term*

| | | |
|---|---|---|
| 4·06 | Graphics | 6 –0 |
| 4·11 | Shades and Shadows | 3 –0 |
| 4·12 | Perspective | 3 –0 |
| 4·311 | Theory of Architecture | 1 –0 |
| 4·411 | Architectural History | 3 –3 |
| E11 | English | 2 –4 |
| L63 | French | 3 –6 |
| M11 | Calculus | 3 –6 |
| MS11 | Military Science | 3 –0 |
| PT1 | Physical Training | 1 –0 |
| | Units of exercise and preparation: | 28 –19 |

*Second Term*

| | | |
|---|---|---|
| 4·312 | Theory of Architecture | 1 –0 |
| 4·412 | Architectural History | 3 –3 |
| 4·712 | Design I | 12 –0 |
| E12 | English | 2 –4 |
| L64 | French | 3 –6 |
| M12 | Calculus | 3 –6 |
| MS12 | Military Science | 3 –0 |
| PT2 | Physical Training | 1 –0 |
| | Units of exercise and preparation: | 28 –19 |

**Required during Summer 1932**

4·20 Office Practice ............ 7 –0

### SECOND YEAR

*First Term*

| | | |
|---|---|---|
| 2·231 | Mechanics | 3 –6 |
| 4·021 | Freehand Drawing | 4 –0 |
| 4·211 | Office Practice | 3 –0 |
| 4·321 | Theory of Architecture | 1 –1 |
| 4·421 | Architectural History | 2 –1 |
| 4·721 | Design II | 11 –0 |
| E21 | English and History | 3 –5 |
| L65 | French | 2 –3 |
| MS21 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 32 –16 |

*Second Term*

| | | |
|---|---|---|
| 2·232 | Mechanics | 3 –6 |
| 4·022 | Freehand Drawing | 4 –0 |
| 4·212 | Office Practice | 3 –0 |
| 4·322 | Theory of Architecture | 1 –1 |
| 4·422 | Architectural History | 2 –1 |
| 4·722 | Design II | 11 –0 |
| E22 | English and History | 3 –5 |
| L66 | French | 2 –3 |
| MS22 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 32 –16 |

### THIRD YEAR

*First Term*

| | | |
|---|---|---|
| 4·031 | Freehand Drawing | 4 –0 |
| 4·071 | Modeling | 3 –0 |
| 4·331 | Theory of Architecture | 2 –0 |
| 4·461 | European Civ. & Art | 3 –4 |
| 4·61 | Town Planning | 2 –3 |
| 4·731 | Design III | 13 –0 |
| 4·811 | Constructive Design | 7 –0 |
| E41 | Problem Analysis | 2 –2 |
| Ec31 | Political Economy | 3 –3 |
| | Units of exercise and preparation: | 39 –12 |

*Second Term*

| | | |
|---|---|---|
| 4·032 | Freehand Drawing | 4 –0 |
| 4·072 | Modeling | 3 –0 |
| 4·332 | Theory of Architecture | 2 –0 |
| 4·462 | European Civ. & Art | 3 –4 |
| 4·732 | Design III | 15 –0 |
| 4·812 | Constructive Design | 7 –0 |
| E42 | Problem Analysis | 2 –2 |
| Ec32 | Political Economy | 3 –3 |
| | Units of exercise and preparation: | 39 –9 |

## IV. ARCHITECTURE — *Continued*

### FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 2·595 | Mech. Equip. of Bldgs. | 2 – 2 |
| 4·041 | Freehand Drawing | 4 – 0 |
| 4·081 | Color, Comp., Th. & App. | 1 – 3 |
| 4·241 | Professional Relations | 1 – 1 |
| 4·341 | Theory of Architecture | 1 – 1 |
| 4·471 | European Civ. & Art | 3 – 4 |
| 4·741 | Design IV | 17 – 0 |
| | General Study | 4 – 4 |
| | Units of exercise and preparation: | 33 – 15 |

*Second Term*

| | | |
|---|---|---|
| 4·042 | Freehand Drawing | 4 – 0 |
| 4·082 | Color, Comp., Th. & App. | 1 – 3 |
| 4·242 | Professional Relations | 1 – 1 |
| 4·342 | Theory of Architecture | 1 – 1 |
| 4·472 | European Civ. & Art | 3 – 4 |
| 4·742 | Design IV | 29 – 0 |
| | Units of exercise and preparation: | 39 – 9 |

### FIFTH YEAR

*First Term*

| | | |
|---|---|---|
| 4·051 | Free. Draw. & Fig. Comp. | 6 – 0 |
| 4·091 | Color, Comp., Th. & App. | 1 – 4 |
| 4·481 | European Civ. & Art | 2 – 3 |
| 4·53 | Architectural Humanities | 1 – 1 |
| 4·751 | Design V | 30 – 0 |
| | Units of exercise and preparation: | 40 – 8 |

*Second Term*

| | | |
|---|---|---|
| 4·052 | Free. Draw. & Fig. Comp. | 6 – 0 |
| 4·092 | Color, Comp., Th. & App. | 1 – 4 |
| 4·482 | European Civ. & Art | 2 – 3 |
| 4·52 | Philosophy of Arch. | 1 – 1 |
| 4·752 | Design V | 12 – 0 |
| | Thesis | 18 |
| | Units of exercise and preparation: | 48 |

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

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

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.

The course in Architectural Engineering is therefore 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.

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.

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 76

## SECOND YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 1·02 | Surveying | 2 –2 | 2·15 | Applied Mechanics | 3 –5 |
| 2·00 | Applied Kinematics | 5 –3 | 4·414 | Architectural History | 2 –2 |
| 4·13 | Perspective | 2 –2 | 4·90 | Structural Drawing | 4 –0 |
| 4·413 | Architectural History | 2 –2 | 8·04 | Physics | 6 –4 |
| 8·03 | Physics | 5 –5 | 12·49 | Geology of Materials | 2 –2 |
| E21 | English and History | 3 –5 | E22 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 | M22 | Differential Equations | 3 –6 |
| MS21 | Military Science | 3 –0 | MS22 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 25 –25 | | Units of exercise and preparation: | 26 –24 |

### Required during Summer 1932

| | | |
|---|---|---|
| 2·20 | Applied Mechanics | 3 –6 |
| 4·22 | Office Practice | 6 –0 |

## THIRD YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 2·21 | Applied Mechanics | 3 –5 | 1·40 | Structures | 3 –5 |
| 2·30 | Materials of Eng. | 2 –2 | 2·912 | Structural Castings | 1 –0 |
| 4·423 | Architectural History | 1 –1 | 4·424 | Architectural History | 1 –1 |
| 4·461 | European Civ. & Art | 3 –4 | 4·462 | European Civ. & Art | 3 –4 |
| 4·80 | Building Construction | 1 –1 | 4·78 | Planning Principles | 4 –8 |
| 4·911 | Structural Analysis | 12 –0 | 4·912 | Structural Analysis | 8 –0 |
| 8·06 | Acoustics, Ill. & Color | 1 –2 | E33 | Report Writing | 2 –2 |
| Ec31 | Political Economy | 3 –3 | Ec32 | Political Economy | 3 –3 |
| | General Study | 2 –2 | | Units of exercise and preparation: | 25 –23 |
| | Units of exercise and preparation: | 28 –20 | | | |

## FOURTH YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 1·41 | Structures | 4 –8 | 1·422 | Structures | 2 –4 |
| 1·48 | Foundations | 3 –4 | 2·392 | Rein. Concrete Design | 6 –0 |
| 1·63 | Hydraulics | 2 –3 | 2·59 | Mech. Equip. of Bldgs | 4 –3 |
| 2·36 | Testing Materials Lab | 2 –1 | 4·25 | Estimating | 1 –3 |
| 2·362 | Test. Mat. Lab. (Con.) | 3 –2 | 4·922 | Structural Design | 9 –0 |
| 2·391 | Rein. Concrete Design | 7 –0 | 17·50 | Job Management | 1 –1 |
| 4·921 | Structural Design | 5 –0 | | Thesis | 10 |
| | General Study | 2 –2 | | General Study | 2 –2 |
| | Units of exercise and preparation: | 28 –20 | | Units of exercise and preparation: | 48 |

## V. CHEMISTRY

The curriculum in Chemistry includes a number of individual subjects in Chemistry, most of which are general and fundamental in character. The aim of the course is to give the student thorough instruction by means of lectures, recitations and laboratory practice, in the fundamental principles of inorganic, analytical, organic, physical and industrial chemistry. Instruction in mathematics, physics, English and German is included in the course. This fundamental instruction is the same for all students for the first three years. At the end of the third year, all regular classes in chemical subjects are omitted for a period of two weeks for review, study and conference with instructors. This is followed by special comprehensive examinations to determine to what extent students have assimilated and correlated the work of 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 no 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.

# V. CHEMISTRY

**FIRST YEAR.** **See page 76**

**Required during Summer 1932 (Following First Year)**

5·10 Qualitative Analysis...... 14 –4

## SECOND YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 5·12 | Quantitative Analysis.... | 7 –2 | 5·13 | Quantitative Analysis.... | 7 –2 |
| 8·03 | Physics................ | 5 –5 | 8·04 | Physics................ | 6 –4 |
| E21 | English and History..... | 3 –5 | E22 | English and History..... | 3 –5 |
| G60 | Geology................ | 2 –2 | M22 | Differential Equations.... | 3 –6 |
| M21 | Calculus................ | 3 –6 | MS22 | Military Science......... | 3 –0 |
| MS21 | Military Science......... | 3 –0 | | Language.............. | 3 –5 |
| | Language.............. | 3 –5 | | General Study.......... | 2 –2 |
| Units of exercise and preparation: | | 26 –25 | Units of exercise and preparation: | | 27 –24 |

## THIRD YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 5·141 | Analytical Chem......... | 3 –2 | 5·142 | Analytical Chem.*....... | 3 –1 |
| 5·41 | Organic Chemistry I..... | 4 –3 | 5·42 | Organic Chemistry I*.... | 3 –2 |
| 5·414 | Organic Chem. Lab...... | 9 –0 | 5·424 | Organic Chem. Lab.* ... | 11 –0 |
| 5·61 | Physical Chemistry I | 5 –5 | 5·62 | Physical Chemistry II* .. | 4 –5 |
| 5·81 | Chemical Literature I.... | 3 –2 | 5·82 | Chemical Literature II*.. | 1 –1 |
| 7·01 | Biology................ | 5 –2 | 5·89 | Chemistry............. | 6 |
| Ec31 | Political Economy....... | 3 –3 | 10·203 | Industrial Chemistry*.... | 3 –4 |
| Units of exercise and preparation: | | 32 –17 | Ec32 | Political Economy....... | 3 –3 |
| | | | Units of exercise and preparation: | | 50 |

## FOURTH YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 3·61 | Metallography.......... | 4 –1 | 5·062 | Inorganic Chemistry..... | 2 –3 |
| 5·061 | Inorganic Chemistry..... | 2 –3 | 5·64 | Physical Chemistry IV... | 3 –4 |
| 5·63 | Physical Chemistry III... | 4 –4 | 5·83 | History of Chemistry.... | 2 –2 |
| 5·961 | Thesis................. | 15 | 5·96 | Thesis Conference....... | 1 –1 |
| 10·21 | Industrial Chemistry..... | 2 –2 | 5·962 | Thesis................. | 15 |
| | Elective............... | 4 | | General Study.......... | 2 –2 |
| | General Study....... ... | 2 –2 | | Elective............... | 10 |
| Units of exercise and preparation: | | 45 | Units of exercise and preparation: | | 47 |

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.

* Subject discontinued after thirteen weeks. No final examination. A two week reading and conference period is allowed to prepare for general examinations in Chemistry 5·89 which covers the material of all chemical subjects of the first three years.

## VI. ELECTRICAL ENGINEERING

Great importance is attached in Electrical Engineering to the study of mathematics, chemistry, physics and applied mechanics in the earlier years, and of the theory of electricity and magnetism beginning in the second year and continuing throughout the remainder of the course. The work in Principles of Electrical Engineering is conducted by means of recitations and supervised problem work. Along with these are associated the essential principles of heat power engineering, hydraulic power engineering, the designing of 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, communications, etc.

The theoretical work runs parallel with an extended course in the laboratories, which begins with the work in chemistry and physics and extends through all of the scientific branches studied. The electrical measurements laboratories and the laboratories devoted to electrical machinery are component parts of the equipment. These laboratories are extensively provided with apparatus adapted to the needs of undergraduate and advanced study. The 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.

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. No admissions to the third year are assured without clear records in first and second-year subjects and in entrance requirements.

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

# VI. ELECTRICAL ENGINEERING

**FIRST YEAR.** See page 76

## SECOND YEAR

*First Term*

| | | |
|---|---|---|
| 2·00 | Applied Kinematics | 5 –3 |
| 2·941 | Machine Tool Lab. | 4 –0 |
| 8.03 | Physics | 5 –5 |
| E21 | English and History | 3 –5 |
| Ec21 | Political Economy | 3 –5 |
| M21 | Calculus | 3 –6 |
| MS21 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 26 –24 |

*Second Term*

| | | |
|---|---|---|
| 2·15 | Applied Mechanics | 3 –5 |
| 6·00 | Electrical Eng. Prin. | 5 –4 |
| 6·75 | Electrical Eng. Lab. | 2 –2 |
| 8·04 | Physics | 6 –4 |
| E22 | English and History | 3 –5 |
| M22 | Differential Equations | 3 –6 |
| MS22 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 25 –26 |

**Required during Summer 1932**

1·02 Surveying . . . . . . . . . . . . . . . 2 –2

## THIRD YEAR

*First Term*

| | | |
|---|---|---|
| 2.20 | Applied Mechanics | 3 –6 |
| 2·40 | Eng. Thermodynamics | 4 –5 |
| 6·01 | Electrical Eng., Prin. | 3 –4 |
| 6·70 | Electrical Eng. Lab. | 6 –5 |
| Ec31 | Political Economy | 3 –3 |
| M31 | Differential Equa. of Elec. | 2 –4 |
| | Units of exercise and preparation: | 21 –27 |

*Second Term*

| | | |
|---|---|---|
| 2·22 | Applied Mechanics | 3 –5 |
| 2·42 | Eng. Thermodynamics | 4 –5 |
| 6·02 | Electrical Eng., Prin. | 5 –6 |
| 6·71 | Electrical Eng. Lab. | 5 –5 |
| Ec32 | Political Economy | 3 –3 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 22 –26 |

## FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 1·64 | Hydraulics | 3 –6 |
| 2·621 | Engineering Lab. | 3 –2 |
| 6·03 | Electrical Eng., Prin. | 6 –8 |
| 6·72 | Electrical Eng. Lab. | 4 –4 |
| | General Study | 2 –2 |
| | Professional Elective | 3 –6 |
| | Units of exercise and preparation: | 21 –28 |

*Second Term*

| | | |
|---|---|---|
| 6·04 | Electrical Eng., Prin. | 6 –9 |
| G51 | Biography in Science | 3 –5 |
| | Thesis | 15 |
| | Professional Elective | 3 –6 |
| | Units of exercise and preparation: | 47 |

*Electives* (First Term)

| | | |
|---|---|---|
| 6·221 | Central Stations | 3 –6 |
| 6·241 | Electric Railways | 3 –6 |
| 6·251 | Electric Mach. Des. | 3 –6 |
| 6·26 | Elec. Insul. & its Behavior. | 5 –4 |
| 6·27 | Illumination | 3 –6 |
| 6·281 | Prin. Wire Com. | 3 –6 |
| 6·29 | Storage Batteries | 1 –1 |
| 6·80 | Electrical Eng. Lab. | Time arr. |

*Electives* (Second Term)

| | | |
|---|---|---|
| 6·20 | Power Trans. Equip. | 3 –6 |
| 6·21 | Ind. App. of Elec. Pr. | 3 –6 |
| 6·222 | Central Stations | 3 –6 |
| 6·242 | Electric Railways | 3 –6 |
| 6·252 | Electric Mach. Des. | 3 –6 |
| 6·282 | Prin. Radio Com. | 3 –6 |
| 6·29 | Storage Batteries | 1 –1 |
| 6·48 | Elec. Equip. Bldgs. | 1 –2 |
| 6·80 | Electrical Eng. Lab. | Time arr. |

# 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* | | |
|---|---|---|---|---|---|
| 2·20 | Applied Mechanics | 3–6 | 6·02 | Electrical Eng., Prin. | 5–6 |
| 6·01 | Electrical Eng., Prin. | 3–4 | 6·302 | Electrical Com. Prin. | 3–6 |
| 6·301 | Electrical Com. Prin. | 3–6 | 6·71 | Electrical Eng. Lab. | 5–5 |
| 6·70 | Electrical Eng. Lab. | 6–5 | Ec32 | Political Economy | 3–3 |
| Ec31 | Political Economy | 3–3 | M77 | Vector Analysis | 3–5 |
| M31 | Differential Equa. of Elec. | 2–4 | | General Study | 2–2 |
| | Units of exercise and preparation: | 20–28 | | Units of exercise and preparation: | 21–27 |

#### FOURTH YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 6·03 | Electrical Eng., Prin. | 6–8 | 6·312 | Electrical Com. Prin. | 3–5 |
| 6·311 | Electrical Com. Prin. | 3–5 | 6·332 | Electrical Com. Lab. | 3–4 |
| 6·331 | Electrical Com. Lab. | 5–6 | 8·05 | Sound, Speech and Aud. | 3–6 |
| 6·72 | Electrical Eng. Lab. | 4–4 | 8·542 | Electromag. Wave Prop. | 2–3 |
| 8·541 | Electromag. Theory | 2–2 | G51 | Biography in Science | 3–5 |
| | 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.**

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

The Institute offers three distinct coöperative courses in Electrical Engineering. Option 1 affords training for the technical and executive responsibilities of electrical manufacturing industries. The manufacturing practice is taken at the 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. For those desiring to go into electric railway work, experience with the Boston Elevated Railway is available. For communications work, the coöperation is with the shops of the Western Electric Company, Inc., the plants of the New York Telephone Company and the laboratories of the Bell Telephone Laboratories, Inc., coördinated through the American Telephone and Telegraph Company.

Each course covers a period of five years, the first two being identical with Course VI, and the last three being equally divided between instruction at the Institute and practical training in the shops of the General Electric Company, or in the plants of the Boston Edison Company, the Boston Elevated Railway, or the Bell Telephone System.

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

The training at the plants is laid out and conducted with a view to educational value and is intimately correlated with the professional instruction at the Institute. In the final year considerable latitude may be exercised in the assignment of men to posts in the engineering and research bureaus of the respective companies 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 forty-six. Candidates for admission are subject to the approval of both the Institute and the coöperating companies. On account of the limitations of number and the unitary nature of the training, men who are admitted to a course with the approval of both parties are expected to carry it through to completion unless prevented by exceptional circumstances. Well qualified students who have completed at other institutions the substantial equivalent of the work of the first two years of Course VI may be admitted to advanced standing at the beginning of the coöperative training. Students in training at the plants are subject to the usual regulations of the company. They receive regular compensation for their work, the total of which approximates the tuition charges for the three years of coöperation. The work in the shops, testing departments and engineering divisions is supplemented by conferences with department heads in which technical and administrative problems arising in the work are discussed, while at the shops students also devote a maximum of four hours a week to classroom work in electrical theory and general studies, for which ten hours' of preparation per week is expected. At the conclusion of the course, graduates are free to accept employment wherever offered without further obligation to the coöperating company.

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

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

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

## VI-A. ELECTRICAL ENGINEERING

**FIRST YEAR.** See page 76

**Required during Summer (Following First Year)**
**1932. Options 2 and 3**
**1933. Options 1, 2 and 3**

1·02 Surveying ............... 2 –2

**SECOND YEAR.** Same as Course VI

### THIRD YEAR

#### Group A

| *Summer Term* 1932 | | **At M. I. T.** |
|---|---|---|
| 2·20 | Applied Mechanics | 3 –6 |
| 2·40 | Eng. Thermodynamics | 4 –5 |
| 6·01 | Electrical Eng., Prin. | 3 –4 |
| 6·76 | Electrical Eng. Lab. | 3 –4 |

| *First Term* | | **At Works** |
|---|---|---|
| 6·021 | Electrical Eng., Prin. | 2 –4 |
| E44 | Committee Work | 2 –4 |
| | (1) Manufacturing Prac. | 48 h.p.w. |
| 6·901 | General Electric Co. | |
| | (2) Public Utility Prac. | 48 h.p.w. |
| 6·911 | Edison Elec. Ill. Co. | |
| 6·921 | Boston Elevated Ry. | |
| | (3) Communications Prac. | 48 h.p.w. |
| 6·941 | Western Electric Co. | |

| *Second Term* | | **At M. I. T.** |
|---|---|---|
| 2·22 | Applied Mechanics | 3 –5 |
| 2·36 | Testing Materials Lab. | 2 –1 |
| 2·42 | Eng. Thermodynamics | 4 –5 |
| 6·023 | Electrical Eng., Prin. | 5 –6 |
| 6·77 | Electrical Eng. Lab. | 3 –2 |
| Ec32 | Political Economy | 3 –3 |
| M31 | Differential Equa. of Elec. | 2 –4 |

#### Group B

| *Summer Term* 1932 | | **At Works** |
|---|---|---|
| 6·01 | Electrical Eng., Prin. | 2 –5 |
| E45 | Business English | 1 –3 |
| | (1) Manufacturing Prac. | 48 h.p.w. |
| 6·901 | General Electric Co. | |
| | (2) Public Utility Prac. | 48 h.p.w. |
| 6·911 | Edison Elec. Ill. Co. | |
| 6·921 | Boston Elevated Ry. | |
| | (3) Communications Prac. | 48 h.p.w. |
| 6·941 | Western Electric Co. | |

| *First Term* | | **At M. I. T.** |
|---|---|---|
| 2·20 | Applied Mechanics | 3 –6 |
| 2·40 | Eng. Thermodynamics | 4 –5 |
| 6·02 | Electrical Eng., Prin. | 5 –6 |
| 6·76 | Electrical Eng. Lab. | 3 –4 |
| Ec32 | Political Economy | 3 –3 |
| M31 | Differential Equa. of Elec. | 2 –4 |

| *Second Term* | | **At Works** |
|---|---|---|
| 6·031 | Elec. Eng., Prin. | 2 –5 |
| E46 | Modern Forms of Lit. | 2 –4 |
| | (1) Manufacturing Prac. | 48 h.p.w. |
| 6·902 | General Electric Co. | |
| | (2) Public Utility Prac. | 48 h.p.w. |
| 6·912 | Edison Elec. Ill. Co. | |
| 6·922 | Boston Elevated Ry. | |
| | (3) Communications Prac. | 48 h.p.w. |
| 6·942 | N. Y. Telephone Co. | |

# VI-A. ELECTRICAL ENGINEERING — *Continued*

## FOURTH YEAR

### Group A

| *Summer Term* 1932 | | At Works |
|---|---|---|
| 6·032 | Electrical Eng., Prin...... | 2 –5 |
| E45 | Business English......... | 1 –3 |
| | (1) Manufacturing Prac...48 h.p.w. | |
| 6·902 | General Electric Co. | |
| | (2) Public Utility Prac....48 h.p.w. | |
| 6·912 | Edison Elec. Ill. Co. | |
| 6·922 | Boston Elevated Ry. | |
| | (3) Communications Prac. 48 h.p.w. | |
| 6·942 | N. Y. Telephone Co. | |

| *First Term* | | At M. I. T. |
|---|---|---|
| 1·64 | Hydraulics.............. | 3 –6 |
| 2·621 | (1, 2) Engineering Lab...... | 3 –2 |
| 6·041 | (1, 2) Elec. Eng., Prin.... | 3 –5 |
| 6·330 | (3) Elec. Com. Lab....... | 4 –4 |
| 6·39T | Engineering Electronics... | 5 –4 |
| 6·78 | (1, 2) Elec. Eng. Lab...... | 4 –6 |
| 6·781 | (3) Elec. Eng. Lab....... | 3 –4 |
| G51 | Biography in Science..... | 3 –5 |
| M77 | (3) Vector Analysis....... | 3 –5 |

| *Second Term* | | At Works |
|---|---|---|
| E46 | Modern Forms of Lit. .... | 2 –4 |
| 6·042 | (1, 2) Elec. Eng., Prin..... | 2 –6 |
| 6·312 | (3) Elec. Com. Prin....... | 2 –6 |
| | (1) Manufacturing Prac..48 h.p.w. | |
| 6·903 | General Electric Co. | |
| | (2) Public Utility Prac...48 h.p.w. | |
| 6·913 | Edison Elec. Ill. Co. | |
| 6·923 | Boston Elevated Ry. | |
| | (3) Communications Prac. 48 h.p.w. | |
| 6·943 | Bell Telephone Lab. | |

### Group B

| *Summer Term* 1932 | | At M. I. T. |
|---|---|---|
| 2·22 | Applied Mechanics....... | 3 –5 |
| 2·36 | Testing Materials Lab..... | 2 –1 |
| 2·42 | Eng. Thermodynamics.... | 4 –5 |
| 6·032 | (1, 2) Elec. Eng., Prin..... | 3 –4 |
| 6·311 | (3) Electrical Com. Prin... | 3 –5 |
| 6·77 | Electrical Eng. Lab....... | 3 –2 |

| *First Term* | | At Works |
|---|---|---|
| 6·032 | (3) Electrical Eng., Prin... | 2 –5 |
| 6·041 | (1, 2) Elec. Eng., Prin..... | 2 –6 |
| E44 | Committee Work........ | 2 –4 |
| | (1) Manufacturing Prac. .48 h.p.w. | |
| 6·903 | General Electric Co. | |
| | (2) Public Utility Prac...48 h.p.w. | |
| 6·913 | Edison Elec. Ill. Co. | |
| 6·923 | Boston Elevated Ry. | |
| | (3) Communications Prac. 48 h.p.w. | |
| 6·943 | Bell Telephone Lab. | |

| *Second Term* | | At M. I. T. |
|---|---|---|
| 1·64 | Hydraulics.............. | 3 –6 |
| 2·621 | (1, 2) Engineering Lab.... | 3 –2 |
| 6·042 | (1, 2) Elec. Eng., Prin.... | 3 –5 |
| 6·312 | (3) Electrical Com. Prin... | 3 –5 |
| 6·330 | (3) Electrical Com. Lab... | 4 –4 |
| 6·39T | (1, 2) Eng. Electronics ... | 5 –4 |
| 6·78 | (1, 2) Electrical Eng. Lab.. | 4 –6 |
| 6·781 | (3) Electrical Eng. Lab.... | 3 –4 |
| G51 | Biography in Science..... | 3 –5 |
| M77 | (3) Vector Analysis....... | 3 –5 |

## GRADUATE YEAR (1932–33)

### Group A

| *Summer Term* 1932 | | At M. I. T. |
|---|---|---|
| | Graduate Study & Research | 34 |

| *First Term* | | At Works |
|---|---|---|
| | Graduate Study & Research | 14 |
| | (1) Manufacturing Prac...48 h.p.w. | |
| 6·904 | General Electric Co. | |
| | (2) Public Utility Prac...48 h.p.w. | |
| 6·914 | Edison Elec. Ill. Co. | |
| 6·924 | Boston Elevated Ry. | |
| | (3) Communications Prac. 48 h.p.w. | |
| 6·944 | Bell Telephone System | |

| *Second Term* | | At M. I. T. |
|---|---|---|
| Ec63 | Business Law and Org.... | 3 –5 |
| | Graduate Study & Research | 40 |

### Group B

| *Summer Term* 1932 | | At Works |
|---|---|---|
| | Graduate Study & Research | 10 |
| | (1) Manufacturing Prac...48 h.p.w. | |
| 6·904 | General Electric Co. | |
| | (2) Public Utility Prac....48 h.p.w. | |
| 6·914 | Edison Elec. Ill. Co. | |
| 6.924 | Boston Elevated Ry. | |
| | (3) Communications Prac. 48 h.p.w. | |
| 6·944 | Bell Telephone System | |

| *First Term* | | At M. I. T. |
|---|---|---|
| | Graduate Study & Research | 48 |

| *Second Term* | | At M. I. T. |
|---|---|---|
| Ec63 | Business Law and Org..... | 3 –5 |
| | Graduate Study & Research | 40 |

## VII. BIOLOGY AND PUBLIC HEALTH

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

**Option 1. Biology and Public Health.** This option deals primarily with the biological sciences in general, and with their applications to public health administration and sanitation. In the public health field careers are open in the official health agencies of the government, states and cities, or in the service of private corporations or unofficial health organizations for men well trained in bacteriology, sanitary biology, industrial hygiene, municipal sanitation and the technique of health administration and public health laboratory procedures. This option offers especial advantage in preparation for medical studies or for teaching or biological research.

The field of Public Health Administration offers opportunity for a wide variety of positions, such as those of Health Officer, Epidemiologist, Sanitary Inspector or expert in other phases of Municipal Sanitation.

Many large industries have found it advantageous to supervise through a specialist in Industrial Hygiene the conditions under which their operatives are obliged to work, and to maintain laboratories and other equipment to safeguard their welfare. The study of the basic sciences on which public health depends, supplemented by special inquiry in the hygiene and sanitation of industry, occupational accidents, industrial hazards, defective ventilation, and control of communicable diseases, may lead the student of Public Health into the new and growing field of Industrial Hygiene, or the study of health problems in the factory or industrial plant. This option leads to the degree of Bachelor of Science in Biology and Public Health.

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

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

**Option 3. Public Health Engineering.** This option is arranged to meet the increasing demand for men who have knowledge of bacteriology and the principles of sanitation, public health, industrial hygiene and public health administration, together with sound basic training in engineering. It prepares men for the type of work known as public health engineering. It includes the planning, supervising and control of water supplies and waste disposal systems; the engineering supervision of milk supply; the development of engineering projects for securing healthful environment through proper housing; the elimination of dangerous pests; drainage, etc. In addition the problems of industrial hygiene receive particular attention. This type of engineer will probably find a most useful field in factory sanitation and control and in the type of work carried out by the United States Public Health Service and some of the large private health organizations.

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

# VII. BIOLOGY AND PUBLIC HEALTH

## Option 1. Biology and Public Health

**FIRST YEAR.** See page 76

### SECOND YEAR

*First Term*

| | | |
|---|---|---|
| 5·11 | Qualitative Analysis | 7 –2 |
| 7·01 | Biology, General | 5 –2 |
| 8·03 | Physics | 5 –5 |
| E21 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 |
| MS21 | Military Science | 3 –0 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 28 –22 |

*Second Term*

| | | |
|---|---|---|
| 5·12 | Quantitative Analysis | 7 –2 |
| 7·06 | Botany | 6 –4 |
| 7·10 | Zoology | 5 –3 |
| 8·04 | Physics | 6 –4 |
| E22 | English and History | 3 –5 |
| MS22 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 30 –18 |

**Required during Summer 1932**

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

### THIRD YEAR

*First Term*

| | | |
|---|---|---|
| 5·25 | Chemistry of Foods | 5 –1 |
| 5·684 | Physical Chem., Elem. | 3 –3 |
| 7·11 | Anatomy and Histology | 8 –4 |
| 7·301 | Bacteriology | 6 –4 |
| 7·50 | Infection and Immunity | 3 –3 |
| Ec31 | Political Economy | 3 –3 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 30 –20 |

*Second Term*

| | | |
|---|---|---|
| 5·20 | Chem. of Water and Sew. | 4 –1 |
| 7·12 | Anatomy and Histology | 7 –4 |
| 7·20 | Physiology | 6 –5 |
| 7·302 | Bacteriology | 6 –3 |
| 7·57 | Municipal Sanitation | 4 –4 |
| Ec32 | Political Economy | 3 –3 |
| | Units of exercise and preparation: | 30 –20 |

### FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 7·22 | Personal Hygiene and Nut. | 2 –2 |
| 7·361 | Indust. Microbiology | 5 –2 |
| 7·541 | Public Health Admin. | 2 –3 |
| 7·551 | Public Health Lab. Meth. | 6 –2 |
| 7·58 | Vital Statistics | 2 –3 |
| 7·80 | Biochemistry | 8 –5 |
| 7·91 | Biological Colloquium | 1 –1 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 28 –20 |

*Second Term*

| | | |
|---|---|---|
| 7·03 | Theoretical Biology | 2 –3 |
| 7·08 | Parasitology | 2 –4 |
| 7·52 | Industrial Hygiene | 4 –4 |
| 7·542 | Public Health Admin. | 2 –3 |
| 7·552 | Pub. Health Lab. Meth. | 3 –1 |
| 7·92 | Biological Colloquium | 1 –1 |
| | Thesis | 15 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 49 |

# VII. BIOLOGY AND PUBLIC HEALTH — *Continued*

## Option 2. Industrial Biology

### FIRST YEAR. See page 76

### SECOND YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 5·11 | Qualitative Analysis | 7–2 | 5·12 | Quantitative Analysis | 7–2 |
| 7·01 | Biology, General | 5–2 | 7·06 | Botany | 6–4 |
| 8·03 | Physics | 5–5 | 7·10 | Zoology | 5–3 |
| E21 | English and History | 3–5 | 8·04 | Physics | 6–4 |
| M21 | Calculus | 3–6 | E22 | English and History | 3–5 |
| MS21 | Military Science | 3–0 | MS22 | Military Science | 3–0 |
| | General Study | 2–2 | | Units of exercise and preparation: | 30–18 |
| | Units of exercise and preparation: | 28–22 | | | |

### Required during Summer 1932

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

### THIRD YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 5·25 | Chemistry of Foods | 5–1 | 5·20 | Chem. of Water and Sew. | 4–1 |
| 5·684 | Physical Chem. Elem. | 3–3 | 7·20 | Physiology | 6–5 |
| 7·07 | Mycology | 3–2 | 7·302 | Bacteriology | 6–3 |
| 7·15 | Essentials of Anat. | 3–3 | 7·33 | Plant Diseases | 1–2 |
| 7·301 | Bacteriology | 6–4 | 7·57 | Municipal Sanitation | 4–4 |
| 7·701 | Tech. Food Sup. | 4–2 | 7·702 | Tech. Food Supplies | 4–4 |
| Ec31 | Political Economy | 3–3 | Ec32 | Political Economy | 3–3 |
| | General Study | 2–2 | | Units of exercise and preparation: | 28–22 |
| | Units of exercise and preparation: | 29–20 | | | |

### FOURTH YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 2·491 | Refrigeration | 1–2 | 7·03 | Theoret. Biology | 2–3 |
| 7·361 | Indust. Microbiology | 5–2 | 7·362 | Indust. Microbiology | 4–4 |
| 7·711 | Tech. Food Prod. | 4–4 | 7·52 | Industrial Hygiene | 4–4 |
| 7·80 | Biochemistry | 8–5 | 7·712 | Tech. Food Products | 5–4 |
| 7·91 | Biological Colloquium | 1–1 | 7·92 | Biological Colloquium | 1–1 |
| | Thesis | 6 | | Thesis | 12 |
| | Elective | 5 | | General Study | 2–2 |
| | General Study | 2–2 | | Units of exercise and preparation: | 48 |
| | Units of exercise and preparation: | 48 | | | |

## VII. BIOLOGY AND PUBLIC HEALTH — *Continued*

### Option 3. Public Health Engineering

FIRST YEAR. See page 76

### SECOND YEAR

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| 5·11 | Qualitative Analysis | 7 – 2 | 2·15 | Applied Mechanics | 3 – 5 |
| 7·01 | Biology, General | 5 – 2 | 5·12 | Quantitative Analysis | 7 – 2 |
| 8·03 | Physics | 5 – 5 | 8·04 | Physics | 6 – 4 |
| E21 | English and History | 3 – 5 | E22 | English and History | 3 – 5 |
| M21 | Calculus | 3 – 6 | M22 | Differential Equations | 3 – 6 |
| MS21 | Military Science | 3 – 0 | MS22 | Military Science | 3 – 0 |
| | General Study | 2 – 2 | | Units of exercise and preparation: | 25 – 22 |
| | Units of exercise and preparation: | 28 – 22 | | | |

### Required during Summer 1932. At Camp Technology

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

### THIRD YEAR

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| 1·211 | Railway and High. Eng. | 1 – 3 | 1·22 | Railway and High. Eng. | 2 – 2 |
| 2·20 | Applied Mechanics | 3 – 6 | 1·40 | Structures | 3 – 5 |
| 5·41 | Organic Chemistry | 4 – 3 | 1·62 | Hydraulics | 3 – 5 |
| 7·301 | Bacteriology | 6 – 4 | 5·20 | Chem. of Water and Sew.. | 4 – 1 |
| 7·50 | Infection and Immunity | 3 – 3 | 7·302 | Bacteriology | 6 – 3 |
| Ec31 | Political Economy | 3 – 3 | 7·57 | Municipal Sanitation | 4 – 4 |
| | General Study | 2 – 2 | Ec32 | Political Economy | 3 – 3 |
| | Units of exercise and preparation: | 22 – 24 | | Units of exercise and preparation: | 25 – 23 |

### FOURTH YEAR

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| 1·411 | Structures | 4 – 8 | 1·78 | Sanitary Engineering | 3 – 4 |
| 1·75 | Hydraulic and San. Eng. | 4 – 5 | 1·802 | Sanitary Design | 6 – 0 |
| 1·801 | Sanitary Design | 4 – 0 | 2·59 | Mech. Equip. of Bldg. | 4 – 3 |
| 7·541 | Public Health Admin. | 2 – 3 | 7·52 | Industrial Hygiene | 4 – 4 |
| 7·58 | Vital Statistics | 2 – 3 | 7·542 | Public Health Admin. | 2 – 3 |
| 7·59 | Sanitation | 6 – 2 | 7·92 | Biological Colloquium | 1 – 1 |
| 7·91 | Biological Colloquium | 1 – 1 | | General Study | 2 – 2 |
| | General Study | 2 – 2 | | Thesis | 10 |
| | Units of exercise and preparation: | 25 – 24 | | Units of exercise and preparation: | 49 |

# VIII. PHYSICS

The course in Physics is intended to be sufficiently broad to provide for the needs of those who desire to prepare for graduate work and research in pure physics, either experimental or theoretical, as well as for those who desire to go into work in industrial and applied physics. Students are given a sound fundamental training in the various branches of physics, as well as in mathematics, chemistry, and liberal subjects. Laboratory instruction is given in the more important phases of experimental physics, including modern physics, and training in theoretical physics is provided. In the fourth year the work is largely elective, so that the student may follow up the particular branch of the subject in which he is most interested. The thesis furnishes additional opportunity to go rather deeply into a particular field. For example, a senior can work in a special branch of experimental physics, as for example electronics, spectroscopy, X-rays, radiation measurements, taking the specialized courses in those fields and related ones, and perhaps a little theoretical physics and mathematics. Or he can choose theoretical physics, in which case he would take considerable theoretical and mathematical work, but also some experimental work to preserve a balance. He may choose a more applied field, as applied optics, in which he may choose courses in advanced optics and photography, or heat measurements, or industrial physics such as ceramics. In addition to subjects in the physics department, a senior may desire to take some work in other departments, in closely related fields; as in mathematics, if he is theoretically inclined, or in electrical engineering, if his interests lie along the lines of communication, or in physical chemistry or electrochemistry, if he is specializing in the thermodynamic side or in geophysics. In fact, physics with its broad training in the basis of physical science is coming to be recognized as a sound foundation for future specialization in a number of related sciences.

The Department reserves the right to limit admission to Course VIII above the second year to that number of students who may be properly trained with the professional equipment available. The limitation if necessary will be effected by selection of the applicants of highest grade.

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

# VIII. PHYSICS

**FIRST YEAR.** **See page 76**

## SECOND YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 5·11 | Qualitative Analysis | 7 – 2 | 8·04 | Physics | 6 – 4 |
| 8·03 | Physics | 5 – 5 | 8·45 | Introd. to Phys. Science | 4 – 6 |
| E21 | English and History | 3 – 5 | E22 | English and History | 3 – 5 |
| M21 | Calculus | 3 – 6 | M22 | Differential Equations | 3 – 6 |
| MS21 | Military Science | 3 – 0 | MS22 | Military Science | 3 – 0 |
| | Language | 3 – 5 | | Language | 3 – 5 |
| Units of exercise and preparation: | | 24 – 23 | Units of exercise and preparation: | | 22 – 26 |

## THIRD YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 5·41 | Organic Chemistry | 4 – 3 | 8·201 | Electricity and Electronics | 3 – 5 |
| 8·161 | Optics | 3 – 6 | 8·202 | Electronic Lab. | 3 – 2 |
| 8·162 | Optical Measurements | 3 – 2 | 8·311 | Atomic Structure | 3 – 5 |
| 8·461 | Int. to Theoret. Phys. | 4 – 8 | 8·312 | Atomic Struc. Lab. | 3 – 2 |
| 8·50 | Heat and Thermodynamics | 3 – 4 | 8·462 | Int. to Theoret. Phys. | 4 – 8 |
| Ec31 | Political Economy | 3 – 3 | Ec32 | Political Economy | 3 – 3 |
| | General Study | 2 – 2 | | General Study | 2 – 2 |
| Units of exercise and preparation: | | 22 – 28 | Units of exercise and preparation: | | 21 – 27 |

## FOURTH YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 8·471 | Hist. Dev. of Physics | 3 – 6 | 8·472 | Rec. Develop. of Phys. | 3 – 6 |
| | General Study | 2 – 2 | | Thesis | 16 |
| | Elective | 32 | | General Study | 2 – 2 |
| | Thesis | 4 | | Elective | 20 |
| Units of exercise and preparation: | | 49 | Units of exercise and preparation: | | 49 |

# 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 humanistic studies such 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 76

### SECOND YEAR

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| 5·11 | Qualitative Analysis | 7–2 | 5·12 | Quantitative Analysis | 7–2 |
| 8·03 | Physics | 5–5 | 8·04 | Physics | 6–4 |
| E21 | English and History | 3–5 | E22 | English and History | 3–5 |
| M21 | Calculus | 3–6 | M22 | Differential Equations | 3–6 |
| MS21 | Military Science | 3–0 | MS22 | Military Science | 3–0 |
| | Language | 3–5 | | Language | 3–5 |
| | | | | General Study | 2–2 |
| | Units of exercise and preparation: | 24–23 | | Units of exercise and preparation: | 27–24 |

### THIRD YEAR

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| 5·41 | Organic Chemistry | 4–3 | 12·30 | Geology | 4–2 |
| 5·418 | Organic Chem. Lab. | 6–0 | Ec32 | Political Economy | 3–3 |
| 7·01 | Biology General | 5–2 | G64 | Organic Evolution | 2–2 |
| 8·11 | Heat Measurements | 2–1 | | Elective | 6 |
| 12·01 | Mineralogy | 8–2 | | Professional Elective | 26 |
| Ec31 | Political Economy | 3–3 | | Units of exercise and preparation: | 48 |
| | Electives | 10 | | | |
| | Units of exercise and preparation: | 49 | | | |

### FOURTH YEAR

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| 12·31 | Geology | 5–3 | G66 | Descriptive Astronomy | 2–2 |
| | General Study | 2–2 | | Major Professional Elec. | 9 |
| | Major Prof. Elective | 9 | | Prof. Elective and Thesis | 35 |
| | Prof. Elective and 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 76

### SECOND YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 2·00 | Applied Kinematics | 5–3 | 1·02 | Surveying | 2–2 |
| 2·12 | Machine Drawing | 6–0 | 2·15 | Applied Mechanics | 3–5 |
| 8·03 | Physics | 5–5 | 2·96 | Machine Tool Lab. | 3–0 |
| E21 | English and History | 3–5 | 8·04 | Physics | 6–4 |
| M21 | Calculus | 3–6 | E22 | English and History | 3–5 |
| MS21 | Military Science | 3–0 | M22 | Differential Equations | 3–6 |
| | Elective | 6 | MS22 | Military Science | 3–0 |
| | | | | Elective | 5 |
| Units of exercise and preparation: | | 50 | Units of exercise and preparation: | | 50 |

### THIRD YEAR

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

### FOURTH YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 2·62 | Engineering Lab. | 4–2 | | Elective and Thesis | 44 |
| 6·85 | Electrical Eng. Lab. | 2–3 | | General Study | 2–2 |
| | Elective and Thesis | 33 | | | |
| | 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 falls naturally into three groups: first, subjects which provide a thorough knowledge of the fundamental principles of chemistry; second, those which furnish a sound knowledge of mechanical engineering subjects, both in theory and in practice; third, those 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 chemistry course except in the case of some of the laboratory subjects. At the end of the third year all regular classes in chemical subjects are omitted for a period of two weeks for review, study, and conference with instructors. This is followed by special comprehensive examinations to determine to what extent students have assimilated and correlated the work of the first three years. The training in applied mechanics and testing materials laboratory is given with special reference to the particular needs of this course. This is true also of the work of the course which is given in Electrical Engineering. 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 undergraduates the last part of the senior year. Students desiring this course should apply the first term of the fourth year and those accepted will spend the second term at the Field Station of the School of Chemical Engineering Practice.

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

# X. CHEMICAL ENGINEERING

**FIRST YEAR.** **See page 76**

**Required during Summer 1932 (Following First Year)**

5·10 Qualitative Analysis....... 14–4

## SECOND YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 5·12 | Quantitative Analysis | 7–2 | 2·15 | Applied Mechanics | 3–5 |
| 8·03 | Physics | 5–5 | 5·13 | Quantitative Analysis | 7–2 |
| 10·11 | Prob. of Chem. Eng. | 1–0 | 8·04 | Physics | 6–4 |
| E21 | English and History | 3–5 | E22 | English and History | 3–5 |
| M21 | Calculus | 3–6 | MS22 | Military Science | 3–0 |
| MS21 | Military Science | 3–0 | | Language | 3–5 |
| | Language | 3–5 | | General Study (G54) | 2–2 |
| Units of exercise and preparation: | | 25–23 | Units of exercise and preparation: | | 27–23 |

Students credited with Elementary and Intermediate French will take Elementary German. Students credited with Elementary and Intermediate German will take Elementary French. Students credited with both Elementary French and Elementary German will take Chemical Engineering literature 10·191 and 10·192.

## THIRD YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 2·20 | Applied Mechanics | 3–6 | 2·36 | Testing Materials Lab. | 2–1 |
| 5·41 | Organic Chemistry I. | 4–3 | 5·42 | Organic Chemistry I* | 3–2 |
| 5·416 | Organic Chem. Lab. | 9–0 | 5·426 | Organic Chem. Lab.* | 5–0 |
| 5·61 | Physical Chemistry I | 5–5 | 5·62 | Physical Chemistry* | 4–5 |
| 10·17 | Industrial Chemistry | 3–2 | 5·89 | Chemistry | 6 |
| Ec31 | Political Economy | 3–3 | 10·18 | Industrial Chemistry* | 3–4 |
| | General Study | 2–2 | 10·28 | Chemical Eng. | 3–6 |
| Units of exercise and preparation: | | 29–21 | Ec32 | Political Economy | 3–3 |
| | | | Units of exercise and preparation: | | 50 |

## FOURTH YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 6·40 | Electrical Eng. Elem. | 4–6 | 2·622 | Engineering Laboratory | 3–3 |
| 10·21 | Industrial Chemistry | 2–2 | 6·85 | Electrical Eng. Lab. | 2–3 |
| 10·26 | Industrial Chem. Lab. | 5–1 | 10·15 | Thesis Reports | 2–2 |
| 10·29 | Chemical Engineering | 3–6 | 10·32 | Chemical Engineering | 5–4 |
| 10·31 | Chemical Engineering | 5–4 | | Prof. Electives and Thesis | 22 |
| M41 | Differential Equations | 3–6 | | General Study | 2–2 |
| | Thesis | 3 | Units of exercise and preparation: | | 50 |
| Units of exercise and preparation: | | 50 | | | |

* Subject discontinued after thirteen weeks; no final examination. A two week reading or conference period is allowed to prepare for the general examination in Chemistry 5·89 which covers the material of all chemical subjects of the first three years.

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

# X-B. CHEMICAL ENGINEERING PRACTICE

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

## FOURTH YEAR

### School Chemical Engineering Practice

*Second Term*

| | | |
|---|---|---|
| 10·30 | Engineering Equipment | 4 –3 |
| 10·32 | Chemical Engineering | 5 –4 |
| | *Field Station | 11 |
| | *Field Station | 11 |
| | Thesis | 12 |
| | | 50 |

* Students will take two of the Following Stations:

| | | |
|---|---|---|
| 10·84 | Bangor | 11 |
| 10·85 | Boston | 11 |
| 10·86 | Buffalo | 11 |

## XI. SANITARY ENGINEERING

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

The course of study includes those civil engineering subjects an understanding of which is required for complete engineering service in connection with the construction of sanitary engineering works, and also such subjects in mechanical and electrical engineering as are necessary to familiarize the student with the principles underlying the selection of pumping and treatment plant equipment. Much time is devoted to instruction and laboratory work in analytical and sanitary chemistry and to the biology and bacteriology of water and sewage. Extended courses run throughout the fourth year in the principles of the design and operation of modern water works, water treatment plants, sewerage systems and sewage and waste disposal works.

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

Facilities are available in the Sanitary Engineering Laboratory and in other laboratories of the Institute for research work in sanitary hydraulics and in the treatment of water and wastes.

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

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

# XI. SANITARY ENGINEERING

**FIRST YEAR.** **See page 76**

## SECOND YEAR

*First Term*

| | | |
|---|---|---|
| 1·18 | Map Read. and Top. Draw. | 2 –0 |
| 5·11 | Qualitative Analysis | 7 –2 |
| 7·01 | Biology | 5 –2 |
| 8·03 | Physics | 5 –5 |
| E21 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 |
| MS21 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 28 –20 |

*Second Term*

| | | |
|---|---|---|
| 2·15 | Applied Mechanics | 3 –5 |
| 5·12 | Quantitative Analysis | 7 –2 |
| 8·04 | Physics | 6 –4 |
| E22 | English and History | 3 –5 |
| M22 | Differential Equations | 3 –6 |
| MS22 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 25 –22 |

**Required during Summer 1932. At Camp Technology***

| | | |
|---|---|---|
| 1·041 | Surveying | 12 –1 |
| 1·20 | Railroad Fieldwork | 5 –0 |
| 1·60 | Hydrographic Surveying | 5 –0 |

## THIRD YEAR

*First Term*

| | | |
|---|---|---|
| 1·211 | Railway and High. Eng. | 1 –3 |
| 1·43 | Materials | 1 –2 |
| 2·20 | Applied Mechanics | 3 –6 |
| 6·40 | Electrical Eng. Elem. | 4 –6 |
| 7·281 | Sanitary Biology | 7 –3 |
| Ec31 | Political Economy | 3 –3 |
| | General Study | 4 –4 |
| | Units of exercise and preparation: | 23 –27 |

*Second Term*

| | | |
|---|---|---|
| 1·22 | Railway and High. Eng. | 2 –2 |
| 1·35 | Roads and Pavements | 2 –1 |
| 1·40 | Structures | 3 –5 |
| 1·62 | Hydraulics | 3 –5 |
| 2·36 | Testing Materials Lab. | 2 –1 |
| 5·23 | Sanitary Chemistry | 7 –1 |
| 6·86 | Electrical Eng. Lab. | 1 –2 |
| 7·29 | Bacteriology | 5 –2 |
| Ec32 | Political Economy | 3 –3 |
| | Units of exercise and preparation: | 28 –22 |

## FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 1·41 | Structures | 4 –8 |
| 1·48 | Foundations | 3 –4 |
| 1·75 | Hyd. and Sanitary Eng. | 4 –5 |
| 1·801 | Sanitary Design | 4 –0 |
| 2·46 | Heat Engineering | 4 –7 |
| 12·321 | Geology | 2 –1 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 23 –27 |

*Second Term*

| | | |
|---|---|---|
| 1·421 | Structures | 2 –4 |
| 1·52 | Structural Design | 6 –0 |
| 1·65 | Hydraulic Machinery | 2 –2 |
| 1·78 | Sanitary Engineering | 3 –4 |
| 1·802 | Sanitary Design | 6 –0 |
| 2·47 | Heat Engineering | 2 –3 |
| 2·63 | Eng. and Hyd. Lab. | 2 –2 |
| | Thesis | 7 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 49 |

* See special camp circular.

## XII. GEOLOGY

The course in geology is planned for students who wish to make geology, in its theoretical or practical aspects, their principal line of work. It, therefore, provides for a thorough and exact foundation of physics, chemistry, and mathematics followed by courses in all important branches of geology, such as mineralogy, general geology, field geology, stratigraphy, paleontology, petrography, the various branches of economic geology and geophysics. A broad general knowledge is emphasized but provision is also made for a certain amount of specialization in the fourth year.

A number of electives are included which may be chosen from either engineering subjects closely related to geology, or from more advanced geological subjects. The course is thus given considerable flexibility and can be adapted to the needs of the student who may already know which of the various branches he will elect for his speciality. However, a broad foundation of geological knowledge is the main feature of the course.

The growth of economic geology is a comparatively recent development. The geologist and the geological engineer have won for themselves a prominent place in many technical enterprises related to ore and coal mining, petroleum production, civil engineering and water supply.

There exists now a definite demand for men who have an education in engineering subjects along with their geological training, and this is provided for in this course. Among the graduates of this Department are many of the most prominent practical geologists of the present day.

Courses in various branches of geology are offered to students of other departments, either as part of the particular curriculum or as electives.

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

**Geophysics.** For those students who plan to pursue graduate studies in the geological aspects of geophysics, this Department, in coöperation with the Physics Department, offers in the third and fourth years a broad program of study in the sciences fundamental to geophysics. The program involves basic studies in geology and classical physics, with a continuing emphasis on the underlying mathematical technique. In geology, crystallography, petrography, economic geology, structural geology, and other subjects are required. In physics, the schedule includes studies in dynamics, electromagnetic theory, optics, thermodynamics, and elasticity. The program affords a preparation sufficiently broad and fundamental so that the student may subsequently build upon it, should he so desire, a career in either the more purely geological or the physical aspects of geophysics. The satisfactory completion of this program of study leads to the S.B. degree in Geology.

# XII. GEOLOGY

## FIRST YEAR. See page 76

## SECOND YEAR

| | | |
|---|---|---|
| 5·11 | Qualitative Analysis | 7 – 2 |
| 8·03 | Physics | 5 – 5 |
| 12·01 | Mineralogy | 8 – 2 |
| E21 | English and History | 3 – 5 |
| M21 | Calculus | 3 – 6 |
| MS21 | Military Science | 3 – 0 |
| Units of exercise and preparation: | | 29 – 20 |

*Second Term*

| | | |
|---|---|---|
| 5·12 | Quantitative Analysis | 7 – 2 |
| 8·04 | Physics | 6 – 4 |
| 12·02 | Mineralogy | 5 – 1 |
| 12·30 | Geology | 4 – 2 |
| E22 | English and History | 3 – 5 |
| M22 | Differential Equations | 3 – 6 |
| MS22 | Military Science | 3 – 0 |
| Units of exercise and preparation: | | 31 – 20 |

## THIRD YEAR

*First Term*

| | | |
|---|---|---|
| 3·05 | (*a*) Mining, Elem. of | 2 – 2 |
| 5·13 | Quantitative Analysis | 7 – 2 |
| 7·01 | (*b*) General Biology | 5 – 2 |
| 12·211 | Opt. Crystallography | 4 – 1 |
| 12·31 | Geology | 5 – 3 |
| 12·511 | Paleontology | 3 – 2 |
| Ec31 | Political Economy | 3 – 3 |
| | (*a*) Professional Elec. | 4 – 0 |
| | Language | 3 – 5 |
| Units of exercise and preparation | (*a*) | 31 – 18 |
| | (*b*) | 30 – 18 |

*Second Term*

| | | |
|---|---|---|
| 3·23 | (*a*) Ore Dressing | 3 – 2 |
| 7·10 | (*b*) Zoology | 4 – 2 |
| 12·15 | Petrography | 8 – 2 |
| 12·40 | Geology, Economic | 4 – 3 |
| 12·50 | Historical Geology | 3 – 2 |
| 12·512 | Paleontology | 1 – 1 |
| Ec32 | Political Economy | 3 – 3 |
| G64 | Organic Evolution | 2 – 2 |
| | Language | 3 – 5 |
| Units of exercise and preparation | (*a*) | 27 – 20 |
| | (*b*) | 28 – 20 |

**Required during Summer 1932. At Summer Mining Camp***

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

## FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 5·611 | (*b*) Phys. Chem. Elem. | 4 – 4 |
| 8·801 | (*a*) Electrochemistry, Prin. | 4 – 6 |
| 12·33 | Field Geology | 3 – 2 |
| 12·38 | Physiography | 3 – 1 |
| 12·41 | Econ. Geology Lab. | 6 – 2 |
| 12·46 | Ec. Geol. Non-Met. Dep. | 3 – 3 |
| 12·48 | Eng. Geol. and Hyd. | 3 – 2 |
| 12·60 | Structural Geology | 2 – 3 |
| | (*a*) General Study | 2 – 2 |
| | (*b*) Language | 3 – 5 |
| Units of exercise and preparation | (*a*) | 26 – 21 |
| | (*b*) | 27 – 22 |

*Second Term*

| | | |
|---|---|---|
| 3·46 | Met. of Com. Metals | 3 – 3 |
| 8·802 | (*a*) Electrochem. Prin. | 3 – 6 |
| 12·42 | App. Economic Geology | 2 – 1 |
| 12·61 | Diastro. and Vulcan | 2 – 3 |
| 12·80 | Geol. Coal and Petroleum | 4 – 3 |
| | Thesis | 13 |
| | (*a*) Professional Elective | 7 |
| | (*b*) Language | 3 – 5 |
| | (*b*) General Study | 2 – 2 |
| | (*b*) Professional Elective | 4 |
| Units of exercise and preparation: | | 50 |

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

* See special camp circular.

## XIII. NAVAL ARCHITECTURE AND MARINE ENGINEERING

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

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

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

After preliminary instruction in ship drawing, each student carries through the design of a ship and its machinery for a given service in a systematic manner as in good practice, giving attention both to the logical development of the design and to the requirements for registration, for insurance and governmental inspection. Drawings and all customary computations are made of the structure and arrangements of hull, engines and propellers. 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.

# XIII. NAVAL ARCHITECTURE AND MARINE ENGINEERING

FIRST YEAR. See page 76

## SECOND YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 2·00 | Applied Kinematics | 5 –3 | 2·15 | Applied Mechanics | 3 –5 |
| 2·901 | Forging | 2 –0 | 2·91 | Foundry | 3 –0 |
| 8·03 | Physics | 5 –5 | 8·04 | Physics | 6 –4 |
| 13·31 | Ship Construction | 2 –2 | 13·32 | Ship Construction | 2 –2 |
| 13·50 | Marine Engineering | 2 –1 | 13·41 | Ship Drawing | 5 –0 |
| E21 | English and History | 3 –5 | E22 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 | M22 | Differential Equations | 3 –6 |
| MS21 | Military Science | 3 –0 | MS22 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 25 –22 | | Units of exercise and preparation: | 28 –22 |

## THIRD YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 1·63 | Hydraulics | 2 –3 | 2·21 | Applied Mechanics | 3 –5 |
| 2·20 | Applied Mechanics | 3 –6 | 2·42 | Eng. Thermodynamics | 4 –5 |
| 2·40 | Eng. Thermodynamics | 4 –5 | 2·611 | Engineering Lab | 2 –1 |
| 2·951 | Machine Tool Lab | 6 –0 | 2·952 | Machine Tool Lab | 4 –0 |
| 13·01 | Naval Architecture | 2 –2 | 13·02 | Naval Architecture | 2 –2 |
| 13·33 | Ship Construction | 2 –2 | 13·43 | Ship Design | 6 –0 |
| 13·42 | Ship Design | 3 –0 | 13·51 | Marine Engineering | 2 –3 |
| Ec31 | Political Economy | 3 –3 | Ec32 | Political Economy | 3 –3 |
| | General Study | 2 –2 | | General Study | 2 –2 |
| | Units of exercise and preparation: | 27 –23 | | Units of exercise and preparation: | 28 –21 |

## FOURTH YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 1·63 | Hydraulics | 2 –3 | 2·615 | Engineering Lab. | 2 –2 |
| 2·36 | Testing Materials Lab. | 2 –1 | 5·35 | Applied Chemistry | 1 –2 |
| 2·612 | Engineering Laboratory | 2 –2 | 6·89 | Electrical Eng. Lab. | 2 –2 |
| 6·40 | Electrical Eng. Elem. | 4 –6 | 13·38 | Shipyard Organization | 2 –1 |
| 13·03 | Naval Architecture | 3 –3 | 13·46 | Ship Design | 3 –0 |
| 13·45 | Ship Design | 6 –0 | 13·62 | Marine Engine Design | 5 –0 |
| 13·54 | Marine Engineering | 2 –3 | 13·70 | Steam Turbines | 2 –3 |
| 13·61 | Marine Engine Design | 5 –0 | 13·72 | Marine Diesel Eng. | 2 –2 |
| | General Study | 2 –2 | Ec50 | Accounting | 4 –2 |
| | Units of exercise and preparation: | 28 –20 | | Thesis | 6 |
| | | | | General Study | 2 –2 |
| | | | | Units of exercise and preparation: | 47 |

## XIII-C. SHIP OPERATION

The course in Ship Operation is intended for students who wish to enter the fields of shipping administration and ship management or to engage in other maritime pursuits such as port administration, 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 course in Business and 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 shipowning 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 shipowner 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 Ship Operation.

## XIII-C. SHIP OPERATION

**FIRST YEAR.** See page 76

### SECOND YEAR

*First Term*

| | | |
|---|---|---|
| 2.00 | Applied Kinematics | 5 – 3 |
| 8·03 | Physics | 5 – 5 |
| 13·50 | Marine Engineering | 2 – 1 |
| E21 | English and History | 3 – 5 |
| Ec21 | Political Economy | 3 – 5 |
| M21 | Calculus | 3 – 6 |
| MS21 | Military Science | 3 – 0 |
| | Units of exercise and preparation: | 24 – 25 |

*Second Term*

| | | |
|---|---|---|
| 2·15 | Applied Mechanics | 3 – 5 |
| 2·901 | Forging | 2 – 0 |
| 8·04 | Physics | 6 – 4 |
| 13·32 | Ship Construction | 2 – 2 |
| E22 | English and History | 3 – 5 |
| Ec37 | Banking | 3 – 4 |
| Ec50 | Accounting | 4 – 2 |
| MS22 | Military Science | 3 – 0 |
| | Units of exercise and preparation: | 26 – 22 |

### THIRD YEAR

*First Term*

| | | |
|---|---|---|
| 2·20 | Applied Mechanics | 3 – 6 |
| 2·40 | Eng. Thermodynamics | 4 – 5 |
| 13·011 | Naval Architecture | 2 – 2 |
| 13·33 | Ship Construction | 2 – 2 |
| 13·83 | Terminal Facilities | 3 – 3 |
| E33 | Report Writing | 2 – 2 |
| Ec56 | Corporations | 3 – 6 |
| Ec65 | Statistics | 2 – 2 |
| | Units of exercise and preparation: | 21 – 28 |

*Second Term*

| | | |
|---|---|---|
| 2·30 | Materials of Engineering | 2 – 2 |
| 2·36 | Testing Materials Lab | 2 – 1 |
| 2·42 | Eng. Thermodynamics | 4 – 5 |
| 2·611 | Engineering Lab. | 2 – 1 |
| 13·021 | Naval Architecture | 2 – 2 |
| 13·51 | Marine Engineering | 2 – 3 |
| 13·72 | Marine Diesel Engines | 2 – 2 |
| Ec57 | Corp. Finance and Invest. | 3 – 6 |
| Ec80 | Shipping Admin. | 2 – 4 |
| | General Study | 2 – 2 |
| | Units of exercise and preparation: | 23 – 28 |

### FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 2·612 | Engineering Lab | 2 – 2 |
| 6·40 | Electrical Eng. Elem. | 4 – 6 |
| 13·47 | Ship Design | 6 – 0 |
| 13·56 | Marine Engineering | 2 – 3 |
| 13·81 | Ship Operation | 2 – 3 |
| Ec51 | Industrial Accounting | 4 – 4 |
| Ec61 | Business Law | 3 – 3 |
| Ec65 | Statistics | 2 – 2 |
| | Units of exercise and preparation: | 25 – 23 |

*Second Term*

| | | |
|---|---|---|
| 2.30 | Materials of Engineering | 2 – 2 |
| 2·36 | Testing Materials Lab | 2 – 1 |
| 2·961 | Machine Tool Lab. | 2 – 0 |
| 5·35 | Applied Chemistry | 1 – 2 |
| 6·89 | Electrical Eng. Lab. | 2 – 2 |
| 13·66 | Marine Engineering Des. | 2 – 0 |
| 13·82 | Ship Operation | 3 – 4 |
| Ec46 | Industrial Relations | 3 – 5 |
| Ec62 | Business Law | 3 – 3 |
| | Thesis | 7 |
| | General Study | 2 – 2 |
| | Units of exercise and preparation: | 50 |

## XIII-A. NAVAL CONSTRUCTION

### Course for Naval Constructors

The Department of Naval Architecture and Marine Engineering offers to United States Naval Constructors a graduate course (XIII-A) of prescribed studies extending over two years, leading to the degree of Master of Science in Naval Construction. The complete curriculum is given below.

### SENIOR YEAR

*First Term*

| | | |
|---|---|---|
| 13·01 | Naval Architecture | 2–2 |
| 13·11 | Th. of Warship Des. | 4–6 |
| 13·21 | Warship Design | 8–0 |
| 13·58 | Marine Engineering | 3–4 |
| Ec35 | Political Economy | 3–5 |
| Ec61 | Business Law | 3–3 |
| L13 | German, Elementary | 4–8 |
| | Units of exercise and preparation: | 27–28 |

*Second Term*

| | | |
|---|---|---|
| 2·48 | Internal Comb. Eng. | 1–2 |
| 13·02 | Naval Architecture | 2–2 |
| 13·12 | Th. of Warship Des. | 4–4 |
| 13·22 | Warship Design | 8–0 |
| 13·37 | Merchant Shipbuilding | 2–2 |
| 13·39 | Shipyard Practice | 2–2 |
| 13·48 | Model Making | 2–0 |
| 13·64 | Marine Eng. Design | 4–0 |
| 13·70 | Steam Turbines | 2–3 |
| M38 | Calculus, Advanced | 3–6 |
| | Units of exercise and preparation: | 30–21 |

### GRADUATE YEAR

*First Term*

| | | |
|---|---|---|
| 1·45 | Structures | 3–6 |
| 2·291 | Theoret. Mechanics | 3–6 |
| 8·07 | Precision of Measure | 1–1 |
| 13·03 | Naval Architecture | 3–3 |
| 13·13 | Th. of Warship Des. | 6–9 |
| 13·23 | Warship Design | 8–0 |
| 16·76 | Aeronautics | 3–2 |
| | Units of exercise and preparation: | 27–27 |

*Second Term*

| | | |
|---|---|---|
| 1·46 | Structural Design | 2–0 |
| 2·292 | Theoret. Mechanics | 3–6 |
| 13·14 | Th. of Warship Des. | 5–6 |
| 13·24 | Warship Design | 10–0 |
| 16·78 | Aeronautics | 3–5 |
| | Thesis | 13 |
| | Units of exercise and preparation: | 53 |

## XIV. ELECTROCHEMICAL ENGINEERING

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

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

Throughout the third year the principles of electrochemical and chemical phenomena are discussed both from the kinetic and thermodynamic points of view. The application of these principles to electrochemical processes is continued in the first term of the fourth year, the classroom work being accompanied by extended laboratory practice in electrochemical measurements. In the second term this work is concluded by a course in applied electrochemistry including electrodeposition, accumulators, electric furnaces and their products, electrolytic processes and electrometallurgy, and by work in the laboratory in applied electrochemistry. Related to the work in electrometallurgy are courses in the examination of metals and alloys by the methods of metallography and X-ray analysis. 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.

In the fourth year a wide range of elective studies is allowed in the field of physics, chemistry, mathematics, metallurgy, electrical engineering, etc., to meet the needs of those who desire to specialize along particular lines of work.

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

# XIV. ELECTROCHEMICAL ENGINEERING

**FIRST YEAR.** See page 76

**Required during Summer 1932 (Following First Year)**

5·10 Qualitative Analysis....... 14–4

## SECOND YEAR

*First Term*

| | | |
|---|---|---|
| 2·96 | Machine Tool Lab....... | 3–0 |
| 5·12 | Quantitative Analysis.... | 7–2 |
| 8·03 | Physics................ | 5–5 |
| E21 | English and History..... | 3–5 |
| M21 | Calculus............... | 3–6 |
| MS21 | Military Science......... | 3–0 |
| | Language............. | 3–5 |
| | Units of exercise and preparation: | 27–23 |

*Second Term*

| | | |
|---|---|---|
| 5·31 | Gas Analysis........... | 1–1 |
| 6·00 | Electrical Eng., Prin..... | 5–4 |
| 8·04 | Physics................ | 6–4 |
| E22 | English and History..... | 3–5 |
| M22 | Differential Equations.... | 3–6 |
| MS22 | Military Science........ | 3–0 |
| | Language............. | 3–5 |
| | Units of exercise and preparation: | 24–25 |

## THIRD YEAR

*First Term*

| | | |
|---|---|---|
| 5·41 | Organic Chemistry....... | 4–3 |
| 5·418 | Organic Chemical Lab.... | 6–0 |
| 6·01 | Electrical Eng., Prin...... | 3–4 |
| 6·81 | Electrical Eng. Lab....... | 3–2 |
| 8·12 | Heat Measurements...... | 3–1 |
| 8·801 | Electrochemistry, Prin..... | 4–6 |
| Ec31 | Political Economy........ | 3–3 |
| | General Study.......... | 2–2 |
| | Units of exercise and preparation: | 28–21 |

*Second Term*

| | | |
|---|---|---|
| 6·02 | Electrical Eng., Prin....... | 5–6 |
| 6·82 | Electrical Eng. Lab....... | 3–2 |
| 8·201 | Elec. and Electronics..... | 3–5 |
| 8·202 | Electronic Lab.......... | 3–2 |
| 8·802 | Electrochemistry........ | 3–6 |
| Ec32 | Political Economy........ | 3–3 |
| | General Study.......... | 2–2 |
| | Units of exercise and preparation: | 22–26 |

## FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 3·61 | Metallography.......... | 4–1 |
| 6·09 | Electrical Eng., Prin...... | 3–6 |
| 6·83 | Electrical Eng. Lab....... | 3–2 |
| 8·07 | Precision of Measure...... | 1–1 |
| 8·82 | Electrochemistry, Prin..... | 2–4 |
| 8·851 | App. Electrochemistry.... | 1–1 |
| 8·86 | Electrochemical Lab...... | 5–1 |
| 8·871 | App. Electrochem. Lab.... | 2–1 |
| | Thesis................. | 1 |
| | Elective............... | 7 |
| | General Study.......... | 2–2 |
| | Units of exercise and preparation: | 50 |

*Second Term*

| | | |
|---|---|---|
| 3·656 | X-Ray Metallography.... | 3–3 |
| 8·852 | App. Electrochemistry.... | 2–4 |
| 8·872 | App. Electrochem. Lab.... | 2–1 |
| 8·93 | Colloquium............. | 1–1 |
| | Thesis................. | 15 |
| | Elective............... | 14 |
| | General Study.......... | 2–2 |
| | Units of exercise and preparation: | 50 |

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 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
# BUSINESS AND ENGINEERING ADMINISTRATION

The course in Business and Engineering Administration provides training for men who expect ultimately to undertake the management of such manufacturing, commercial or financial enterprises as demand a knowledge of scientific and engineering principles. Consideration of economic theory and business functions and their relationship in industry, is combined with instruction in general engineering. Problem courses in production, distribution, finance, accounting, economics, statistics, labor relations, business law, and industrial policy, are used to develop the breadth of outlook essential to the successful administrator. These subjects follow preliminary training in the fundamental sciences of physics, chemistry and mathematics which serves to establish habits of precise thinking and accurate observation. In addition, the student elects a field of engineering in which he gains understanding of technical principles and processes. Further requirements in language, literature, English composition, report writing and cultural electives serve to develop the student's powers of expression and appreciation.

The objectives of the course may best be illustrated by a brief description of certain of the more important subjects. Executive problems of Production and Distribution are presented by the case method, classroom exercises being in the nature of business conferences. The production and marketing aspects of a given topic are considered simultaneously. This develops a coördinated or administrative viewpoint in analyzing business problems. In the field of Finance, banking is considered from the standpoint of the business executive who as a customer makes use of banking facilities. The study of the financial organization of the corporation and its operating responsibilities relating to income, surplus and expansion emphasize the problems of the individual establishment, while the treatment of securities and investments brings to the classroom the tested experience of coöperating lecturers from investment houses and banks. The instruction in Accounting is designed to provide future executives with an analytical instrument of control, rather than to train bookkeepers or professional accountants. In like manner, instruction in Business Law marks those areas of business relationships in which the executive may employ preventive rather than curative legal service. The study of Industrial Relations affords a broad grasp of trends in the fields of labor. In the study of the technique of executive control consideration is given to typical executive difficulties in the management of men.

The student in this course is offered a choice of engineering studies, classified under two options: (1) Engineering
(2) Chemistry.

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

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

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

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

In Option 2 (Chemical Engineering) students receive instruction in the important branches of chemistry and chemical engineering. The primary purpose of the option is to train men for ultimate administrative positions rather than for technical research or process control. The option meets the needs of students planning to enter the paper, leather, rubber, fertilizer, or other chemical industries.

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

* For men interested in shipping administration, ship management and other branches of marine transportation the Institute offers a course in Ship Operation (XIII-C) which closely parallels the course in Business and Engineering Administration. A description of this course together with the schedule of studies will be found on pages 128-129.

# XV
# BUSINESS AND ENGINEERING ADMINISTRATION

### Option 1. Engineering

FIRST YEAR. See page 76

### SECOND YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 2·00 | Applied Kinematics | 5 –3 | 2·15 | Applied Mechanics | 3 –5 |
| 8·03 | Physics | 5 –5 | 8·04 | Physics | 6 –4 |
| Ec21 | Political Economy | 3 –5 | Ec37 | Banking | 3 –4 |
| Ec65 | Statistics | 2 –2 | Ec50 | Accounting | 4 –2 |
| E21 | English and History | 3 –5 | E22 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 | M22 | Differential Equations | 3 –6 |
| MS21 | Military Science | 3 –0 | MS22 | Military Science | 3 –0 |
| Units of exercise and preparation: | | 24 –26 | Units of exercise and preparation: | | 25 –26 |

### Required during Summer, 1932

**Group (a) Civil Engineering. At Camp Technology**

| | | |
|---|---|---|
| 1·041 | Surveying | 12 –1 |
| 1·20 | Railway Fieldwork | 5 –0 |
| 1·60 | Hydrographic Surveying | 5 –0 |

**Group (b) Mechanical and Electrical Engineering. At M. I. T.**

| | | |
|---|---|---|
| 2·901 | Forging | 2 –0 |
| 2·91 | Foundry | 3 –0 |
| 2·971 | Machine Tool Lab | 3 –0 |

**Group (c) Industrial Practice. At M. I. T.**

| | | |
|---|---|---|
| 1·02 | Surveying | 2 –2 |
| 2·91 | Foundry | 3 –0 |
| 2·951 | Machine Tool Laboratory | 6 –0 |

## XV. BUSINESS AND ENGINEERING ADMINISTRATION — *Continued*

### THIRD YEAR

#### Option 1. Engineering

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| 2·20 | Applied Mechanics | 3–6 | 2·30 | Materials of Engineering | 2–2 |
| 2·46 | Heat Engineering | 4–7 | 2·47 | Heat Engineering | 2–3 |
| 8·07 | Precision of Meas. | 1–1 | 6·89 | Elec. Eng. Lab. | 2–2 |
| Ec56 | Corporations | 3–6 | Ec57 | Corp. Finance & Invest. | 3–6 |
| E33 | Report Writing | 2–2 | Ec70 | Business Management | 4–4 |
| | Group Subjects* | | | General Study | 2–2 |
| | | | | Group Subjects* | |

#### *Group (a) Civil Engineering

| | | | | | |
|---|---|---|---|---|---|
| 1·211 | Railway and High Eng. | 1–3 | 1·22 | Railway and High. Eng. | 2–2 |
| 6·40 | Electrical Eng. Elem. | 4–6 | 1·40 | Structures | 3–5 |
| | | | 2·36 | Testing Materials Lab. | 2–1 |

#### *Group (b) Mechanical and Electrical Engineering

| | | | | | |
|---|---|---|---|---|---|
| 2·12 | Machine Drawing | 6–0 | 1·02 | Surveying | 2–2 |
| 2·972 | Machine Tool Lab. | 3–0 | 6·40 | Electrical Eng. Elem. | 4–6 |
| | General Study | 2–2 | | | |

#### *Group (c) Industrial Practice

| | | | | | |
|---|---|---|---|---|---|
| 6·40 | Electrical Eng. Elem. | 4–6 | 1·63 | Hydraulics | 2–3 |
| | General Study | 2–2 | 2·12 | Machine Drawing | 6–0 |
| | | | 2·36 | Testing Materials Lab. | 2–1 |

#### Required during Summer 1932 (Group 1c only)

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

# XV. BUSINESS AND ENGINEERING ADMINISTRATION — *Continued*

## FOURTH YEAR

### Option 1. Engineering

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| Ec51 | Industrial Accounting..... | 4 – 4 | Ec46 | Industrial Relations...... | 3 – 5 |
| Ec61 | Business Law............ | 3 – 3 | Ec62 | Business Law............ | 3 – 3 |
| Ec71 | Business Management.... | 4 – 6 | Ec72 | Business Management.... | 4 – 6 |
| Ec98 | Ind. Research Methods ... | 1 – 1 | | Thesis.................. | 6 |
| | Group Subjects*......... | | | Group Subjects*......... | |

### *Group (a) Civil Engineering

| | | | | | |
|---|---|---|---|---|---|
| 1·25 | Eng. Const. and Estim.... | 2 – 3 | 1·421 | Structures............... | 2 – 4 |
| 1·41 | Structures............... | 4 – 8 | 1·54 | Structural Design........ | 4 – 0 |
| 1·48 | Foundations............. | 3 – 4 | 1·63 | Hydraulics.............. | 2 – 3 |
| | | | | General Study........... | 2 – 2 |

### *Group (b) Mechanical and Electrical Engineering

| | | | | | |
|---|---|---|---|---|---|
| 1·63 | Hydraulics.............. | 2 – 3 | 2·615 | Engineering Laboratory... | 2 – 2 |
| 2·36 | Testing Materials Lab.... | 2 – 1 | 6·43 | Gen. & Dis. of Elec. Energy | 4 – 6 |
| 2·614 | Engineering Lab.. ........ | 4 – 3 | | Professional Elective...... | 2 – 2 |
| 2·721 | Machine Design......... | 4 – 0 | | | |
| | Professional Elective...... | 2 – 2 | | | |

#### *Professional Electives*

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 1·64 | Hydraulics ............. | 3 – 6 | 2·58 | Power Plant Design ..... | 4 – 0 |
| 3·61 | Metallography ......... | 4 – 1 | 2·722 | Machine Design ........ | 4 – 0 |
| 5·38 | Lubricating & Fuel Oil Test | 3 – 1 | 2·851 | Fire Protection Eng. .... | 2 – 2 |
| 5·683 | Physical Chemistry..... | 2 – 2 | 2·854 | Mech. Equip. Bldgs. .... | 2 – 2 |
| 16·76 | Aeronautics ............ | 3 – 1 | 2·858 | Inspection Methods ..... | 2 – 2 |
| | | | 5·843 | Engineering Chemistry .. | 2 – 2 |

### *Group (c) Industrial Practice

| | | | | | |
|---|---|---|---|---|---|
| 2·62 | Engineering Lab.......... | 4 – 2 | Ec99 | Industrial Problems...... | 2 – 4 |
| | Approved Subjects†...... | 18 | | Approved Subjects†...... | 10 |

† The engineering subjects must form a coördinated program and be approved by the registration officer. They may be selected from such fields as:

| | |
|---|---|
| Automotive | Metal Working |
| Textile | Refrigeration |

# XV. BUSINESS AND ENGINEERING ADMINISTRATION — *Continued*

## Option 2. Chemical Engineering

### FIRST YEAR. See page 76

**Required during Summer 1932 (Following First Year)**

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

### SECOND YEAR

*First Term*

| | | |
|---|---|---|
| 5·12 | Quantitative Analysis.... | 7 –2 |
| 8·03 | Physics................ | 5 –5 |
| Ec21 | Political Economy....... | 3 –5 |
| Ec65 | Statistics.............. | 2 –2 |
| E21 | English and History..... | 3 –5 |
| M21 | Calculus................ | 3 –6 |
| MS21 | Military Science......... | 3 –0 |
| | Units of exercise and preparation: | 26 –25 |

*Second Term*

| | | |
|---|---|---|
| 2·00 | Applied Kinematics...... | 5 –3 |
| 5·13 | Quantitative Analysis.... | 7 –2 |
| 8·04 | Physics................ | 6 –4 |
| Ec37 | Banking............... | 3 –4 |
| Ec50 | Accounting............. | 4 –2 |
| E22 | English and History..... | 3 –5 |
| MS22 | Military Science........ | 3 –0 |
| | Units of exercise and preparation: | 31 –20 |

### THIRD YEAR

*First Term*

| | | |
|---|---|---|
| 2·40 | Eng. Thermodynamics... | 4 –5 |
| 5·41 | Organic Chemistry...... | 4 –3 |
| 5·416 | Org. Chem. Lab......... | 9 –0 |
| 5·611 | Physical Chem., Elem.... | 4 –4 |
| 8·07 | Pr. of Measurements..... | 1 –1 |
| Ec56 | Corporations........... | 3 –6 |
| E33 | Report Writing......... | 2 –2 |
| | Units of exercise and preparation: | 27 –21 |

*Second Term*

| | | |
|---|---|---|
| 2·42 | Eng. Thermodynamics... | 4 –5 |
| 6·40 | Electrical Eng. Elem..... | 4 –6 |
| 6·89 | Electrical Eng. Lab...... | 2 –2 |
| 10·201 | Industrial Chemistry..... | 4 –4 |
| Ec57 | Corp. Finance and Inv. .. | 3 –6 |
| Ec70 | Business Management... | 4 –4 |
| | Units of exercise and preparation: | 21 –27 |

### FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 10·21 | Industrial Chemistry...... | 2 –2 |
| 10·26 | Industrial Chem. Lab..... | 5 –1 |
| 10·31 | Chemical Engineering..... | 5 –4 |
| Ec51 | Industrial Accounting..... | 4 –4 |
| Ec61 | Business Law............ | 3 –3 |
| Ec71 | Business Management.... | 4 –6 |
| Ec98 | Ind. Res. Methods....... | 1 –1 |
| | General Study............ | 2 –2 |
| | Units of exercise and preparation: | 26 –23 |

*Second Term*

| | | |
|---|---|---|
| 2·62 | Engineering Lab......... | 4 –2 |
| 10·32 | Chemical Engineering..... | 5 –4 |
| Ec46 | Industrial Relations...... | 3 –5 |
| Ec62 | Business Law............ | 3 –3 |
| Ec72 | Business Management.... | 4 –6 |
| | Thesis.................. | 6 |
| | General Study........... | 2 –2 |
| | Units of exercise and preparation: | 49 |

## XVI. AERONAUTICAL ENGINEERING

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

In general, the professional subjects are directed particularly toward airplane design, but in order that the student may gain some knowledge of other branches of aeronautical activity, he is allowed to elect in the fourth year certain subjects in some related professional field. In this connection attention is invited to the option in Air Transportation with special reference to the construction of airports and airways, given in the Department of Civil Engineering, and to the fact that the Automotive or Engine Design options in Mechanical Engineering furnish excellent preparation for later specialization in aircraft engine design. Attention is also invited to the work preparatory to graduate specialization in Meteorology, offered by the Department of Physics.

Owing to the fact that the number of applicants for Course XVI often greatly exceeds the facilities available for instruction, the Course in Aeronautical Engineering reserves the right to limit the number of students in each class. Applications will be received during the second term of the first year, and notifications of admission or refusal will be issued shortly after the spring examinations. Toward the end of the second year, a limited number of additional applications will be considered. Students whose work has been unsatisfactory may be required to withdraw from the course at any time in favor of better qualified men. Students not enrolled in the Course are admitted to aeronautical subjects only when facilities permit and if their records are good.

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

The professional work of the fourth year presupposes preparation in theoretical and applied aerodynamics and structures (M43, M44, 16·00 and 1·401). *These are offered during the summer session for transferring students who are otherwise prepared for fourth year work.*

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

# XVI. AERONAUTICAL ENGINEERING

**FIRST YEAR.** See page 76

## SECOND YEAR

*First Term*

| | | |
|---|---|---|
| 2·00 | Applied Kinematics | 5 –3 |
| 2·12 | Machine Drawing | 6 –0 |
| 8·03 | Physics | 5 –5 |
| E21 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 |
| MS21 | Military Science | 3 –0 |
| | Language | 2 –4 |
| | Units of exercise and preparation: | 27 –23 |

*Second Term*

| | | |
|---|---|---|
| 2·102 | Mech. Eng. Drawing | 4 –0 |
| 2·15 | Applied Mechanics | 3 –5 |
| 8·04 | Physics | 6 –4 |
| E22 | English and History | 3 –5 |
| M22 | Differential Equations | 3 –6 |
| MS22 | Military Science | 3 –0 |
| | Language | 2 –4 |
| | Units of exercise and preparation: | 24 –24 |

**Required during Summer 1932**

| | | |
|---|---|---|
| 16·52 | Airplane Shopwork | 8 –2 |
| 16·53 | Aircraft Prod. Methods | 7 –2 |

## THIRD YEAR

*First Term*

| | | |
|---|---|---|
| 2·20 | Applied Mechanics | 3 –6 |
| 2·30 | Materials of Eng | 2 –2 |
| 2·40 | Eng. Thermodynamics | 4 –5 |
| 5·683 | Phys. Chemistry | 2 –2 |
| M43 | Theoret. Aeronautics | 6 –4 |
| | General Study | 2 –2 |
| | Language | 3 –5 |
| | Units of exercise and preparation: | 22 –26 |

*Second Term*

| | | |
|---|---|---|
| 1·401 | Structures | 3 –5 |
| 2·35 | Testing Materials Lab | 4 –2 |
| 2·42 | Eng. Thermodynamics | 4 –5 |
| 2·611 | Eng. Laboratory | 2 –1 |
| 16·00 | Aerodyn. Airplane Des | 3 –3 |
| M44 | Theoret. Aeronautics | 6 –4 |
| | Language | 3 –5 |
| | Units of exercise and preparation: | 24 –25 |

## FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 6·40 | Electrical Eng. Elem | 4 –6 |
| 6·85 | Electrical Eng. Lab | 2 –3 |
| 16·01 | Aerodyn. of Airplane Des. | 4 –4 |
| 16·02 | Aircraft Structures | 2 –2 |
| 16·11 | Airplane Des. Prac | 4 –0 |
| 16·32 | Aeronautical Lab | 4 –3 |
| Ec31 | Political Economy | 3 –3 |
| | Elective | 2 –2 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 27 –25 |

*Second Term*

| | | |
|---|---|---|
| 2·251 | (*a*) Dynamics of Mach | 2 –4 |
| 16·05 | (*b*) Airplane Structures | 3 –3 |
| 16·12 | Airplane Des. Prac | 4 –0 |
| 16·55 | Airplane Design | 7 –2 |
| Ec32 | Political Economy | 3 –3 |
| | General Study | 2 –2 |
| | Elective | 12 |
| | Thesis | 9 |
| | Units of exercise and preparation: | 50 |

*Electives* (First Term)

| | | |
|---|---|---|
| 10·79 | Automotive Fuels | 3 –3 |
| 16·12 | Airplane Des. Practice | 4 –0 |
| | General Study | 2 –2 |

*Electives* (Second Term)

| | | |
|---|---|---|
| 16·08 | Airplane Design Prob | 6 –6 |
| 16·44 | Com. Oper. of Aircraft | 3 –6 |
| 16·63 | Aero. Lab. & Res. Meth | 4 –2 |
| 16·83 | Airplane Engines | 6 –6 |
| 16·90 | Meteorology, Int | 2 –2 |

Other subjects may be selected with approval of Registration Officer.

## XVII. BUILDING CONSTRUCTION

This course is planned to supply trained men to the building industry and its allied industries, who may be expected to contribute to the solution of the many problems that confront these industries, in reducing wastes, introducing new economies and new methods and in setting up a better system of building economics. The course may be described as the interpretation of the science of materials to the art of building.

It provides the usual fundamentals associated with a sound engineering training, in addition to which it lays particular emphasis upon materials and the manner in which they are assembled, according to what is known as the best practice in buildings of wood, timber, reinforced concrete and steel.

Courses are also given in building finance, building management, accounting, quantity surveying and appraisement, superintendence, business and industrial relations, and the history of construction.

The course provides the basic training for graduate work in materials; the economics of building and town planning; management and maintenance of buildings; and in general building and associated industries.

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

# XVII. BUILDING CONSTRUCTION

**FIRST YEAR.** See page 76

## SECOND YEAR

*First Term*

| | | |
|---|---|---|
| 2·00 | Applied Kinematics | 5 –3 |
| 5·844 | Eng. Chemistry | 5 –1 |
| 8·03 | Physics | 5 –5 |
| 17·21 | Building Construction | 5 –1 |
| E21 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 |
| MS21 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 29 –21 |

*Second Term*

| | | |
|---|---|---|
| 2·15 | Applied Mechanics | 3 –5 |
| 8·04 | Physics | 6 –4 |
| 17·20 | History of Construction | 3 –0 |
| 17·22 | Building Construction | 5 –1 |
| 17·73 | Materials | 2 –1 |
| E22 | English and History | 3 –5 |
| M22 | Differential Equations | 3 –6 |
| MS22 | Military Science | 3 –0 |
| | Units of exercise and preparation: | 28 –22 |

**Required during Summer 1932. At Camp Technology***

| | | |
|---|---|---|
| 1·042 | Surveying | 11 –1 |
| 17·65 | Quantity Surveying and Estimating | 11 –0 |

## THIRD YEAR

*First Term*

| | | |
|---|---|---|
| 2·20 | Applied Mechanics | 3 –6 |
| 2·46 | Heat Engineering | 4 –7 |
| 6·40 | Electrical Eng., Elem. | 4 –6 |
| 17·31 | Building Construction | 5 –1 |
| 17·51 | Structural Analysis | 4 –2 |
| Ec21 | Political Economy | 3 –5 |
| | Units of exercise and preparation: | 23 –27 |

*Second Term*

| | | |
|---|---|---|
| 1·40 | Structures | 3 –5 |
| 1·63 | Hydraulics | 2 –3 |
| 2·47 | Heat Engineering | 2 –3 |
| 6·48 | Elec. Equip. of Bldgs. | 1 –2 |
| 6·89 | Electrical Eng. Lab. | 2 –2 |
| 12·49 | Geology | 2 –2 |
| 17·52 | Structural Analysis | 5 –2 |
| 17·74 | Materials | 2 –2 |
| Ec50 | Accounting | 4 –2 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 25 –25 |

## FOURTH YEAR

*First Term*

| | | |
|---|---|---|
| 1·472 | Struct. Theory and Des. | 5 –6 |
| 1·48 | Foundations | 3 –4 |
| 2·36 | Testing Materials Lab. | 2 –1 |
| 2·363 | Test. Mat. Lab. (Con.) | 2 –0 |
| 17·41 | Building Construction | 15 –0 |
| Ec53 | Building Finance | 3 –6 |
| | Units of exercise and preparation: | 30 –17 |

*Second Term*

| | | |
|---|---|---|
| 1·021 | Surveying | 4 –1 |
| 1·473 | Struct. Theory and Des. | 5 –6 |
| 2·59 | Mech. Equip. of Bldgs. | 4 –3 |
| 17·42 | Building Construction | 14 –0 |
| 17·50 | Job Management | 1 –1 |
| | Thesis | 7 |
| | General Study | 2 –2 |
| | Units of exercise and preparation: | 50 |

* See special camp circular.

# XVIII. MATHEMATICS

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

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

In the second year the student may choose between the kinetics and applied mechanics common to the engineering group of courses, and the chemistry required in the chemical group. Any student who has completed satisfactorily the work of the first two years in any of the professional courses in the Institute or their equivalent, provided always that a creditable record has been obtained in mathematics and physics, may be admitted to the third year in this course. Such a student will have to make up the course in Higher Algebra and Geometry, but extra work done in the second year will be credited to him in place of elective work of the third year.

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. In all cases he should present a consistent choice of elective subjects with the approval of the department.

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

# XVIII. MATHEMATICS

**FIRST YEAR.** See page 76

## SECOND YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 8·03 | Physics | 5 –5 | 8·04 | Physics | 6 –4 |
| E21 | English and History | 3 –5 | E22 | English and History | 3 –5 |
| M21 | Calculus | 3 –6 | M22 | Differential Equations | 3 –6 |
| M23 | Higher Algebra and Geom. | 3 –6 | M23 | Higher Algebra and Geom. | 3 –6 |
| MS21 | Military Science | 3 –0 | MS22 | Military Science | 3 –0 |
| | Elective | 9 | | Elective | 9 |
| Units of exercise and preparation: | | 48 | Units of exercise and preparation: | | 48 |

## THIRD YEAR

| First Term | | | Second Term | | |
|---|---|---|---|---|---|
| 8·461 | Int. to Theoret. Physics | 4 –8 | 8·462 | Int. to Theoret. Physics | 4 –8 |
| Ec31 | Political Economy | 3 –3 | Ec32 | Political Economy | 3 –3 |
| | Mathematical Elective | 3 –6 | | Mathematical Elective | 3 –6 |
| | Elective | 17 | | Elective | 17 |
| | 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 | | |
|---|---|---|---|---|---|
| M26 | Least Squares and Prob. | 2 –2 | M54 | Mathematical Lab. | 3 –9 |
| | Elective and Thesis | 40 | | Elective and Thesis | 36 |
| | General Study | 2 –2 | | | |
| Units of exercise and preparation: | | 48 | Units of exercise and preparation: | | 48 |

# 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.

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

Changes in this schedule may be made to suit the special needs of officers when such changes have been approved by the Faculty.

**Required during Summer 1932 Preceding the Academic Year**

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

## FOURTH YEAR

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| 1·25 | Eng. Const. and Estim. | 2 –3 | 1·42 | Structures | 4 –8 |
| 1·41 | Structures | 4 –8 | 2·36 | Testing Materials Lab. | 2 –1 |
| 1·581 | Reinf. Concrete Des. | 6 –2 | 2·395 | Con. Bldg., Des. and Spec. | 2 –4 |
| 2·30 | Materials of Eng. | 2 –2 | 2·631 | Eng. and Hyd. Lab. | 3 –3 |
| 2·363 | Testing Mat. Lab. (Con.). | 2 –0 | 3·711 | Heat Treatment | 2 –0 |
| 5·683 | Physical Chemistry | 2 –2 | 6·21 | Ind. App. Elec. Power | 3 –6 |
| 6·40 | Electrical Eng., Elem. | 4 –6 | 6·85 | Electrical Eng. Lab. | 2 –3 |
| 7·31 | Bacteriology | 2 –2 | 7·57 | Municipal Sanitation | 4 –4 |
| | Thesis | 3 | | Thesis | 6 |
| Units of exercise and preparation: | | 52 | Units of exercise and preparation: | | 57 |

## UNDERGRADUATE SCHEDULES FOR RESERVE OFFICERS' TRAINING CORPS

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

## BASIC COURSE

All physically fit male students who are citizens of the United States under twenty-eight years of age and who enter the Institute as first-year students, are required to complete satisfactorily the entire basic course. Similarly qualified students who enter in the second year are required to complete the second year of the basic course. Students who have received instruction in the R. O. T. C. at another institution under an officer of the Army will receive credit therefor upon presentation of suitable evidence to the Professor of Military Science and Tactics.

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

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

**First Year**

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

**Second Year**

| | | | | | |
|---|---|---|---|---|---|
| MS21. | Military map reading, field engineering and basic military subjects | 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 materiel | 3 –0 |
| | | | MS225. | Air Corps Unit: Tactics and communications | 3 –0 |
| | | | MS226. | Chemical Warfare Unit: Elements of chemical warfare training | 3 –0 |

## ADVANCED COURSE

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

The course is open to students who have satisfactorily completed two years in the basic course at this Institute or elsewhere, who are acceptable to the Professor of Military Science and Tactics, and who have received the approval of the professor in charge of the course in which they are registered. A student enrolled in the advanced course receives commutation of uniform at the rate of thirty dollars for the first year and ten dollars for the second year and commutation of subsistence at the rate of thirty cents per day from date of enrollment until the end of the second Institute year thereafter, including one summer vacation, except for the period of the R. O. T. C. camp, when he will be subsisted by the Government. To enroll, he must execute a contract to continue the course of instruction for two years, should he remain that length of time at the Institute, and the fulfillment of this contract then becomes a prerequisite for graduation. The contract includes the obligation to attend a six weeks' R. O. T. C. camp, normally during June and July following the first year of the advanced course, at which all expenses, including transportation, are paid by the Government. In very exceptional cases, attendance at camp may be postponed until after the senior year, but only upon the express agreement that the student's diploma will be withheld until after the completion of the R. O. T. C. camp.

*Students in the advanced course are required to elect G3, International Law and American Foreign Policy, and G98, Military History and Policy of the United States, as two of their General Studies.* (Students in Courses VI-A, XIII-A, XIII-C, XV and XVII are excused from the requirement in G3.) Students in the advanced course are also required to register for MS31, MS32, MS41 and MS42 at one of the hours prescribed for MS11 or MS12.

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

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

## COAST ARTILLERY UNIT

Open to students in all courses. Students whose Institute courses do not include surveying and who are unable to demonstrate proficiency in this subject will be required to take one of the Institute Surveying subjects. Omissions and other approved changes in course schedules are noted below under the number of the course.

### Third Year

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| MS31. | Drill and command..... | 1–0 | MS32. | Drill and command..... | 1–0 |
| MS311. | Fire control and gunnery for heavy artillery...... | 3–2 | MS321. | Fire control and gunnery for anti-aircraft artillery. | 3–2 |

### Fourth Year

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| MS41. | Drill and command..... | 1–0 | MS42. | Drill and command..... | 1–0 |
| MS411. | Artillery materiel; organization, administration, and duties of the Coast Artillery Corps......... | 2–1 | MS421. | Tactical employment of anti-aircraft and heavy artillery............... | 2–1 |

## ENGINEER UNIT

Open only to students in Courses I, II, III, IV, IV-A, VI, VI-A, VII, IX-B, XI, XII, XIII-C, XV$_1$, XVI, and XVII. Except in MS41 and MS42, instruction in the fourth year is given by Institute personnel. Approved changes in course schedules are noted below under the number of the course.

### Third Year

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| MS31. | Drill and command..... | 1–0 | MS32. | Drill and command..... | 1–0 |
| MS312. | Organization, administration, and duties of the Corps of Engineers...... | 3–3 | MS322. | Fortifications; military roads and bridges; engineer combat principles; military law........... | 3–3 |

### Fourth Year

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| MS41. | Drill and command..... | 1–0 | MS42. | Drill and command..... | 1–0 |

## SIGNAL UNIT

Open only to students in Courses VI, VI-A, VI-C, VIII, IX-B, XIV, and XV$_1$b. Except in MS41 and MS42, instruction in the fourth year is given by Institute personnel. Approved changes in course schedules are noted below under the number of the course.

### Third Year

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| MS31. | Drill and command..... | 1–0 | MS32. | Drill and command..... | 1–0 |
| MS313. | Signal Corps tactics; codes and ciphers; organization and equipment; military law........... | 3–3 | MS323. | Military telegraphy and telephony; radio sets.... | 3–3 |

### Fourth Year

| | *First Term* | | | *Second Term* | |
|---|---|---|---|---|---|
| MS41. | Drill and command..... | 1–0 | MS42. | Drill and command..... | 1–0 |

## ORDNANCE UNIT

Open only to students in Courses II, $III_3$, $III_4$, VI-A, IX-A, X, X-B, XIII, XIV, XV, and XVIII. Except in MS41 and MS42, instruction in the fourth year is given by Institute personnel. Approved changes in course schedules are noted below under the number of the course.

### Third Year

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| MS31. | Drill and command..... | 1 –0 | MS32. | Drill and command..... | 1 –0 |
| MS314. | Organization and duties of the Ordnance Department................. | 1 –1 | MS324. | Organization and duties of the Ordnance Department................. | 1 –1 |

### Fourth Year

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| MS41. | Drill and command..... | 1 –0 | MS42. | Drill and command..... | 1 –0 |

## AIR CORPS UNIT

Open only to students in Course XVI. Except in MS31 and MS42, instruction in first term of third year and second term of fourth year is given by Institute personnel. Approved changes in course schedules are noted below under the number of the course.

### Third Year

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| MS31. | Drill and command..... | 1 –0 | MS32. | Drill and command..... | 1 –0 |
| | | | MS325. | Airplane instruments, aerial navigation, bomb racks, and meteorology.. | 3 –3 |

### Fourth Year

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| MS41. | Drill and command..... | 1 –0 | MS42. | Drill and command..... | 1 –0 |
| MS415. | Pursuit, attack, observation, and bombardment operations; administration and supply........ | 3 –3 | | | |

## CHEMICAL WARFARE UNIT

Open only to students in Courses V, X, X-B, XIV and $XV_2$. Except in the subjects indicated below, instruction is given by Institute personnel. Approved changes in course schedules are noted below under the number of the course.

### Third Year

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| MS31. | Drill and command..... | 1 –0 | MS32. | Drill and command..... | 1 –0 |
| MS316. | Organization, administration, and duties of the Chemical Warfare Service | 2 –2 | MS326. | Tactics and technique of the Chemical Warfare Service............... | 1 –1 |

### Fourth Year

| *First Term* | | | *Second Term* | | |
|---|---|---|---|---|---|
| MS41. | Drill and command..... | 1 –0 | MS42. | Drill and command..... | 1 –0 |

# CHANGES IN COURSE SCHEDULES

The following table shows approved changes in Course Schedules for the various units of the R. O. T. C. Changes shown in italics are required.

| *Course* | *Yr.* | *Tm.* | *Unit* | *Change* | |
|---|---|---|---|---|---|
| II | 3 | 1 | C. A. C.; C. E. | Omit: General Study | 2 – 2 |
| | 3 | 2 | C. A. C.; C. E. | Omit: General Study | 2 – 2 |
| IIG | 4 | 1 | C. A. C. | Omit: Testing Materials Lab. 2·35 | 4 – 2 |
| | | | | Add: Testing Materials Lab. 2·36 | 2 – 1 |
| | 4 | 2 | C. A. C. | Omit: Industrial Plants 2·782 | 4 – 0 |
| | | | O. D. | Omit: Engineering Lab. 2·602 | 4 – 4 |
| | | | | Industrial Plants 2·782 | 4 – 0 |
| | | | | General Study | 2 – 2 |
| | | | | Add: Engineering Lab. 2·603 | 2 – 2 |
| | | | | *Ordnance Engineering* 2·88 | 5 – 3 |
| | | | | Heat Treatment 3·71 | 4 – 2 |
| II | 4 | 1,2 | C. A. C.; O. D. | Applicants must have their schedules approved by the Military Department and by the head of the Department of Mechanical Engineering. | |
| III$_1$ | 3 | 2 | C. A. C.; C. E. | Omit: General Study | 2 – 2 |
| | 4 | 2 | C. A. C. | Omit: General Study | 2 – 2 |
| III$_2$ | 3 | 2 | C. A. C.; C. E. | Omit: General Study | 2 – 2 |
| III$_3$ | 3 | 2 | C. A. C.; C. E. | Omit: General Study | 2 – 2 |
| | 4 | 1 | C. A. C. | Omit: General Study | 2 – 2 |
| | 4 | 2 | C. A. C. | Omit: Elective | 4 |
| V | 3 | 2 | C. W. S. | Omit: Organic Chemical Lab. 5·424 | 13 – 0 |
| | | | | Add: *Study of War Gases* 5·33 | 1 – 1 |
| | | | | Organic Chemical Lab. 5·425 | 9 – 0 |
| | 4 | 2 | C. W. S. | Omit: Elective | 4 |
| | | | | Add: *Powder and Explosives* 5·43 | 2 – 2 |
| VI | 3 | 1 | C. A. C.; C. E.; S. C. | Omit: Political Economy Ec31 | 3 – 3 |
| | 3 | 2 | C. A. C.; C. E.; S. C. | Omit: Political Economy Ec32 | 3 – 3 |
| | 4 | 1 | C. A. C.; C. E. | Omit: Professional Elective | 3 – 6 |
| | | | | Add: Political Economy Ec31 | 3 – 3 |
| | | | S. C. | Omit: Hydraulics 1·64 | 3 – 6 |
| | | | | Add: Political Economy Ec31 | 3 – 3 |
| | | | | Thesis | 2 |
| | 4 | 2 | C. A. C. | Omit: Professional Elective | 3 – 6 |
| | | | | Add: Political Economy Ec32 | 3 – 3 |
| | | | C. E. | Omit: Professional Elective | 3 – 6 |
| | | | | Add: Political Economy Ec32 | 3 – 3 |
| | | | | Thesis | 4 |
| | | | S. C. | Omit: Thesis | 3 |
| | | | | Add: Political Economy Ec32 | 3 – 3 |
| VII$_1$ | 3 | 1 | C. A. C.; C. E. | Omit: General Study | 2 – 2 |
| | 4 | 2 | C. A. C. | Omit: General Study | 2 – 2 |
| VII$_2$ | 3 | 2 | C. A. C.; C. E. | Omit: General Study | 2 – 2 |
| | 4 | 1 | C. A. C. | Omit: Elective | 5 |
| VII$_3$ | 3 | 1 | C. A. C.; C. E. | Omit: General Study | 2 – 2 |
| VIII | 4 | 1 | S. C. | *Include an elective that meets Signal Corps requirements* | 3 – 6 |
| | 4 | 2 | S. C. | *Include an elective that meets Signal Corps requirements* | 3 – 6 |

| *Course* | *Yr.* | *Tm.* | *Units* | *Change* | |
|---|---|---|---|---|---|
| IX-B | 4 | 1 | S. C. | *Include Electrical Communications* 6·301 *or other elective approved by the Signal Unit* | 3 –6 |
| | 4 | 2 | S. C. | *Include Electrical Communications* 6·302 *or other elective approved by the Signal Unit* | 3 –6 |
| X | 3 | 1 | C. A. C.; C. W. S. | Omit: General Study | 2 –2 |
| | 4 | 2 | C. A. C.; O. D.; C. W. S. | Omit: Professional Elective | 4 |
| | | | O. D.; C. W. S. | Add: *Powder and Explosives* 5·43 | 2 –2 |
| XIV | 4 | 1 | C. A. C. | Omit: Elective | 3 |
| | 4 | 2 | C. A. C. | Omit: Elective | 2 |
| | | | C. W. S. | Omit: Elective | 6 |
| | | | | Add: *Study of War Gases* 5·33 | 1 –1 |
| | | | | *Powder and Explosives* 5·43 | 2 –2 |
| XV$_1$a | 3 | 2 | C. A. C.; C. E. | Omit: General Study | 2 –2 |
| XV$_1$b | 3 | 1 | C. A. C.; C. E.; S. C. | Omit: General Study | 2 –2 |
| | 4 | 1 | C. A. C. | Omit: Professional Elective | 2 –2 |
| | 4 | 2 | C. A. C. | Omit: Professional Elective | 2 –2 |
| XV$_1$c | 3 | 1 | C. A. C. | Omit: General Study | 2 –2 |
| | 4 | 1 | C. A. C. | Omit: Elective | 4 |
| | 4 | 2 | C. A. C. | Omit: Elective | 4 |
| XVI | 3 | 1 | C. A. C.; C. E. | Omit: General Study | 2 –2 |
| | 4 | 1 | A. C. | Omit: General Study | 2 –2 |
| XVII | 3 | 2 | C. A. C.; C. E. | Omit: General Study | 2 –2 |

# DESCRIPTION OF SUBJECTS

## I. CIVIL AND SANITARY ENGINEERING

**Subjects 1·00 to 1·99** (see page 75)

**1·00. Surveying.** An elementary course in the theory and practice of plane and topographical surveying. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

**1·01. Surveying and Topographical Drawing.** A course in surveying consisting of fieldwork, computations and the making of scale drawings, profiles, contour maps, and conventional signs for topography, followed by a study of their application to the solution of engineering problems. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

**1·02. Surveying.** A course in elementary surveying. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

**1·021. Surveying.** The theory and practice of plane surveying is taken up in the classroom and is supplemented by problems, including the computation of earthwork. In the field, training is given in the use of the transit, level and tape. Many of the field problems are similar to those met in practice. Especially designed for students taking Building Construction. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

**1·04. Surveying.** At Camp Technology. The field work consists of plane, topographic, hydrographic and elementary railway surveying. Plans and maps are made from notes taken in the field.

This subject satisfies the requirements in surveying for Courses II, $III_3$, IV-A, VI, VI-A, IX-B, $XV_{1b,1c}$. It will not be accepted in place of the work in surveying in Courses I, $VII_2$, XI, $XV_{1a}$, and XVII.

It will not be given unless eight or more students apply. Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vols. I and II.*

**1·041. Surveying.** At Camp Technology. The fieldwork consists of plane and topographic surveying, in which the transit, tape, level and plane table are used, the astronomical determination of the meridian, the adjustment of instruments and many important problems in surveying. Plans and maps are made from notes taken in the field (not accepted in place of 1·05 and 1·06 in Course I). Textbook: *Breed and Hosmer's Principles and Practice of Surveying, Vols. I and II.*

**1·042. Surveying.** At Camp Technology. Lectures, fieldwork and drafting. The theory and practice of plane and topographic surveying is taken up in the classroom and is supplemented by many problems. Field training is given in the use of surveying instruments. Specially designed for students in Course XVII. Textbook: *Principles and Practice of Surveying, Vol. I, Breed and Hosmer.*

**1·05. Plane Surveying.** At Camp Technology. 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. 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 and 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** (B). At Camp Technology. Three weeks of field and office work. The measurement of a base line; triangulation with repeating and with direction instrument; precise and trigonometric leveling; observations for time, latitude and longitude with astronomical transit; and magnetic observations for declination, dip and intensity. (Elective for a limited number of students in Course I who have satisfactorily completed the third year.)

**1·10. Surveying.** At Summer Mining Camp, Dover, New Jersey. The fieldwork consists of plane, topographic, magnetic dip-needle, magnetometer and mine surveying. Plans and maps, both surface and underground, are made from the notes taken in the field. Discussions of surveying methods are 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. 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.*

**1·131. Geodesy** (B). An extended course in continuation of 1·13. The treatment of the mathematical theory of triangulation, geodetic instruments, the ellipsoid, the figure of the earth, gravitational methods, and leveling, is given in greater detail. Attention is given to the most recent practice in geodetic work in this country. Textbook: *Hosmer's Geodesy.*

**1·132. Geodetic Astronomy and Navigation** (B). Includes the theory and practice of astronomy as applied to the determination of astronomical positions and azimuths in a geodetic survey, and certain applications to celo-navigation. Textbooks: *Chauvenet's Spherical and Practical Astronomy; Hayford's Geodetic Astronomy.*

**1·133. Geodetic Laboratory** (B). Includes the comparison of standards of length, measurement of force of gravity with pendulums, determination of the magnetic elements, and the testing and calibration of various geodetic instruments.

**1·134. Adjustment of Observations** (B). Covers the principal methods of adjusting triangulation, leveling and astronomical observations by the method of least squares. Textbook: *Wright and Hayford's Adjustment of Observations.*

**1·135. Seismology** (B). Includes the study of instrumental means of determining the motions and the forces produced by earthquakes and of locating the epicenter and the effects upon engineering structures.

**1·137. Instrument Design** (B). A study of the principles involved in the design of instruments for seismological work; includes the study of various recording and damping mechanisms, the prediction of the performance of an instrument from its equations, and the actual design of a seismometer.

**1·138. Seismological Laboratory** (B). Includes the use and adjustment of seismometers and the determination of constants; also experiments on models and the interpretation of records.

**1·14. Advanced Geodesy** (A). Methods of developing the higher formulas for 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.** Includes a study of the methods of using the compass, log, sextant and charts, the usual methods of navigating by dead reckoning (including Mercator and great-circle sailing), location of ships by astronomical observation for latitude and longitude, and by Sumner's method. Students will have practice in adjusting the compass, using the sextant and the charts.

**1·16. Aerial Surveying** (B). A study of the various methods of constructing maps from photographs for engineering purposes, and the methods of making topographic maps from vertical and from oblique photographs. A study is also made of the different methods of control of aerial surveys. The work covered is confined to the methods of producing the maps from the photographs, and does not take up the technical work of photography or of piloting.

**1·18. Map Reading and Topographical Drawing.** A study of the different conventional signs employed in making topographic maps. Each student is required to make a number of plates of conventional signs, and to solve problems relating to contour maps.

**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. 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 $I_3$, $VII_3$, XI and $XV_{1a}$. Textbooks: *Allen's Railroad Curves and Earthwork; Allen's Field and Office Tables.*

**1·23, 1·24. Engineering Drafting.** (1) The making of a plan and a profile from the notes of a railway location survey made at Camp Technology; (2) the application of the theory of curves and earthwork developed in 1·21 and 1·22 to the solution of problems in hydraulic, railway, airport, or highway construction.

**1·25. Engineering Construction and Estimates** (B). 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** (B). Includes maintenance of way and structures; interlocking and block signals, and remote, centralized and automatic train control. Textbooks: *Railway Engineering and Maintenance Cyclopedia; Notes on Railway Signaling.*

**1·27. Railway Transportation** (B). 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** (B). Includes 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.

**1·301, 1·302. Advanced Railway Transportation** (A). A continuation of the undergraduate courses in railway engineering and transportation. It pertains to design and operation of freight, passenger and locomotive terminals; use of motor transport by railways; railway economics; public relation and control; and involves individual investigations and reports.

**1·31. Advanced Railway Design** (A). Design and analysis of freight, passenger and locomotive terminals; elimination of grade crossings; and other problems adapted especially to students' requirements.

**1·32. Design of Harbor Works** (A). The work covered includes the study of tides, currents, wave action, methods of shore protection, layout of channels and anchorage basins, size of ships; methods of making soundings, borings, pile driving, pile tests, wharf construction, dredging, land reclamation and other waterfront construction; design of wharves, bulkheads and similar structures; methods and equipment for cargo handling, study of preservative treatment of timber.

**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** (B). Physical tests of various kinds of road materials and discussion of their value in highway construction.

**1·37. Highway Transportation** (B). A comprehensive study of state highways, Federal Aid, transportation surveys, 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.*

**1·371. Pavements and Highway Transportation** (B). An outline of the principles governing location, construction, and maintenance of roads and city pavements. A comprehensive study of state highways, highway financing, methods and analysis of transportation surveys, highway legislation, results of recent research, design of pavements, construction and organization methods, motor vehicle types and operating economics, snow removal, highway safety, city traffic problems.

**1·38. Highway Design** (B). 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 Squire's 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. Theory of 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, the analysis of trusses by algebraic and graphical methods and the design of simple columns. Textbook: *Niles and Newell's Airplane Structures.*

**1·41, 1·42. Theory of Structures** (B). 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. First term: roof and bridge trusses of various forms. Second term: 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.** For students in Course I-A and $VII_3$. 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 for students in Courses $I_4$, XI and $XV_{13}$. 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 for students in Course IV-A. 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.** 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. Structural Design.** Calculations and design drawings are made for a small steel truss highway bridge. Intended to illustrate and amplify the work of 1·45 by a practical design problem.

**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's Steel Construction.*

**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.*

**1·48. Foundations** (B). A study of the methods of constructing foundations for bridges, buildings and other structures based on modern research in Soil Mechanics. Textbook: *Hool and Kinne's Foundations, Abutments and Footings.*

**1·491. Soil Mechanics** (A). A detailed study of those physical and mechanical properties of soil which govern its behaviour as an engineering material. Principles of soil classification; analyses of variations in structure and density; studies of the laws of permeability and capillarity; the quicksand phenomenon; compressibility, consolidation, intrinsic pressure, internal friction, cohesion, elasticity, plasticity; and correlation of these factors with problems in earthwork engineering. Textbook: *Mimeographed Notes.*

**1·492. Soil Mechanics** (A). Specific applications of modern soil research are considered on the basis of the physical studies of 1·491. Stability of slopes and retaining walls; bearing capacity and settlement of foundations; piles and pile groups; earth and masonry dams, with special reference to stability, seepage, and piping effect; highway subgrades; and special types of foundations. Textbook: *Mimeographed Notes.*

**1·501, 1·502. Bridge Design** (B). 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.

**1·510. Structural Design** (B). Similar to 1·502 and includes a problem in the analysis of stresses and proportioning of members of an airplane.

**1·511, 1·512. Bridge Design** (B). Abridged from 1·501, 1·502 and especially adapted to the needs of students in $I_3$.

**1·52. Structural Design.** Similar in character to 1·501, 1·502, giving only an outline of the subject.

**1·53. Structural Design.** Similar in character to 1·501, 1·502, giving only an outline of the subject.

**1·54. Structural Design.** Similar in character to 1·501, 1·502, giving only an outline of the subject.

**1·551, 1·552. Advanced Structural Design** (A). Supplements Advanced Structures and illustrates the applications of the principles there studied. The time is devoted to the design of statically indeterminate structures. The structures considered include tall buildings, arches of both the hinged and no-hinged type, continuous trusses and suspension bridges.

**1·561, 1·562. Advanced Structures** (A). 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** (A). The investigation of the various sources of secondary stress in trusses, the computation of the secondary stresses in a number of simple trusses and the study of methods of design which will eliminate excessive secondary stresses. Textbook: *Johnson, Bryan and Turnneaure's Modern Framed Structures, Part II.*

**1·581, 1·582** (A). **Reinforced Concrete Design.** Theoretical and practical principles involved in the design of structures of reinforced concrete. First term: 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. Second term: (*a*) an investigation of bending moments in reinforced concrete structures by exact methods, such as those of least work, slope deflections, etc.; (*b*) a discussion of professional papers concerning current developments in the design of concrete structures. Textbook: *Sutherland and Clifford's Reinforced Concrete Design.*

**1·60. Hydrographic Surveying.** At Camp Technology. (*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. 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 sextant and the transit in locating them. Textbook: *Liddell's Stream Gaging.*

**1·62. Hydraulics.** 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 subjects of flow in open channels and the dynamics of streams are 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.*

**1·65. Hydraulic Machinery.** A consideration of the theoretical principles of hydraulic turbines and centrifugal pumps together with a consideration of the performance and practical selection of these machines. Textbooks: *Daugherty's Hydraulic Turbines and Daugherty's Centrifugal Pumps.*

**1·66. Advanced Hydraulics** (A). An elaboration of subjects fundamentally treated in 1·62 and, in addition, studies in the advanced field of theory and practice. Special treatment of pipe flow (including air, water and oil), the alternate stages of flow in open channels, design of transitions, the hydraulic jump, laws of hydraulic similitude and model experimentation are among the subjects included. Textbooks: *Russell's Hydraulics; Gibson's Hydraulics, and Professional Papers.*

**1·67. Design of High Masonry Dams** (A). A course dealing with the principles involved in the design of high arched masonry dams. Lectures are supplemented by design exercises in which the methods used in the design of the Hoover dam are applied to an assigned problem.

**1·68. Theory of Hydraulic Models** (A). Presents the principles of dimensional analysis and the laws of hydraulic models, and considers various completed model studies.

**1·691. River Hydraulic Laboratory** (A). Instruction in the construction of models for river hydraulic experiments, in the method of making such experiments, and in the interpretation of the results thereof. Registration for the subject is limited in accordance with the number of models available in the laboratory.

**1·692. River Engineering** (A). A study of the hydraulic principles governing rivers, followed by a consideration of methods for their regulation.

**1·70. Water Power Engineering** (B). This subject and 1·71 treats of the problems involved in the location, design and construction of hydro-electric developments as a foundation for practice in this field, or for the advanced studies of the graduate year. The subjects include a thorough study of hydrology: precipitation, run-off, water losses and their relations; the analysis of stream flow data as a basis for estimates of water power, flood flow, storage and pondage problems, followed by the theory and practice of hydraulic turbines and general plant arrangement. Textbook: *Barrows' Water Power Engineering.*

**1·71. Water Power Engineering** (B). 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** (A). These subjects are supplemented by subjects 1·851, 1·852 and include the study and design of the various portions of some water power project at a site where actual data are available from surveys and reports. Other general problems of power development are also considered, with their basic theory and practice. A field trip of several days' duration to examine typical power and storage developments is included. Textbook: *Barrows' Water Power Engineering.* Reference Book: *Creager and Justin's Hydroelectric Handbook.*

**1·75. Hydraulic and Sanitary Engineering** (B). The first eleven weeks are devoted to a comprehensive study of the principles of water supply engineering, which includes rainfall and run-off, consumption of water, surface and ground water supplies, dams and impounding reservoirs, supply and distribution works, principles of treatment of water and design of treatment works. Opportunities for group inspection of nearby treatment works are included and a limited number of students are permitted to receive several days' instruction in the operation of the water treatment plant of the City of Providence. The last four weeks are devoted to a study of the principles of design of sanitary sewers and storm drains, including methods for estimating the quantity of sewage and storm water run-off.

Textbooks: *Babbitt and Doland's Water Supply Engineering; Metcalf and Eddy's Sewerage and Sewage Disposal, a Textbook.*

**1·76. Sanitary Engineering** (B). A continuation of 1·75 covering the principles of design and construction of sewage collecting systems and appurtenances, the principles of sewage treatment and the design and construction of treatment works. Opportunities are offered for group inspection of nearby sewage works and a limited number of students are permitted to receive several days' training in the operation of the sewage treatment plant of the City of Worcester. Textbook: *Metcalf and Eddy's Sewerage and Sewage Disposal, a Textbook.*

**1·77. Sanitary Engineering of Buildings** (B). A study of the principles of plumbing engineering and their application to (*a*) the design of water distribution systems for buildings, (*b*) the selection and location of fixtures and appurtenances, (*c*) the design of sanitary drains and vents, and (*d*) the design of storm water drains. Textbooks: *Notes, textbooks and professional papers by various authors. (Given at the option of the instructor in charge.)*

**1·78. Sanitary Engineering** (B). A continuation of 1·75, covering in more detail the subject matter of 1·76 and in addition thereto the elements of disposal of industrial wastes and municipal refuse and garbage. Opportunities are offered for group inspection of nearby sewage works and for several days' training in the operation of the City of Worcester sewage treatment plant. Textbook: *Metcalf and Eddy's Sewerage and Sewage Disposal, a Textbook.*

**1·79. Hydraulic and Sanitary Design** (B). The design of a sanitary intercepting sewer for a given community followed by the design of a system of storm drains for a small area.

**1·801. Sanitary Design** (B). An investigation for and report on a gravity water supply for a given community.

**1·802. Sanitary Design** (B). The same as 1·79 followed by the design of a sewage treatment plant for the community.

**1·811. Advanced Sanitary Engineering** (A). A comprehensive study of the principles of modern water treatment engineering, including coagulation, sedimentation, filtration, sterilization, softening, corrosion, and removal of tastes and odors. Opportunities are offered for group inspection of nearby treatment works and for several days' training in the operation of the water treatment plant of the City of Providence. Textbooks: *Notes prepared by Professor Camp and textbooks and professional papers by various authors.*

**1·812. Advanced Sanitary Engineering** (A). A comprehensive study of the principles of modern sewage treatment engineering, including screening, removal of grit, sedimentation, removal of colloids and stabilization by contact surfaces and by aeration with activated sludge, chlorination of sewage, digestion, treatment and disposal of sludge, and collection and utilization of gas. Opportunities are offered for group inspection of nearby sewage works and for several days' training in the operation of the sewage treatment plant of the City of Worcester. Textbooks: *Notes prepared by Professor Camp and textbooks and professional papers by various authors.*

**1·851, 1·852. Advanced Water Power Design** (A). For description see Advanced Water Power Engineering 1·731, 1·732.

**1·881. Advanced Sanitary Design** (A). The design of a modern water treatment plant to effect the proper treatment of a given water to be used for domestic and industrial consumption. Conducted in parallel with 1·811.

**1·882. Advanced Sanitary Design** (A). The design of a modern sewage treatment plant to effect the proper treatment of a given raw sewage. Conducted in parallel with 1·812.

**1·902 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 these 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); (*c*) Research and Special Investigations.

**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 the Boston and Maine Railroad.

**1·904. Railroad Operation Practice.** Fourth period of coöperative work with the Boston and Maine Railroad.

The following subject is offered as a General Study. For description of subject see Division of General Studies, page 235.

**G10. Development of Transportation.**

# II. MECHANICAL ENGINEERING

**Subjects 2·00 to 2·99** (see page 75)

**2·00. Applied Kinematics.** A study of the laws of motion, including velocity and acceleration as applied to bodies whose motion is controlled by "mechanical means."

Velocity treated as a vector quantity. Determination of velocities of various points in a change of connected pieces by both graphical and algebraic methods. Some work along the same lines with acceleration.

Transmission and modification of motion from one piece to another: (*a*) By direct contact. Illustrated by study of gear tooth action, cam action, etc. (*b*) By a rigid intermediate connector. Illustrated by studying a variety of linkages. (*c*) By a flexible intermediate connector. Illustrated by belt, rope or chain, etc.

Resultant motion derived from two independent sources. Illustrated by epicyclic gear trains, certain types of pulley blocks, etc.

A limited amount of work in connection with the motion of a body whose points move in non-parallel planes.

The subject is taught by lectures and informal discussions in the classroom, home study and solution of typical problems and a two-hour period each week in the drafting room, under supervision, employing graphical methods of investigation and solution. Textbook: *Elements of Mechanism, Schwamb, Merrill and James.*

**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 representative machine are made, together with sufficient drawing lay-out to show the design of the frame casting, and the relation of the parts. Certain problems in automotive design are also included.

**2·04. Mechanical Engineering Equipment.** A description of the construction and mechanical operation of power plant machinery exclusive of boilers and the immediate accessories of a steam boiler. It covers the steam engine and turbine with their valve gears and governors and the auxiliary equipment and accessories necessary for their operation. In addition to the machinery used for power generation such machines as air compressors, pumps, steam steering gears, etc., are studied and a description of internal combustion engines is given. Textbook: *Power Plant Machinery, Vols. I and II, James and Dole, or Elementary Steam Power Engineering, Mac Naughton.*

**2·05. Mechanism of Machines.** 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. 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** (B). Lectures and recitations of 2·05, omitting the lectures on alignment charts.

**2·07, 2·08. Automatic Machinery** (A). 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). 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 applied kinematics, 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 and Sloane; Elements of Mechanism, Schwamb, Merrill and James.*

**2·102. Mechanical Engineering Drawing.** Modification of 2·10 involving the graphical study of motions and forces. Textbook: *Working Drawings of Machinery, James, Mackenzie and Sloane.*

**2·12. Machine Drawing.** An abridgment of 2·13. Textbooks: *Working Drawings and Machinery, James and Mackenzie and Sloane.*

**2·13. Machine Drawing.** Instruction and practice in the production and use of working drawings, including layout, detail, and assembly drawings. 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 and Sloane.*

**2·15. Applied Mechanics** (Statics and Dynamics). Analysis of force systems in two and three dimensions by analytical and graphical methods; the laws of equilibrium; distributed forces; components of stress; centers of gravity; moments of inertia and products of inertia; dynamics of translation including momentum, energy, work and power; the application of the principles of statics to the determination of stresses in simple frames.

**2·151. Applied Mechanics** (Kinetics). Part of 2·15, kinetics only.

**2·20. Applied Mechanics** (Strength of Materials). The physical properties of materials; the common theory of bending; including shearing forces and bending moments, the distribution of normal and shearing stresses, the equation of the elastic curve and the determination of slopes and deflections in beams; eccentric loading; stresses due to combinations of axial and transverse loads; theories for determining the strength of columns; the theory of torsion of circular bars; particular emphasis being placed on the application of these theories in the solution of engineering problems.

**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, statics and strength of materials including the theory of continuous beams. Textbook: *Applied Mechanics, Vols. I and II, Fuller and Johnston.*

**2·22. Applied Mechanics.** The study of some of the more advanced problems in engineering dynamics including the determination of stresses due to inertia in moving parts of machinery: also, the 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.*

**2·231. 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** (B). 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. This course includes also a study of dynamometers for the measurement of power.

**2·252. Advanced Dynamics of Machines** (A). 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 direction; natural axes, centrifugal couples and the dynamics of rotation. (Open only to students at General Electric Company.)

**2·254. Dynamics of Engines** (A). Lectures and drawing-room exercises on the inertia forces and the stresses in the running parts of high-speed gasoline engines. Application is made chiefly to the types of engines used in automobiles.

**2·255. Dynamics of Aircraft Engines** (A). An advanced course given to students having considerable knowledge of engine balancing and practical experience with aircraft engines.

**2·256. Dynamics of Rotation** (A). A study of inertia effects in bodies rotating about axes whose directions are changing. Designed for application to gyroscopic control devices. (Open only to students in the courses in Torpedo Design.)

**2·26. Mechanics of Engineering** (B). 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.

**2·281, 2·282. Advanced Mechanics and Theory of Elasticity** (A). An advanced course in the strength of materials and dynamics, including the theory of flexure 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** (A). A 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). 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.

**2·291, 2·292. Theoretical Mechanics** (A). The fundamental principles of statics and dynamics.

**2·295. Applied Hydrodynamics** (A). The continuous medium, compressible and incompressible, viscous and ideal fluid. Absolute and relative streamlines; path lines; steady and unsteady flow; continuity; rotational and irrotational motion, velocity potential. Euler's equations. Applications: Flow in open and closed streams; theory of airplane propellers, turbines. Conformal transformation applied to the study of plane motion; theory of waves; Laminar and turbulent flow. Laws of similitude; secondary motion generated by the influence of skin friction.

**2·296. General Theory of Hydraulic Turbines and Pumps** (A). The modern types; the flow through a turbine as a periodically steady one; simplification and restriction to a unidimensional theory; torque and axial thrust; equation of energy; operating conditions. Discussion of best design for different specific speeds; laws of similitude and theory of model tests; supplementary treatment with respect to a finite number of blades; discussion of cavitation.

**2·30. Materials of Engineering.** The manufacture and physical properties of alloys, iron, steel, plaster, lime, cement, concrete, brick, timber and other engineering materials. Attention is given to the relationship existing between constitution and physical properties of materials in general with special reference to the effect of change of composition, hot and cold work and heat treatment upon the properties of metals. One of the objects of this course is to give instruction that will enable the student to draw up and interpret specifications for common materials. Textbook: *Materials of Construction, Mills.* (*Fourth edition.*)

**2·301. Materials of Engineering.** 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.*

**2·305. Materials and Testing** (B). 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.

**2·32. Photoelasticity.** Offered for Army and Navy officers only. 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.

**2·331. Engineering Metals** (B). Conferences, reports and discussions dealing with the mechanical properties, structural characteristics and industrial applications of metals and alloys with respect to their engineering significance, including consideration of the effects of high and low temperatures, repeated stresses, wear resistance, corrosion resistance, etc. Textbooks: *Metals Handbook and Current Technical Publications.*

**2·332. Engineering Metals Problems** (A). Conferences, reports and discussions as outlined for 2·331 with the addition of comprehensive laboratory problems of similar nature. Textbooks: *Metals Handbook and Current Technical Publications.*

**2·341, 2·342. Rheology** (A). A study of the science of the flow of matter, especial attention being given to the relations between experimental results and theory. The theory is developed as far as possible to meet the needs of the research engineer. Examples taken from the theories of hydrodynamics, elasticity and plasticity are given to illustrate the general principles underlying the laws of the flow of matter. A special study is made of the behavior of semi-elastic and semi-plastic fluids of metals at high temperatures used in forging and in welding and in the rolling mill, as well as the behavior of materials under forced vibrations, the fatigue of metals and frictional resistances in such bodies.

**2·35. Testing Materials Laboratory** (B). Includes the work of 2·36 and in addition some attention is given to the testing of fabrics, microscopic examination of non-metallic materials, macroscopic examination of metals, the X-ray examination of castings, welds, etc., and stress analysis by means of polarized light. Laboratory instruction in this course is supplemented by a series of lectures. 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. The first part of the work must, necessarily, be of routine nature and is common for all students. The last part is varied somewhat for the different courses in order to adapt the work to their particular needs. 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. Instruction is supplemented by excursions to concrete jobs, concrete products companies and central mixing plants.

**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.

**2·38. 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.

**2·391. Reinforced Concrete Design** (B). Covers by lecture and problem work the design of reinforced concrete floor systems, columns and footings. Special attention is given to the consideration of costs and economical design. Textbook: *Concrete Engineer's Handbook, Hool and Johnson.*

**2·392. Reinforced Concrete Design** (B). A continuation of 2·391 consisting of the complete design of a typical cross-section for a building, including flat slab and ribbed floor systems, also simple and combined footings. Lectures and problems cover moments at beam and column connections.

**2·393. Reinforced Concrete Design, Advanced** (A). 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** (A). 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.** The laws of thermodynamics with their applications to engineering problems; physical properties of gases and saturated and superheated vapors — especially of air and steam; ideal and actual cycles of hot air and internal combustion engines. The fundamental laws governing the flow of fluids with application to orifices and nozzles. The student learns to use the equations, vapor tables and diagrams, through independent solution of problems. Textbooks: *A Standard Textbook on Thermodynamics; The Temperature Entropy Diagram, Berry; Steam Tables.*

**2·41. Boilers and Engines.** 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. Textbook: *Gebhardt, Steam Power Plant Engineering.*

**2·42. Engineering Thermodynamics.** A continuation of 2·40. Completes a discussion of flow of fluids and applications to the steam turbine; 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. Textbooks same as for 2·40.

**2·43. Refrigeration** (B). 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. Heat Engineering.** Study of valve gears which are treated and designed by both the Reuleaux and Zeuner methods; the laws of thermodynamics and the application of the laws shown by application to engineering problems; 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. Textbook: *Notes on Heat*

*Engineering Prepared for Class.* Reference Books: *Any standard treatise on thermodynamics; Mechanism of the Steam Engine, James and Dole; Power Plant Machinery, Vol. II, James and Dole; Steam tables.*

**2·461. Thermodynamics.** Series of lectures covering Thermodynamics of perfect gases, saturated superheated steam, air compressors, refrigerating machinery, variation of actual gases from perfect gases together with some applications of Thermodynamics to engineering problems.

**2·47. Heat Engineering.** A continuation of 2·46. 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: *Notes prepared for class.* Reference Books: *Any standard treatise on Thermodynamics; Gebhardt's Steam Power Plant Engineering.*

**2·48. Internal Combustion Engines** (B). Oil and gasoline engines, adapted to the needs of naval constructors.

**2·49. Refrigeration** (B). A thermodynamic study of complicated systems of compression and absorption refrigeration of the properties of various brine solutions, of problems encountered in the manufacture of ice, and in other applications of mechanical refrigeration, and a discussion of the effects of bacteria, molds and fungi upon the spoilage of foods.

**2·491. Refrigeration.** Lectures on the types and applications of refrigerating machinery similar in character to 2·49 but less theoretical.

**2·501. Advanced Refrigeration** (A). Use of various equations of state, van der Waals, Dieterici, Keyes, reduced forms, etc., with special application to the liquefaction of air. Thermodynamics of mixtures of gases and vapors with applications to the absorption refrigerating systems and to the separation of gaseous mixtures.

**2·502. Advanced Heat Transmission** (A). The variations of surface coefficients, conductivities, etc., under varying conditions; laws of heat transmission as illustrated in steam condensers, feed water heaters, brine coolers, radiators, steam boilers, engine cylinders, cooling of castings, freezing of ice, etc. It includes the application of Fourier's series of cases involving fluctuating temperature conditions.

**2·503. Advanced Heat Engineering** (A). 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.

**2·504. Refrigeration Engineering** (A). A discussion of various problems arising in the applications of refrigeration to science, engineering and industry. Students prepare and present papers on special topics.

**2·505. Storage and Transportation of Foodstuffs** (A). A study of warehouses, precooling plants, refrigerated cars, trucks, and ships, their insulation and refrigerating equipment. Dry ice shipments, freezing processes, refrigeration load, temperature and humidity conditions required with various products, legal aspects of industry, food laws, relationship between industry and society.

**2·506. Design of Refrigerating Plant** (A). Study of economic needs of a locality. Design of plant to meet industrial needs; layout, insulation, walls, doors, windows, etc. Calculation of refrigeration load and amount of cooling surface. Location of coils, ventilating ducts. Humidity. Design of Power plant.

**2·51. Torpedoes** (A). 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** (B). From a given load curve and from a chart showing the demands for steam used for industrial purposes a complete assembly drawing of a power house is made, the assembly drawing being in sufficient detail to enable one to construct working drawings from it. The work consists largely of calculations combined with drawing room work. The cost of the plant is estimated as is also the cost of operation. Textbook: *Power Plant Design by Miller and Holt.*

**2·581. Power Plants Advanced** (A). 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.

**2·59. Mechanical Equipment of Buildings, Heating and Ventilation.** Elementary principles of the thermodynamics of gases and steam with their application to the equipment of a building; principles and practice of heating and ventilation; discussion of the various other mechanical equipment of a building, such as elevators, dust collecting systems, etc. Fifteen hours are given over to trips. Textbook: *Heating and Ventilation, by Allen and Walker.*

**2·591. Advanced Heating and Ventilation** (A). A complete study of the various types of heating and ventilation systems to include principles of design, type of building for which adapted, methods of control, etc.

**2·592. Heating and Ventilation Design** (A). The choice of type of heating and ventilating system for a particular building, layout of piping and duct system, together with complete calculations and estimation of cost. An investigation and study of existing plants will be made with trips to these plants whenever possible to bring out the practical problems involved in design.

**2·593. Air Conditioning** (A). A complete study of the fundamental laws of Air Conditioning underlying the psychrometric and comfort charts together with application of these charts to air conditioning problems. Typical air conditioning equipment and humidity controls will be studied in detail together with their application to various types of problems.

**2·594. Refrigeration and Air Conditioning Laboratory** (A). Experiments with various refrigeration systems including the application of heating and refrigeration to air conditioning apparatus. Research problems.

**2·595. Mechanical Equipment of Buildings.** Abridgment of 2·59.

**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.

**2·602. Engineering Laboratory** (B). 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. More complete investigations of the performance of some of the larger equipment are made including a test on one of the turbines in the power plant. Some practice is given in the treatment of boiler feedwater also in heat transfer by low temperature radiation and convection.

**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 2·615. 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.

For Courses taking no subsequent Engineering Laboratory some exercises of a more advanced type are included.

**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 but exercises on internal combustion engines are taken instead of gas and fuel analysis.

**2·621. Engineering Laboratory.** Covers part of 2·62.

**2·622. Engineering Laboratory.** Similar to 2·621.

**2·63. Engineering and Hydraulic Laboratory.** Use of instruments required for testing steam and hydraulic machinery; some practice in conducting tests on such machinery.

**2·631. Engineering and Hydraulic Laboratory.** Similar to 2·63 but more time is devoted to hydraulic experiments.

**2·64. Refrigeration Laboratory** (B). A general experimental course on refrigerating machines and 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.

**2·66. Automobile Laboratory** (B). 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** (B). 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** (B). 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, carburization, 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** (A). Fifteen hours devoted to lectures and recitations. Sixty-five hours given to testing of motor vehicles. Performance of motor vehicles studied in laboratory and on road. Riding comfort, braking ability, fuel mileage, oil consumption, effect of various accessories on performance, etc., investigated. 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. Automotive Engine Laboratory** (B). Engine mounting, couplings, fuel measuring devices, power measuring devices and instruments used in 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, Test Forms, etc.*

**2·691. Automotive Engine Laboratory** (B). Lectures on fundamentals of gasoline engine construction, design, and operation. Study in the laboratory of automotive engines and their parts. Short engine tests are conducted to familiarize the student with engine performance and operation of engines and to give experience in handling test apparatus. Textbook: *Manufacturers and Government Handbooks and Reports.*

**2·70. Machine Design.** Typical problems in machine design which may be solved by the application of the principles of statics. 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 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** (B). 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.

**2·721. Machine Design.** A discussion of the principles underlying the design of machine elements, including fastenings, shafting, bearings, belting, gearing, balance wheels, etc. Particular emphasis is laid on the proper choice of materials, methods of manufacture, and rational methods of design. Illustrative problems are assigned for solution in the drawing room.

**2·722. Machine Design.** An extension of 2·721 taking up more advanced problems and the complete analysis and report on a production machine.

**2·741. Machine Design, Advanced** (A). A systematic application of the principles of applied mechanics to the design of machines of complicated character. The subjects of centrifugal effects, balancing, lubrication and combined stresses are treated at considerable length. Textbook: *Library research.*

**2·742. Machine Design, Advanced** (A). 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). 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.

**2·761. Machine Design** (A). 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** (A). 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** (B). Lectures and drawing-room exercises in the design of reciprocating engines of stationary type 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** (B). Problems involved in the organization of a modern manufacturing plant and the planning, construction and equipment of the buildings required: (*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.

**2·782. Industrial Plants** (B). An extension of 2·781 with special reference to the design of the structures. The design of a brick and a reinforced concrete factory is included in this course.

**2·79. Gasoline Automobile** (B). 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** (A). Fundamentals of automotive engineering are the bases of this course — engines and chassis; theoretical considerations of the general principles governing the action and design. Study is made of all important parts; and procedure of design is outlined.

**2·811, 2·812. Automotive Design** (A). 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** (B). 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** (B). Study of fire-proofing and fire-protective apparatus. The erection, installation and operation of protective devices of all kinds. A number of problems are worked out showing how modern shops and mills may be safeguarded against fire in the most effective manner. Textbook: *Library reference — Notes prepared for class.*

**2·852. Locomotive Engineering** (B). Lectures dealing largely with the steam locomotive, but in which the electric, the diesel, and the diesel electric locomotive are briefly discussed. 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 studied and calculations made of the stresses in main and side rods, counter balancing, bearing pressure of journals, crank pins, etc. 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** (B). 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** (B). Description and discussion of the general principles of construction of the mechanical equipment of large buildings, including elevators, pneumatic systems of dust collection, water supply systems, water-heating systems, sewage disposal, etc.

**2·855. Steam Turbine Engineering** (B). Different types of modern steam turbines. 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. Textbook: *Church, Principles of Steam Turbines.*

**2·858. Inspection Methods** (B). 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** (B). 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 is calculated and designed to fit the requirements. Textbook: *Notes prepared for class.*

**2·871. Textile Laboratory.** This subject embraces ninety hours of special work in the Textile Laboratory, including investigations, tests and researches in the physical properties of various textile fibres, yarns and fabrics. Textbooks: *Laboratory Notes and Library References.*

**2·872. Design of Cotton Machinery** (A). 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). 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). 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). 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** (A). 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. Textbook: *Notes prepared for class.*

**2·877. Textile Microscopy** (B). A study of the application of optical and microscopical equipment to the technical analysis of textiles. Lectures and laboratory cover the types of equipment, their use and the technique of textile micro-analysis for fibre, yarn and fabric. Textbook: *Library references.*

**2·88. Ordnance Engineering** (B). Lectures and calculations on gun design, including stresses and strains in built-up and wire-wrapped guns; the design of recoil and counter-recoil mechanisms. The calculation of stresses in gun carriages, foundations, gear trains, roller bearings, and foundation bolts used in different types of mounts, forms an important part of the course.

**2·891. Mechanics.** The fundamental principles of mechanics necessary for the solution of problems arising in the design of ordnance of various types.

**2·90. Forge Shop.** Systematic instruction in the use of each tool, the study of each material worked, with explanation of various grades and of the proper methods of working each; and discussion of methods of making large forgings. Work in steel is included. Training is given in the use of the power hammer; and drop forging is also included.

**2·901. Forging.** Similar to 2·90.

**2·91. Foundry.** Principles and practice of foundry operation and the production of all classes of castings. Lecture, demonstration and practice in hand and machine molding and core making; mixing, melting and pouring metals. Castings are made in white metal 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.**

**2·912. Structural Castings.** Essentially, a lecture course describing the principles and practice of foundry operations in the production of iron and steel castings, and giving instruction in designing castings; primarily intended as preparation for the structural designer.

The Foundry lectures will be illustrated by demonstrations and stereopticon slides, and supplemented by visits to foundries.

**2·92. Pattern Making.** 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.

**2·922. Pattern Making.**

**2·941. Machine Tool Laboratory.** 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, belt lacing, soldering, welding. 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. Each student is assigned problems involving laying-out work, chipping and drilling, filing and fitting cast-iron and steel parts, alignment and babbitting of bearings, scraping machine-slides, pipe-fitting, hardness tests of metals with scleroscope, tapping, grinding drills and other tools; centering, squaring, straight and taper turning and fitting, screw cutting, finishing and polishing, gear cutting, mandrel making, hardening, tempering, grinding and welding. Special attention is given 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 gauges. 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 gauges 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.

**2·971. Machine Tool Laboratory.** Covers a part of 2.951.

**2·972. Machine Tool Laboratory.** A continuation of 2·971.

**2·98. Production Methods.** 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** (A). Methods of constructing automobiles, trucks 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.

**2·982. Preparation for Manufacturing** (B). A study of many of the engineering problems which must be solved before a finished article can be manufactured in large quantities after the design of the article has been completed; such as engineering organization, estimating costs of production, the design of tools and equipment, factory extensions, and quality control. The practices of large corporations having the most highly organized engineering departments along these lines will be cited as illustrations and used as the foundation for discussion.

**2·983. Production Design** (B). A study of the fundamental principles involved in the preparation of the manufacturing design of a commodity to be produced in large quantities. Includes a study of the fundamental principles of dimensioning detail drawings with tolerances, and preparation of other necessary specifications which are required to convey precise and complete information to the productive departments. The subject is taught by lectures and work in the drafting room preparing complete drawings and specifications for a specific commodity.

Textbooks: *Production Design, Olsen; Principles of Interchangeable Manufacturing, Buckingham.*

**2·99. Metrology and Dimensional Engineering Standardization** (A). A study of fundamental units of measure, measuring systems, and calibration of standards; the purpose of measurements in scientific and research work, engineering in general use; a study of conventional measuring instruments, their characteristics and methods of calibration; accuracy of measurements; analysis of measurements; shop measurements and analysis by means of measurement; dimensional engineering standardization; and inspection engineering. Textbooks: *Library Research, American Engineering Standards, S. A. E. Handbook, and Notes prepared for class.*

# III. MINING AND METALLURGY

**Subjects 3·00 to 3·99** (see page **75**)

**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.** 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. 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. Economics of Mining** (B). 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.

**3·031. Mining Economics** (B). Lectures simultaneous with 3·03.

**3·04. Mining, Principles of** (B). The principles and practice of mine sampling and examination; the interpretation of data and the writing of reports; inquiry into the risk factor in mining investments and its effect on valuation; the principles controlling methods and extent of development; the character of mechanical equipment; standardization, administration, depreciation and depletion; 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.** For students in metallurgy, geology, chemical engineering and others who are interested in ores or minerals, which may be the raw materials of their industries. Mining methods, including exploring, sampling, development and production; mining equipment, as air compressors, hoists, machine drills, underground and surface transportation; and laws relating to mining. Textbook: *Young, Elements of Mining.*

**3·061, 3·062. Mining Engineering, Advanced** (A). For graduate students who have had some experience in mining practice and mining engineering, and who desire to do advanced work in some branch of the subject not specifically covered by other subjects. 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.

**3·101, 3·102. Mine Valuation** (A). Interpretation of mine sampling, estimates of ore reserves, design and estimates of cost of plant equipment, determination of operating costs and valuation of the ore deposit. Given by the case system and the time is devoted to lectures, conferences, assigned readings, computations, and written reports. Designed for graduate students who have a background of experience in mining practice.

**3·12. Mining Economics, Advanced** (A). The study and analysis of the reports of mining 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, Elements of** (B). Lectures and laboratory instruction in manipulation of geophysical apparatus and field exercises. 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.

**3·21. Ore Dressing** (B). The mechanical concentration of the mine ore to separate the valuable minerals from the waste. The greater part of the time is devoted to wet gravity concentration and flotation, including crushing machinery, screens, classifiers, jigs, vanners, tables and flotation machines. Amalgamation, pneumatic, electrostatic and other minor processes are also discussed, as well as accessory apparatus, mill principles, milling economics and typical mill flow sheets. It is aimed to correlate the lectures with 3·22. Textbook: *Richards and Locke, Textbook of Ore Dressing.*

**3·22. Ore-Dressing Laboratory** (B). 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. Individual tests are made on crushing machines, sizing screens, hydraulic classifiers, magnets and flotation machines. One very important part of this work is the cleaning up, weighing, sampling and analyzing of all the products, the computation of results and the preparation of written reports which are discussed at the weekly seminars.

**3·23. Ore Dressing.** The lectures embody the principles of wet gravity concentration, flotation, amalgamation and magnetic separation. The most important crushing and concentrating machines of interest to the metallurgists are treated briefly. The laboratory work covers three seven-hour periods for three weeks, and three seminars of one hour; it is practically identical with that of 3·22 with the exception that lack of time prevents the student from cleaning up his products and preparing reports. Textbook: *Richards and Locke, Textbook of Ore Dressing.*

**3·241, 3·242. Ore Dressing, Advanced** (A). Somewhat variable in scope and time allotment. Devoted to lectures, conferences and assigned readings in continuation of 3·21 or 3·23.

**3·251, 3·252. Theory and Practice of Flotation** (A). Library readings, conferences and laboratory work, going more deeply into the subject than is possible in undergraduate work, and dealing with special phases in flotation such as fundamental theory, study of reagents, differential flotation, application to oxidized ores and the economics of flotation.

**3·26. Ore Dressing, Economics** (A). Conferences and problems involving the various factors of equipment costs, operating cost, efficiency of operation and profit.

**3·271, 3·272. Ore Dressing, Design** (A). Design of flow-sheets and layout of mills; usually includes a special problem of mill design to cover a set of stated conditions.

**3·31. Fire Assaying.** The sampling of ore and bullion, the assaying of ores for gold, silver and lead, and of bullions, solutions, matte and miscellaneous furnace products. The fire assay of copper, tin, mercury and platinum is briefly discussed. Typical ores, bullions and solutions are used for analysis; the important standard methods are covered. Stress is laid upon the accuracy of results and the neatness of work and of notes. Textbook: *Bugbee, Fire Assaying.*

**3·32. Fire Assaying and Metallurgical Laboratory.** 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 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** (A). The theory and practice of fire assaying, which includes practice with works methods for gold and silver; the fire assay for tin, mercury and members of the platinum group of metals; also a certain amount of research.

**3·41. Metallurgy: Copper and Lead** (B). Deals mainly with the 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: *Hayward, Outline of Metallurgical Practice; Hofman and Hayward, Metallurgy of Copper; Hofman, Metallurgy of Lead.*

**3·411. Metallurgy: Copper and Lead** (B). The lectures are given simultaneously with 3·41. The time for laboratory and library work is shortened. Textbooks: *Hayward, An Outline of Metallurgical Practice Hofman and Hayward, Metallurgy of Copper; Hofman, Metallurgy of Lead.*

**3·412. Metallurgy: Copper, Lead, Zinc, etc.** (B). 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: *Hayward, An Outline of Metallurgical Practice.*

**3·42. Metallurgy: Gold and Silver** (B). The principles of the subject are covered in thirty lectures. The laboratory work is designed to illustrate some of the standard processes and to give the student experience in testing. Samples of known metallic contents are used and students are held individually responsible for the accuracy of their results.

**3·421. Metallurgy: Gold and Silver** (B). The lectures are simultaneous with 3·42. Less time is devoted to work in the laboratory.

**3·422. Metallurgy: Gold and Silver** (B). The same lectures as 3·42 but no laboratory.

**3·43. Metallurgy: Iron and Steel** (B). The physical and chemical properties of iron, steel and alloy steels, and the production and treatment of pig iron, cast iron, wrought iron, steel, etc. Stress is laid mainly on principles; the processes being given in outline and studied in detail in assigned references to books and journals. The lectures are supplemented by plant visits which are covered by subsequent reports and seminars. Textbooks: *Stoughton, Metallurgy of Iron and Steel; Camp and Francis, Making, Shaping and Treating of Steel.*

**3·431. Metallurgy: Iron and Steel** (B). The lectures are simultaneous with 3·43, but less time is devoted to library work and plant visits. Recommended for Army and Navy officers requiring a knowledge of iron and steel for ordnance or structural purposes. Textbooks: *Stoughton, Metallurgy of Iron and Steel; Camp and Francis, Making, Shaping and Treating of Steel.*

**3·432. Metallurgy: Iron and Steel.** The class work is simultaneous with 3·43. Library work and plant visits are omitted. Textbook: *Stoughton, Metallurgy of Iron and Steel.*

**3·44. Metallurgy: General, Zinc and Minor Metals** (B). Covers in a general manner the properties of metals and alloys, treats in detail fuels and refractories, discusses the principles which govern pyro, hydro and electrometallurgical processes and considers typical metallurgical apparatus. In zinc and minor metals the work supplements that given in 3·412. Textbook: *Hofman, General Metallurgy; Hayward, An Outline of Metallurgical Practice.*

**3·45. Metallurgy, Heat Treatment of Steel** (B). Heat treatment of steel including some discussion of furnaces and equipment. The lectures are supplemented by plant visits and library work covered by seminars and reports.

**3·46. Metallurgy of Common Metals.** Designed for engineering students who do not expect to practice metallurgy as a profession. Considers iron and steel, copper, lead, zinc, aluminum, antimony, tin and nickel. The discussion covers sources, methods of extraction, physical properties of metals, principal uses, origin and effect of impurities, refining and industrial alloys. Elective in third or fourth year. Textbook: *Hayward, An Outline of Metallurgical Practice.*

**3·501, 3·502. Metallurgy: Iron and Steel, Advanced** (A). Class work, conferences, plant visits and library work, aiming to supplement and to give a more detailed knowledge of the subject than is possible in the undergraduate courses.

**3·511, 3·512. Metallurgical Plant Design.** Aims to make the student conversant with some construction details of metallurgical plants. Involves the fundamental calculations for a given problem, the study of detail in working drawings, followed by the preparation of drawings of a plant as a whole and of some of the apparatus in detail, together with a final report.

**3·52. General Metallurgy, Advanced** (A). Fuels, refractories and the principles of roasting and smelting are studied with greater thoroughness than is possible in the undergraduate courses. A critical analysis is made of the manner in which these principles are carried out in present practice and suggested improvements are discussed.

**3·53. Non-ferrous Metallurgy, Advanced** (A). For graduate students who have had fundamental courses in non-ferrous metallurgy and wish to continue the study of one or more of the metals. Latitude is allowed in the choice of subject and the time may be adjusted to suit the requirements of the work which may be a combination of library studies and conferences with laboratory work if desired. The work is confined to production and refining. Those desiring to study the properties of metals and alloys should register for 3·651, 3·652.

**3·541, 3·542. Gold and Silver Metallurgy, Advanced** (A). For graduate students who desire to do advanced work in the metallurgy of the precious metals. May be extended to cover the metallurgy of the metals of the platinum group. Conferences, assigned reading, reports and special problems.

**3·56. Metallurgical Plants** (B). Drafting room, library and conference work. Details of apparatus, plant arrangement and operations are studied and presented at occasional seminars.

**3·60. Metallurgical Plant Visits** (B). Consists of one week spent in visiting metallurgical plants in New Jersey and Eastern Pennsylvania. The production of iron and steel, zinc, copper and lead 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 of steel and cast iron. Laboratory exercises include the microscopic examination of a series of typical non-ferrous and ferrous alloys. Practice in photomicrography is an essential part of the subject. Textbook: *Williams and Homerberg, Principles of Metallography.*

**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.)

**3·62. Metallography** (B). 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. Laboratory practice is included.

**3·641. Physical Metallurgy (Non-ferrous)** (B). 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)** (B). Similar to 3·641 but dealing with iron and steel.

**3·643. Light Alloys** (B). A detailed study of the structure, properties, heat treatment and uses of alloys of aluminum, magnesium and beryllium.

**3·651, 3·652. Physical Metallurgy, Advanced** (A). A series of conferences dealing with recent developments in physical metallurgy, accompanied by laboratory exercises in which brief research problems will be undertaken.

**3·656. X-Ray Metallography.** Conferences and laboratory work dealing with the use of X-rays in the study of metals. Includes radiographic examination of metal parts, as well as the X-ray defraction study of the atomic and granular structures of metals, and their relations.

**3·657. X-Ray Metallography, Advanced** (B). Conferences dealing with recent advances in the physics of metals as studied by X-ray methods together with laboratory work consisting of a series of brief research problems.

**3·66. Applications of Metallography** (A). Laboratory conferences, arranged to familiarize the student with the applications of metallography to industrial problems.

**3·67. Physics of Metals** (B). A discussion of the modern theories of the metallic state resulting from a study of the physical properties of metals.

**3·673. Physics of Metals, Advanced** (A). Continuation of 3.67.

**3·68. Metallography of Welding.** General consideration of welding processes. Study of welding from a metallurgical viewpoint. Influence of various factors on quality and structure of welds.

**3·69. Corrosion and Heat Resisting Alloys** (B). A study of metals and alloys with respect to corrosion and heat resistance, including a discussion of intercrystalline failure, corrosion protection, creep and selection of materials.

**3·71. Heat Treatment.** The effect of heat treatment on the physical properties of iron, steel and other metals. Considerable time is devoted to the determination of the proper heat treatment to bring out any particular property desired.

**3·712. Engineering Heat Treatment.** Conferences and laboratory work dealing with the effect of heat treatment on the physical properties of iron, steel and other metals.

**3·713. Heat Treatment.** Conferences and laboratory work dealing with the effect of heat treatment and hot and cold work upon the physical properties of metals used in torpedo construction. Open only to officers of the United States Navy taking torpedo design.

**3·714. Heat Treatment.** A continuation of 3·712, devoted to the study of the effect of heat treatment on the metals used in the automotive industry.

**3·731, 3·732. Physical Metallurgy.** The structure and physical properties of metals used in torpedo construction. Open only to officers of the United States Navy.

**3·74. Theory of Metal Hardening** (A). A critical discussion of the modern theories of the hardening of metals.

**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.** For students outside of the option in Petroleum Production who are interested in the methods of developing, producing and storing the crude products of the petroleum industry. Includes oil and gas land titles, methods of development and production, transportation and storage of petroleum.

**3·85, 3·86. Petroleum Production** (B). Special methods for increasing the flow of oil and gas to wells: the production and distribution of natural gas; the extraction of natural gasoline from natural gas; the utilization of petroleum products as affecting the oil and gas producer; elements of the valuation of oil and gas lands. Laboratory studies of problems in production, transportation and storage of crude petroleum and natural gas. Examination of cores and samples from producing formations for grain size, porosity and saturation. Testing of cements and muds used in oil wells. Treating of emulsions for the removal of water and sediments.

**3·89. Oil Field Visits.** A five-day trip to the oil and gas fields of Western Pennsylvania.

**3·901, 3·902. Oil and Gas Land Valuation** (A). Considers the factors entering into the valuation of oil and gas properties, given by the case system. Lectures, conferences, assigned readings, drawings, computations and written reports. For graduate students who have had some experience in petroleum production.

**3·911, 3·912. Advanced Petroleum Engineering** (A). For graduate students who have had some experience in petroleum production, and who desire to take advanced work in some branch of the subject not specifically covered by other 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** (A). Laws and legal forms relating to the acquisition of petroleum rights to production, storage and transportation of petroleum, natural gas and their products.

## IV. ARCHITECTURE

**Subjects 4·00 to 4·99** (see page 75)

**4·021, 4·022. Freehand Drawing.** Includes drawing from the cast and architectural ornament in charcoal, 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 from the figure.

**4·041, 4·042. Freehand Drawing.** A continuation of 4·032. Drawing from the nude, memory drawing from the figure.

**4·051, 4·052. Freehand Drawing** (B). Continuation of 4·042. Drawing from the nude figure; memory sketching from the model and direct pen and ink work from casts, the figure, etc. The principles of design are stressed and the application made to working drawings direct from life.

**4·053, 4·054. Freehand Drawing** (A). Advanced work open only to students who have passed Freehand Drawing 4·052. The students work in different mediums from the model, making wash drawings, etc., to help in architectural rendering. Large and small drawings are made to give the student a better sense of scale and proportion. The principles of decorative design are stressed as far as possible in the time allotted.

**4·06. Graphics.** The fundamental conceptions of orthographic projections and fundamental problems on lines, planes and solids with supplementary exercises in the application of the principles of descriptive geometry to problems of an architectural nature.

**4·071, 4·072. Modeling.** Aims primarily to develop the student's sense of a third dimension in his study of architectural composition. Sketch exercises in modeling wax upon a given program of an architectural character.

**4·081, 4·082. Color, Composition, Theory and Application.** Aims to familiarize the student with the theories of color, both scientific and aesthetic, and to give him practice in the use of color.

**4·091, 4·092. Color, Composition, Theory and Application** (B). A continuation of 4·081, 4·082, the problems being of a more architectural character.

**4·11. Shades and Shadows.** Fundamental knowledge necessary for casting the conventional shadows employed in architectural design. Drawing-room work in the nature of test exercises based on textbook preparation. Covers the application of descriptive geometry methods and also short methods of construction useful in practice. Textbook: *Notes on Shades and Shadows, H. W. Gardner.*

**4·12. Perspective.** General theories of perspective and the methods of revolved plan and perspective plan. Practical work involving variations, short cuts and office manipulations.

**4·13. Perspective.** Fundamental phenomena of appearance, the general theory of conical projection and its application to perspective, the method of revolved plan upon which all shorter methods are based, curves and apparent distortion. The study of direct division, direct measurement, relations between lines and points in the vanishing-point diagram, 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 of 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** (B). Designed to give an understanding of the professional character of the practice of architecture. In it are discussed the personal, ethical, business and legal relations of the architect with clients, builders, craftsmen, engineers, etc., with whom he has to work in the practice of his profession; the relations that should exist between the architect, his professional organizations and the community in which he lives. References are made to legal handbooks upon the laws governing architecture and building, and to the various documents that are issued by the American Institute of Architects. 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. Textbook: *Mimeograph Notes.*

**4·311, 4·312. Theory of Architecture.** Introduction to the principles of architecture. Drafting room exercises in abstract design to develop a sense of form and structure. Lectures on the fundamental theory of architecture with a general consideration of materials, construction, and elements of buildings.

**4·321, 4·322. Theory of Architecture.** Lectures and drawing exercises supplementing the corresponding course in Design and closely related to it.

**4·331, 4·332. Theory of Architecture.** Lectures and drawing exercises supplementing the corresponding course in Design and closely related to it.

**4·341, 4·342. Theory of Architecture.** Lectures and drawing exercises supplementing the corresponding courses in Design and closely related to it.

**4·411, 4·412. Architectural History.** Lectures, illustrated by stereopticon, covering the periods of Egyptian, Assyrian, Persian, Greek and Roman architecture, supplemented by reference reading and theme writing and 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 illustrated lectures covering the periods of Byzantine, Romanesque, Gothic and Renaissance Architecture, supplemented by class sketching, and by reference reading.

**4·423, 4·424. Architectural History.** The same course as 4·421, 4·422, omitting the classroom sketching.

**4·461, 4·462. European Civilization and Art.** First Course. After a preliminary survey of the chief periods of European history, illustrated by great monuments of architecture and art, the geographical and racial elements and the early developments of civilization are studied, and the course concludes with a survey of the history and art of ancient Egypt, Babylonia, and the Ægean lands. The lectures are very fully illustrated by lantern slides, supplemented by collections of photographs and by reference to the collections in the Boston Museum of Fine Arts. Textbook: *Breasted, Ancient Times; together with topical reading as directed by a Syllabus.*

**4·471, 4·472. European Civilization and Art.** Second Course. The central feature of this course is a study of the development of Greek civilization and art, and of its dissemination through the Mediterranean Basin and the Levant. As the students in Course IV have a specialized course in the history of architecture attention is here particularly concentrated upon sculpture. Illustrative material as in the previous course. Textbook: *Breasted, Ancient Times*, continues to be used, but the greater part of the work consists in topical reading from references given in the *Syllabus*.

**4·481, 4·482. European Civilization and Art** (B). Third Course. The History and Art of the later Middle Ages and the Renaissance. As in the previous course the study of ancient sculpture was a central feature, attention is now especially directed to the development of modern painting down to, and including, the great masters of the Seventeenth Century. No special textbook is used, but a Syllabus includes references, required or suggested, to a wide range of topical reading. The course is very fully illustrated by lantern slides, photographs, color reproductions, and reference to the collections of the Museum of Fine Arts, Fenway Court, and the Fogg Museum.

**4·491, 4·492. European Civilization and Art** (A). Fourth Course. Modern Culture. A presentation of the chief social forces that have, through the last two centuries, shaped contemporary civilization, including some consideration of such topics as the transplanting of European culture to America, and the development of contacts between the civilization of Europe and that of Islam and Asia. The emphasis throughout will be upon the arts as the expression of modern culture.

**4·52. Philosophy of Architecture** (B). 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.

**4·53. Architectural Humanities** (B). A series of lectures by individual lecturers selected for their professional standing and accomplishment.

**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.** Beginning the study of the basic principles of architectural composition by means of short, intensive problems, the subjects being analogous to or a part of actual architectural problems. Emphasis is put on abstract design as determined and limited by materials, structure, and purpose. This work forms a continuation and application of the first term Theory of Architecture and is given by individual instruction in the drafting room and criticism of student work before the class. It also serves to teach the student the principles and methods of drawing and rendering.

**4·721, 4·722. Design II.** A continuation of 4·712. Problems in architectural composition as applied to buildings of simple requirements and varied character. Carried on by means of eight hour preliminary sketch exercises in the form of sketch problems. Some of these are further developed to a final result in a period of from four to five weeks.

**4·731, 4·732. Design III.** A continuation of 4·722. The sketch problem exercises in this course are of twelve hours duration and the problems more advanced in character.

**4·741, 4·742. Design IV.** A continuation of 4·732.

**4·751, 4·752. Design V** (B.) A continuation of 4·742 in methods, the character of the problems being of an advanced nature. Includes the preparation of the thesis required for the degree of Bachelor in Architecture.

**4·761, 4·762. Design** (A). A continuation of 4·752. 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.

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**4·751, 4·752. Design V** (B.) A continuation of 4·742 in methods, the character of the problems being of an advanced nature. Includes the preparation of the thesis required for the degree of Bachelor in Architecture.

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**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** (B). 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** (B). 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 practice in drawing. 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: *Structural Drafting, Bishop.*

**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 and concrete 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 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.

**4·461. European Civilization and Art.**

**4·462. European Civilization and Art.**

# V. CHEMISTRY

**Subjects 5·00 to 5·99** (see page 75)

## 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, General.** The fundamental principles of chemical science and the descriptive chemistry of the more common elements and their important compounds. Textbooks: *Smith-Kendall, College Chemistry; Blanchard and Phelan, Synthetic Inorganic Chemistry; Pitre, Chemical Problems.*

**5·04. Chemistry, General.** Covers in abbreviated form the subject matter of 5·01 and 5·02. Textbook: *Smith-Kendall, College Chemistry.*

**5·05. Atomic Structure, Elementary.** A non-mathematical presentation of modern views on this subject.

**5·061, 5·062. Inorganic Chemistry** (B). Presents in a correlative manner 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** (A). Special topics in inorganic chemistry such as the chemistry of the less common elements, the more complex reactions of the commoner elements, and reactions in non-aqueous solvents.

## 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.*

**5·11. 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.*

**5·13. 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.

**5·141. Analytical Chemistry.** Gas analysis (5·31); special methods (5·39).

**5·142. Analytical Chemistry.** The chemistry of the rarer elements with special reference to methods of separation, identification, and quantitative determination. Application of general analysis to special industries; specifications and interpretation of results.

**5·16. Analytical Chemistry.** Special methods designed for laboratory conditions of the practice school in chemical engineering.

**5·18. Qualitative Analysis, Advanced** (A). A study of the reactions of the rarer elements and their detection. 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.

**5·23. 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** (B). Abridgment of 5·25.

**5·26. Food Analysis** (B). Problems in state and municipal food control, systems of food inspection and methods of food analysis.

## ANALYTICAL CHEMISTRY

### (C) Technical Analysis Division

#### Undergraduate Subjects

**5·30. Proximate Analysis** (B). 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.

**5·37. Chemistry of Road Materials** (B). 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. Organic Chemistry I.** The fundamental principles of the chemistry of the carbon compounds, based on a study of important substances of the aliphatic, aromatic, and heterocyclic divisions.

**5·412. Organic Chemistry.** Lectures and recitations cover in abbreviated form the subject matter of 5·41 and 5·42. Laboratory experiments include the preparation, class reactions and identification of typical organic compounds. (Army Ordnance only.)

**5·413. Organic Chemistry.** Continuation of 5·412. (Army Ordnance only.)

**5·414, 5·424. Organic Chemistry Laboratory.** Ultimate analysis, organic preparations, identification of organic compounds and special experimental problem.

**5·416, 5·426. Organic Chemistry Laboratory.** Organic preparations, typical reactions associated with each class of organic compounds and methods for their identification.

**5·418. Organic Chemistry Laboratory.** Abridgment of 5·416.

**5·42. Organic Chemistry I.** Amplification and extension of 5·41.

**5·425. Organic Chemistry Laboratory.** Differs from 5·424 in the emphasis placed upon compounds of military importance and in shorter time required.

**5·428. Organic Chemistry Laboratory.** Preparation, class reactions and identification of typical organic compounds.

**5·43. Powder and Explosives** (A).

## ORGANIC CHEMISTRY

### Graduate Subjects

**5·51, 5·52. Organic Chemistry II** (A). The important principles of the science are emphasized from a more mature point of view.

**5·53. Organic Chemistry III** (A). Topics, varied from year to year, are presented in lectures accompanied by assigned reading and discussion.

**5·541, 5·542. Organic Chemistry IV** (A). Designed to produce a familiarity with the phenomena exhibited by organic compounds. The laws and principles of organic chemistry are inferred from the known behaviour of the substances.

**5·55. Organic Qualitative Analysis** (A). The study of systematic methods for the identification of organic compounds.

**5·56. Technical Organic Chemistry** (A). The theoretical factors involved in the industrial applications of organic chemistry.

**5·57. Chemistry of Dyes** (A).

**5·581, 5·582. Advanced Organic Laboratory** (A).

**5·584. Molecular Structure of Organic Chemical Compounds** (A). Deals with the classical and the newer methods for determining the molecular structure of organic compounds. Such classes of compounds as the carbohydrates, the hydrocarbons, the amino acids, and tautomeric compounds will be considered in detail.

**5·591, 5·592. Recent Advances in Organic Chemistry** (A).

## PHYSICAL CHEMISTRY

### Undergraduate Subjects

**5·61. Physical Chemistry I.** Pressure-volume relations of gases; vapor pressure; boiling point and freezing point of solutions; chemical equilibrium; phase equilibrium. Textbook: *Noyes and Sherrill, An Advanced Course of Instruction in Chemical Principles; Sherrill, Laboratory Experiments in Physico-Chemical Principles.*

**5·611. Physical Chemistry I.** Same topics as 5·61, without Laboratory. Textbook: *Millard, Physical Chemistry for Colleges.*

**5·62. Physical Chemistry II.** Continuation of 5·61. Thermochemistry; reaction velocity; free energy of chemical changes; transference; conductance; electromotive force of cells. Textbook: *Noyes and Sherrill, An Advanced Course of Instruction in Chemical Principles; Sherrill, Laboratory Experiments in Physico-Chemical Principles.*

**5·63, 5·64. Physical Chemistry III and IV** (B). Continuation of 5·62. 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.

**5·683. Physical Chemistry, Elementary.** For students specializing in Mechanical and Aeronautical Engineering.

**5·684. Physical Chemistry, Elementary.** For students specializing in Biology and Public Health.

## PHYSICAL CHEMISTRY

### Graduate Subjects

**5·71, 5·72. Physical Chemistry** (A). For graduate students who have not had the equivalent of 5·62. Textbook: *Noyes and Sherrill, An Advanced Course of Instruction in Chemical Principles.*

**5·73. Free Energy** (A). 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** (A). Textbooks: *J. H. Jeans, Dynamic Theory of Gases; R. H. Fowler, Statistical Mechanics.*

**5·75. Thermodynamics** (A). The principal general equations of thermodynamics from the entropy point of view.

**5·76. Thermodynamics and Chemistry** (A). The development of equations for the treatment of chemical reactions and of equilibria in chemical systems. Textbook: *Gibbs, Thermodynamics.*

**5·77. Thermodynamics and Chemistry** (A). The phase relations for heterogeneous systems are treated, special attention being given to binary mixtures. Textbook: *Roozeboom, Die Heterogenen Gleichgewichte.*

**5·78. Quantum Theory Applications** (A). The historical development and applications of the quantum theory. Textbooks: *Sommerfield, Atomic Structure and Spectral Lines; Crowther, Ions, Electrons and Ionizing Radiations.*

**5·79. Theory of Solutions** (A). The properties of solutions are related to those of the components, with special emphasis on solutions of strong electrolytes.

## SPECIAL TOPICS IN CHEMISTRY

**5·81. Chemical Literature I.** Reading and discussion of German and French Scientific Literature.

**5·82. Chemical Literature II.** Methods of using the journals, books and indexes.

**5·83. History of Chemistry** (B).

**5·842. Optical Methods** (B). Laboratory practice in the use of the polarizing microscope for the identification of crystalline material. Equipment is available for both microchemical tests and such optical tests as refractive index, interference figures and optical character.

**5·843. Engineering Chemistry.** The manufacture and testing of paints, varnishes, paper, ink, leather, explosives, illuminating gas, coal tar and petroleum products, animal and vegetable oils. Applications of organic chemistry to engineering.

**5·844. Engineering Chemistry.** The applications and tests of bitumens, tars, pitches, paints, oils, and varnishes. For students specializing in Building Construction.

**5·851. Methods of Electrochemical Analysis** (A).

**5·852. Organic Physical Chemistry** (A). Alternate years. (Offered in 1932–33.)

**5·855. Theories and Applications of Catalysis** (A).

**5·89. Chemistry.** All regular classes in chemical subjects for students in Chemistry and Chemical Engineering are omitted for a period of two weeks at the end of the third year for review, study, and conference with instructors. This is followed by examinations to determine to what extent such students have assimilated the chemistry given in the first three years.

## RESEARCH

**5·90. The Logic of Scientific Inquiry** (A). Discussion of the methods used in making an inquiry into the phenomena of nature; uses of reasoning and of the relations between logic and experiment.

**5·911, 5·912. Journal Meeting in Inorganic Chemistry** (A).

**5·921, 5·922. Journal Meeting in Organic Chemistry** (A).

**5·931, 5·932. Journal Meeting in Physical Chemistry** (A).

**5·941, 5·942. Research Conferences in Inorganic, Organic or Physical Chemistry** (A).

**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** (A). Research for any of the advanced degrees in inorganic, analytical, organic or physical chemistry.

# VI. ELECTRICAL ENGINEERING

**Subjects 6·00 to 6·99** (see page 75)

**6·00. Principles of Electrical Engineering (Electric, Dielectric and Magnetic Circuits).** 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).** 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).** Mathematical vector and symbolic methods of representing alternating currents, single and polyphase alternating currents both sinusoidal and non-sinusoidal, series and parallel circuits including simple net works and coupled circuits, brief treatment of the method of symmetrical phase coördinates for handling unbalanced polyphase circuits, air-core and iron-core transformer for power and communication circuits. The course deals principally with the steady-state condition. 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 (Alternating-Current Rotating Machinery).** Discussion of the different types of alternating-current rotating machinery for the generation and transformation of electric power. Method of symmetrical-phase coördinates and its application to unbalanced conditions in certain types of machines. Textbooks: *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** (B). 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.

**6·09. Principles of Electrical Engineering (Alternating-Current Rotating Machinery).** Recitations and supervised problem work. A shorter course than 6·03. Textbooks: *Lawrence, Principles of Alternating-Current Machinery; Lyon, Problems in Alternating-Current Machinery, Second Edition.*

**6·20. Power Transmission Equipment** (B). Construction and characteristics of the equipment employed in the transmission of electric power and application to transmission line design.

**6·21. Industrial Applications of Electric Power** (B). A treatment of electricity in industry with the aim of establishing a scientific basis for applications of motor drives, electric heating, thermionic tubes, photoelectric cells and their connection with the economical use of electric power. The use of electricity as an aid in production and process control is exemplified. Problems involving duty cycles, handling of materials, machining metals and the use of electric furnaces and ovens are given to illustrate these features.

**6·221. Central Stations** (B). The thermal principles and economic considerations influencing the generation of electric power. The generating station is studied with regard to those factors which influence the fuel consumption and the cost of generation per unit of electrical energy output; the layout and calculation of heat balance and flow diagrams; the economic considerations affecting the selection of site and machinery and arrangement of plant; the physical layout of the electrical bay, turbine plant and boiler plant.

**6·222. Central Stations** (B). The theoretical electrical principles and economic considerations influencing the generation of electric power. The generating station 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 and abnormal operating conditions; the operation of synchronous machinery under short circuit conditions; principles of relay selection and applications for generating stations; the layout and design of the cell structure of the electrical equipment; factors influencing selection of electrical equipment.

**6·241, 6·242. Electric Railway** (B). An introductory subject 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. Motors, control, layout of equipment, operation, mechanical design of rolling stock and maintenance are studied. Various systems, service requirements and existing electrifications are also discussed from economic and engineering viewpoints.

**6·251. Electric Machinery Design** (B). Transformers and induction machines. Materials of construction, methods of construction, and the influence of the various factors of design on manufacture and operation of machines.

**6·252. Electric Machinery Design** (B). Design of synchronous and direct-current machines. A continuation of 6·251 but also complete within the term.

**6·26. Electric Insulation and Its Behavior** (B). Lectures and laboratory work covering the theory and behavior of insulating materials and their use in high-tension equipment. The treatment includes an introduction to classical electrostatics, after which the latest experimental results on conduction, dielectric loss, and breakdown are considered, as well as the theories which have been developed to explain these results. The subject concludes with practical applications to cables, condensers, etc. The laboratory work includes breakdown tests on insulating materials at voltages up to 100,000, as well as the measurement of dielectric loss, dielectric constant, and resistivity.

**6·27. Illumination.** Classroom work, problems, and laboratory investigations covering the scientific basis of illuminating engineering as well as practical applications such as industrial lighting, flood lighting, airport lighting, electric signs, etc.

**6·281. Principles of Wire Communication** (B). Transmission over long lines with distributed constants in the steady state, transformers, insertion loss, networks, loading, filters, balancing networks, repeaters and carrier.

**6·282. Principles of Radio Communication** (B). Elementary theory underlying radio communication. Circuits under free and forced vibrations are discussed with emphasis upon their applications to radio communication. High frequency power sources are described. Particular attention is given to thermionic oscillators and regenerative systems. Moderation, demodulation, high and low frequency amplification, and commercial frequency rectification by present methods are studied. Some time is spent on applications of the thermionic tube. Transmitting and receiving systems are considered.

**6·29. Storage Batteries.** Theory, construction, care and application of storage batteries. Given in one term for eight or more students.

**6·301. Principles of Electrical Communication.** An introductory survey of electrical communications. Forms of intelligence; elementary characteristics of speech and hearing; philosophical aspects of steady-state and transient effects;

the translation of intelligence into variations of a mechanical, electrical, or acoustical nature, and their interpretation in terms of undulatory motion with help of the concept of frequency. Frequency-response characteristics of transmission facilities; elastic and electromagnetic waves; discussion of various complete systems such as the telegraph, telephone, and radio facilities. At appropriate points the historical development and its relation to contemporary scientific progress is emphasized.

**6·302. Principles of Electrical Communication.** The classical analysis of networks relating to the communications field. The subject is introduced with the help of mechanical analogies to simple aperiodic and oscillatory electrical systems in order to emphasize the heuristic viewpoint as an aid to the mathematical attack. The steady-state and transient behavior of simple networks is treated simultaneously for the purpose of showing that an agreement between initial conditions and degrees of flexibility in the formal solution is necessary in order to arrive at unique solutions. The subject is then generalized and the network behavior interpreted in the light of normal modes and normal functions. The use of the superposition principle as well as the treatment of periodic force functions in the complex form, are given. Textbook: *Guillemin, Communications Networks, Vol. I.*

**6·311. Principles of Electrical Communication** (B). General treatment of the principles of ionic conduction in gases and in vacua. A comprehensive study is made of the characteristics of thermionic tubes, photoelectric cells and of gaseous conduction tubes in use today with special emphasis upon their engineering applications and limitations as circuit elements. Includes a consideration of networks containing such circuit elements.

**6·312. Principles of Electrical Communication** (B). The electrical transmission properties of lines and cables in the transient and steady states. Some time is spent to show that the usual analytic definitions of inductance and capacitance are first approximations only. A criterion is established which shows the conditions under which the solutions of the transmission problem are valid. The steady-state solution is obtained, and its application to lines and cables illustrated for various typical cases. Line behavior is studied as a function of frequency in order to introduce the problem of distortion and the means used to combat it. The consequent discussion of lumped loading leads to the representation of this type of line by lumped-constant sections and to a consideration of the cut-off properties of such sections. A brief discussion of the use of such sections as filters, follows. The transient behavior of uniform lines is studied in the light of both the wave and normal function analyses in order to bring out the propagation properties with regard to non-periodic as well as periodic impulses. Textbook: *Guillemin, Communications Networks, Vol. II.*

**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.** Study of various apparatus involved in communications measurements; problems in manipulation. Includes bridge measurements, vacuum tube measurements and artificial line and other network measurements including those at radio frequencies. General object to intimately associate theoretical deductions with actual observations, to stimulate appreciation of the value of creative experimental investigation.

**6·39T. Engineering Electronics.** Recitation and laboratory work covering the more important engineering aspects of thermionic and gaseous conduction circuit elements, associated circuits, apparatus and related topics, with a consideration of the fundamental processes involved. The various applications studied in the laboratory include the cathoderay oscillograph, thermionic tube, mercury-arc and tungsten-arc rectifier, grid-controlled arc, and the photo-electric cell.

**6·40. Elements of Electrical Engineering.** Applications of the general principles of the electric and magnetic circuit to the generation, distribution and utilization of direct and alternating-current power. Textbook: *Hudson, Engineering Electricity.*

**6·42. Elements of Electrical Engineering.** Applications of the general principles of the electric and magnetic circuit to the generation, distribution and utilization of direct and alternating-current power with special reference to ordnance service. Textbook: *Hudson, Engineering Electricity.*

**6·43. Generation and Distribution of Electric Energy.** The thermal, economic and electric principles of electric generating stations, the electric principles and economic considerations affecting the transmission and distribution of electric energy and an analysis of the cost of electric energy.

**6·44. Electric Transmission and Control.** 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.

**6·48. Electrical Equipment of Buildings.** Lectures on the design of electric wiring, lighting and elevator systems for buildings. Textbook: *Cook, Interior Wiring.*

**6·501, 6·502. Electrical Engineering Seminar** (A). A series of papers and conferences of the junior instructing staff and of students who are candidates for advanced degrees in electrical engineering, held for the purpose of reviewing the development of the arts and sciences relating to electrical engineering, and studying the trend of their advancement and particularly the effect of scientific research.

A collateral object of the subject is to impress upon the members of the seminar the most effective methods of collecting, analyzing and presenting data and conclusions in a comprehensive technical subject.

**6·511. Electric Circuits** (A). Methods of solving power-circuit problems. Calculation of short-circuit currents in networks. The theory of multi-circuit transformers. Treatment of unbalanced circuits by the method of symmetrical components, with applications. General circuit constants. The theory and construction of performance charts for transmission lines. A comprehensive graphical treatment of transmission systems in the steady state. Textbook: *Dahl, Electric Circuits. — Theory and Applications, Vol. I.*

**6·512. Electric Circuits** (A). The theory and construction of performance charts for synchronous machines. A general discussion of the problem of power-system stability. A comprehensive exposition of analytical and graphical methods for the determination of static power limits and static stability. Analysis of transients in lumped circuits with constant parameters. Some problems involving transients in lumped circuits with variable parameters, particularly circuit interruption problems. Textbook: *Dahl, Electric Circuits — Theory and Applications, Vols. I and II.* (*Vol. II available in note-form only.*)

**6·513. Electric Circuits** (A). Regulators and excitation systems. A comprehensive discussion of their action, involving determination by analytical and graphical methods of performance during the process of voltage build-up and build-down, etc. Stability of power systems during disturbances. The effect of short circuits and sudden switching. Solution by simplified methods as well as by complete point-by-point methods of analysis. Discussion of methods for improvement of stability. Effect of damper windings. Effect of different methods of grounding the system's neutral points. Textbook: *Dahl, Electric Circuits — Theory and Applications, Vol. II.* (*Available in note-form only.*)

**6·521, 6·522. Advanced Alternating-Current Machinery** (A). Devoted to the analysis of the more intricate electrical problems met in the operation of alternating-current machinery. The following are some of the problems discussed. The effect of unbalanced conditions on the operation of synchronous and induction machines. Eddy currents in laminations, solid rotors and the conductors of direct-current and alternating-current machines. Harmonic analysis of the magnetic density existing in the air gap of synchronous and induction machines and its effect on the generated e.m.f., the torque, and on vibration. Transient conditions due to the sudden alteration of the electric circuits or to the sudden application of the shaft load of synchronous and induction machines, particularly the effect of

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sudden short circuit on the current and torque and the conditions arising during pulling into step and phase swinging.

About one-third of the time is allotted to work in the machine transients laboratory upon advanced problems. Induction and synchronous machines are tested for their steady state and transient characteristics by the aid of special laboratory facilities and a nine-element oscillograph having two power vibrators.

**6·531, 6·532. Organization and Administration of Public Service Companies** (A). Lectures associated with reading, study of financial and operating statistics and forms of organization, and written dissertations by the students. The intention is to give the students a knowledge of the business and engineering characteristics of public service companies and the place held by them in national life.

**6·541, 6·542. Power Generating Stations** (A). The theoretical principles and economical considerations relating to electric generating stations. Thermal efficiency and commercial economy of the different steam cycles, reheating, regeneration, binary cycles; the effect of load factor and the load curve on station design; feed water heating for maximum thermal economy, layout and calculation of heat balances; the limitation of short-circuit currents; maintenance of voltage and stability; the calculation of short-circuit currents and the selection of circuit breakers. The control and transfer of power under normal and abnormal operating conditions as influenced by the bus layout of the generating station; principles of relay characteristics and their selection and applications within the station.

**6·551, 6·552. Railroad Electric Traction** (A). Gives 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. Equipment, operation and mechanical design of rolling stock; energy consumption and economy; study of distribution systems. Specialized details of design are necessarily omitted.

**6·561. Advanced Network Theory** (A). Characteristics of four-terminal networks; synthesis of two-terminal reactances, their equivalents and inverses; conventional filter theory; impedance correction; series and parallel operation of filters for band separation. Laboratory work is given.

**6·562. Advanced Network Theory.** (A) Latest contributions to analysis and synthesis of networks. Generalization of conventional filter theory; transient behavior of selective systems; synthesis of two-terminal dissipative impedances and of four-terminal reactive networks; two- and four-terminal equivalents; corrective networks.

**6·571, 6·572. Illumination** (A). Lectures, problems and laboratory investigations covering the elements of the subject as well as the more advanced aspects. Modern light sources, the use of photo-electric cells for photometric measurements, recent developments in interior illumination and in the daylighting of buildings, projection of light, floodlighting, and similar subjects.

**6·58. Operational Circuit Analysis** (A). The fundamental properties of circuits studied by means of the Heaviside Operational Calculus. The substantiation of this method by classical analysis, especially by the Fourier Integral. Special circuit problems. Textbook: *Bush, Operational Circuit Analysis.*

**6·59. Communications Laboratory** (A). A graduate laboratory course in communications in which special problems in measurements and laboratory analyses are assigned.

**6·62. Principles of Electrical Communications** (A). Deals with thermionic gaseous conduction and photo-electric tubes and their associated external networks. The class work is supplemented with laboratory problems.

**6·651, 6·652. Electric Power Distribution** (A). The theoretical principles of electric power distribution. The distribution system in theory. Calculation of power system short-circuit transients. Limitation of short-circuit currents, maintenance of voltage, and the control and transfer of power. Theory of electric power cables, dielectric properties, calculation and limitation of sheath currents. Low-voltage and medium-voltage distribution networks. Interlacing of primary cables, load division and transformer spacing. Theory of relays, methods of obtaining selectivity and their applications. Load characteristics, economic problems in electric distribution, allocation of demand costs, determination of cost of energy loss and rate structures.

**6·661, 6·662. Principles of Electric Machine Development** (A). Design of transformers and direct-current and alternating-current machines and predetermination of characteristics. Voltage wave-form of generators. Special constructions of machines. Principles of the magnetic and other circuits. Calculation of natural frequency of mechanical vibration. Unbalanced magnetic pull. Flux plotting. General methods of comparing engineering formulas.

**6·68. Transmission-Line Transients** (A). A comprehensive study of transients on long lines. The general theory of travelling waves, followed by a consideration in detail of reflections and refractions at junction points, circuit discontinuities and terminals, the effect of resistance, inductance and capacitance in series and in parallel with the line, the effect of choke coils, etc. Lightning and its effect on transmission lines. Review of laboratory and field test methods and apparatus. Principles and practice involved in lightning protection of lines. Reference book: *Ruedenberg, Elektrische Schaltvorgange.*

**6·69. Sound in Electrical Communications** (A). The acoustical principles involved in the production, measurement, transmission and reproduction of sound by electrical means.

**6·70, 6·71, 6·72. Electrical Engineering Laboratory.** For purposes of administration, the work is divided into two parts: (*a*) Technical Electrical Measurements.— Particular attention is given to tests to determine the character and behavior of the materials of electrical engineering under various circumstances, to the study of electrical measuring instruments, and to a study of the principles involved in the operation of modern electronic devices. (*b*) Dynamo-Electric Machinery.— 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. Textbooks: (*a*) *Laws, Electrical Measurements Special Directions for Measurements Division.* (*b*) *Instructions for Students in Electrical Engineering Laboratory, Seventh Edition,* 1932; *Ricker and Tucker, Electrical Engineering Laboratory Experiments, Second Edition.*

**6·73. Electrical Measurements, Advanced** (A). Opportunity is offered to advanced students to obtain additional training in electrical measurements through the study of special problems selected to meet the needs of the individual.

**6·74. Electrical Machinery Laboratory** (A). 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.

**6·75, 6·76, 6·77, 6·78. Electrical Engineering Laboratory.** Study of technical electrical measurements and dynamo electric machinery. Similar to 6·70, 6·71, 6·72. Textbooks: Same as for 6·70, 6·71, 6·72.

**6·781. Electrical Engineering Laboratory.** Nine experiments in alternating-current machinery.

**6·80. Electrical Engineering Laboratory** (B). For students who desire to do more than the regularly required amount of undergraduate laboratory work. Arranged to suit the requirements of the individual student.

**6·81, 6·82, 6·83. Electrical Engineering Laboratory.** Similar to 6·70, 6·71, 6·72.

**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 Electrical Engineering Laboratory, Seventh Edition,* 1932.

**6·86. Electrical Engineering Laboratory.** Seven exercises similar to 6·85.

**6·88. Electrical Engineering Laboratory.** Study of electrical measurements and the testing of dynamo machinery.

In electrical measurements the students calibrate portable indicating instruments, watt-hour meters and instrument transformers.

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. Textbooks: *Ricker and Tucker, Electrical Engineering Laboratory Experiments, Second Edition; Instructions for Students in Electrical Engineering Laboratory, Seventh Edition,* 1932.

**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 plants of the General Electric Company in Lynn, Schenectady, Pittsfield and Erie. The students are not all assigned to the same jobs; neither are they always assigned to the same departments. The following is the list of the various departments to which students are assigned and it also indicates the approximate order in which the manufacturing practice is given.

**General Electric Company**

Machine Shop Training Room, Assembling and Inspecting. Armature Winding.

Drafting and Design, including work on Motors, Transformers and Turbines.

Standardizing Laboratory and Meter Testing.

Direct-Current Motor Test.

Alternating-Current Motor Test.

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 6·924. A Public Utility Practice.** The courses in Public Utility Practice are given by the Edison Electric Illuminating Company and the Boston Elevated Railway Company. The various departments to which the students are assigned are listed below in the approximate order in which the work is given.

**Edison Electric Illuminating Company of Boston**

Maintenance of Line Departments.
Standardizing and Testing Departments.
Steam Division of Generating Department.
Electrical Division of the Generating Department.
Sales Department.
Installation Department.
Supply Department.
Electrical Engineering Office.
Scientific Research and Study covering the many Public Utility Problems.

**Boston Elevated Railway Company**

Dept. of Rolling Stock and Shops.
Maintenance Department.
Transportation Department.
Power Department.
Miscellaneous Work.

**6·911. Public Utility Practice (Edison).** First term's work at the plants of the Edison Electric Illuminating Company of Boston.

**6·912. Public Utility Practice (Edison).** Second term's work at the plants of the Edison Electric Illuminating Company of Boston.

**6·913. Public Utility Practice (Edison).** Third term's work at the plants of the Edison Electric Illuminating Company of Boston.

**6·914. Public Utility Practice (Edison).** Fourth term's work at the plants of the Edison Electric Illuminating Company of Boston.

**6·921. Public Utility Practice (Elevated).** First term's work at the plants of the Boston Elevated Railway.

**6·922. Public Utility Practice (Elevated).** Second term's work at the plants of the Boston Elevated Railway.

**6·923. Public Utility Practice (Elevated).** Third term's work at the plants of the Boston Elevated Railway.

**6·924. Public Utility Practice (Elevated).** Fourth term's work at the plants of the Boston Elevated Railway.

**6·941 to 6·944. Communications Practice.** These 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.

# VII. BIOLOGY AND PUBLIC HEALTH

**Subjects 7·00 to 7·99** (see page 75)

**7·01. General Biology.** An introduction to the study of living things. Essentially a general discussion of the fundamental facts and principles common to all the biological sciences. Elementary and preparatory in character and in aim.

**7·03. Theoretical Biology** (B). Advanced lectures and recitations in general biology designed to acquaint the student with the principal theories and hypotheses which have played an important part in the development of biological science, and particularly of those which underlie the more fruitful research work of the present day. The two major problems discussed are heredity and morphogenesis. Special reading assigned. Textbook: *Sinott and Dunn, Principles of Genetics.*

**7·05. Microscopy of Fibres** (B). A study of microscopic structure and method of identifying the principal textile and cordage fibres of both plant and animal origin. Sectioning, straining 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. Textbook: *Schwarz, Textiles and the Microscope.*

**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 paid also to the structure and development of flowering plants, particularly from the economic aspect. The fundamentals of plant physiology are stressed. Textbook: *Mottier, College Textbook of Botany.*

**7·07. Mycology.** Many decomposition processes are caused by the attacks of fungi of various kinds. 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 molding of foods and 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, Introduction to Human Parasitology*, 1930.

**7·09. Parasitology, Advanced** (A). Advanced work involving intensive study of some of the more important parasites causing diseases of domestic animals and man. The student will be required to study fresh materials from original sources, the aim being to acquaint him with methods of isolation and investigation which he could apply in problems of this character which might arise in his professional career.

**7·10. Zoölogy.** A systematic study of the invertebrate animals, considering their form, structure, distribution, and economic value. Textbook: *Hegner, College Zoölogy, third edition.*

**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; Bremer, Textbook of Histology; Harman, Laboratory Outlines for Embryology.*

**7·13. Cytology** (A). For students who have had a laboratory course in histology. A seminar course on special topics in the literature, including the morphology, physiology, chemistry, and physics of the cell, and the germ-cell cycle.

**7·14. History of Biology** (A). 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. Textbook: *Nordenskröld, History of Biology.*

**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** (A). Numerous insects and mites are known to be of the highest importance to public health and the food industries due to their abundance and destructiveness. The general problems of their recognition and control are considered. Attention is also given to the insects beneficial to man.

**7·20. Physiology, Elements of.** Lectures, laboratory and reports on the physical and chemical bases of 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** (B). Consideration of personal health and disease, their conditions and causes; exercise, work, play, oral hygiene, hygiene of clothing, of the feet, of the alimentary canal, mental hygiene, etc. Special attention is given to diet from the standpoint of the science of nutrition. 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.

**7·281. 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 for the use of various types of apparatus and the laboratory technique of water examination are given particular consideration. Textbook: *Whipple, Microscopy of Drinking Water, fourth edition, advised for reference.*

**7·29. Bacteriology.** Deals with fundamental principles of bacteriology and the general relations of microörganisms to chemical changes such as fermentation, putrefaction and disease. Particular emphasis is placed on the examination of water supplies and the protection of community water sources. Textbook: *Buchanan, Bacteriology; Prescott and Winslow, Elements of Water Bacteriology.*

**7·301, 7·302. Bacteriology** (7·302, B). Fundamental work in the biology of the bacteria. The first term is devoted to general bacteriology with a thorough study of selected types. The second term is devoted to special study of the bacteriology of water, sewage, air and foods. Textbooks: *Tanner, Bacteriology; Prescott and Winslow, Elements of Water Bacteriology, Wiley,* 1931; *Standard Methods of Water and Sewage Analysis; Standard Methods of Milk Analysis; Hammer, Dairy Bacteriology.*

**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** (A). Reports and discussions of bacterial metabolism and growth, the more important diagnostic tests, and recent developments in bacteriology. In the second term laboratory problems and demonstrations include agglutination tests, production and testing of toxins, etc., and special problems.

**7·33. Plant Diseases.** A brief survey of the types of plant diseases of economic significance which are caused by bacteria and fungi. Textbook: *Owens, Principles of Plant Pathology, John Wiley & Sons*, 1929.

**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. 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. Textbooks: *Whipple, Microscopy of Drinking Water; American Public Health Association: Standard Methods of Water Analysis.*

**7·35. Planktonology** (A). Takes up a consideration of those animals and plants which drift about in the water, unattached. They are the greatest single source of fish food, either directly or indirectly. The identification, life history and distribution are particularly considered.

**7·361. Industrial Microbiology** (B). 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 of collateral reading.

**7·362. Industrial Microbiology** (B). A continuation of the preceding with more detailed laboratory investigation on a semi-commercial scale.

**7·371, 7·372. Industrial Microbiology** (A). Seminar work and laboratory studies involving comprehensive reports and investigations of selected problems in the applications of microbiology to the fermentation and food conservation industries. Among the problems which may be considered are the development or improvement of culture and biochemical methods employed in the manufacture of industrial alcohol, acetone, glycerin, butyl alcohol and organic acids, and the study of special relations of microörganisms in the food, textile, fiber, timber and leather industries.

**7·421, 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.** 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** (B). 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** (B). The fundamental biological facts of infection, resistance and immunity. The biological characteristics of infectious diseases of special interest to the sanitarian are considered in detail. Textbooks: *Park and Williams, Pathogenic Microörganisms, Lea and Febiger; Hiss and Zinsser, A Textbook of Bacteriology, D. Appleton and Company.*

**7·52. Industrial Hygiene** (B). 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. Consideration is given to recent research dealing with those factors related to employee effectiveness.

**7·53. Air Examination** (B). A study of the relation of the composition and physics of air to welfare, efficiency and comfort. The greater part of the course will be devoted to laboratory examination, use of special instruments for air testing, and the determination of dangerous gases, mineral and organic dusts and microbic organisms in air, and the relation of these to industrial hygiene.

**7·541, 7·542. Public Health Administration** (B). Lectures and discussions on the history, organization and administration of health departments and private health agencies, local, state and national, and on current public health problems, their valuation and the methods by which they are handled in health departments. A systematic study of the procedures of official public health agencies.

**7·551, 7·552. Public Health Laboratory Methods** (B). 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 Wassermann and Kahn tests. This course is valuable for physicians, laboratory technicians and those preparing for administrative positions in public health.

**7·56. Public Health Surveys** (A). 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 and community health score cards, and suggested satisfactory schemes of organization for municipal health activities will also be made. Textbook: *Horwood's Public Health Surveys; A. P. H. A. City Health Appraisal Form.*

**7·57. Municipal Sanitation** (B). Lectures and problems dealing with the general principles of sanitation as applied to the community, and including water supply, sewage and sewage disposal, sanitation of swimming pools, collection and disposal of refuse, street cleaning, housing, school sanitation, sanitation of foodstores and restaurants, control of insects and rodents, ventilation, etc. Textbook: *Ehlers and Steel's Municipal and Rural Sanitation.*

**7·58. Vital Statistics** (B). Lectures, recitations and problems by which the student acquires a working knowledge of statistical methods, consideration of errors, and the preparation, graphic representation, critical analysis, and interpretation of data. Textbook: *Whipple's Vital Statistics.*

**7·59. Sanitation** (B). Engineering aspects of public milk supplies, including sanitation of production, transportation and mechanical equipment used in pasteurization and handling, and other machinery incidental to the handling of milk and milk products; the principles of public health surveys; street cleaning; drainage in relation to mosquito control and control of other insects; rodent control and rat-proofing in buildings; inspection and control of shellfish areas; the sanitary aspects of food manufacturing, including plant sanitation, inspection of operatives, etc.; garbage disposal practice; smoke and noise prevention; relation of animal diseases to human welfare; general sanitary inspection methods and the principles of epidemiology.

**7·601, 7·602. Health Education** (A). A consideration of the procedures and methods used by health departments and school departments in health education. The health program of the school system is discussed in detail as to both organization and method. Practical field work is provided to allow the student an opportunity to study and participate in these activities.

**7·603. Health Education Methods.** 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 may be arranged if desired. If this subject is taken for credit no other subjects may be taken for credit simultaneously.

**7·604. School Health Administration** (A). Deals, not with the technique and methods of school health work, but with the organization of the health work expected from teachers, doctors, nurses, physical educators, nutritionists and others, presenting the objectives and measurements of accomplishment for each phase of the work. Special consideration is given to the development of a systematic health education program.

**7·605. Health Education Subject Matter.** Presenting 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.

**7·63. 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** (A). Seminar work in which the student makes an investigation of the methods of study of special problems in laboratory technique or in public health administration, such as the control of communicable diseases, the organization and supervision of food inspection or the application of the principles of sanitary science to other problems.

**7·65. Health Hazards in Special Industries** (A). The specialized study of the dangers in particular industries, such as the rubber, textile, steel and fiber industries, and those involving the possibility of infection or of injury through abrasive particles, by poisonous gases or solvents, or other special dangers. Preventative or palliative measures in such cases are also considered.

**7·66. Epidemiology** (A). Conferences devoted to a detailed consideration of the natural history of epidemics, such as typhoid fever, diphtheria and scarlet fever, and their causes in their relation to public water supplies, milk supplies, sewage systems, insects, and personal causative factors. The student by critical examination of the more celebrated and instructive examples is enabled to prepare himself for the interpretation of corresponding phenomena arising in actual practice. A thorough review of the literature on other infectious diseases, including measles, whooping cough, influenza, tuberculosis, poliomyelitis, cerebro-spinal meningitis, is included.

**7·68. Pathology** (A). 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. Textbooks: for 7·701, *J. R. Smith, The World Food Resources;* for 7·702, *H. S. Eakins, Military Meat and Dairy Hygiene.*

**7·711. Technology of Food Products** (B). 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. Textbook: *Moulton, Meat Through the Microscope; Tressler, Marine Products of Commerce.*

**7·712. Technology of Food Products** (B). A continuation of 7·711, with laboratory studies on selected phases of certain industries. Textbook: *W. V. Cruess, Commercial Fruit and Vegetable Products.*

**7·80. Biochemistry** (B). Primarily a laboratory course with experiments designed to illustrate basic principles of biochemical procedure, as applied in various fields. The laboratory work does not lay emphasis upon clinical aspects of physiological chemistry. Lectures cover the nature of chemical processes in plants and animals with special attention to the metabolism of foodstuffs and the nature of protoplasms.

**7·81. Enzyme Chemistry** (A). Lectures, recitations and reports, with laboratory work on quantitative study of enzyme hydrolyses, their products, and the conditions governing activity.

**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.

**7·931, 7·932. Biological Seminar** (A). 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 these meetings.

The following subjects are offered as General Studies. For description of subjects see Division of General Studies, page 235.

**G63. Economic Geography.**

**G71. Principles of Biology and Heredity.**

**G75. Biological Reproduction.**

# VIII. PHYSICS

**Subjects 8·00 to 8·99** (see page 75)

**8·00. Physics (Entrance).** Covers the entrance requirements in Physics. Students passing the course are not required to take the entrance examination. No laboratory work is given. Textbook: *Practical Physics by Black and Davis, Revised Edition.*

**8·01. Physics (Mechanics).** Lectures, recitations, supervised problem and laboratory work devoted to a study of the fundamental laws of point and rigid body mechanics. The approximate order of the subject matter is: Kinematics of a particle, Newton's laws, linear dynamics of a particle, conservation of linear momentum, plane kinematics and dynamics of particles; work, energy and power, conservation of energy, special examples including collisions of particles; projectiles; friction; simple harmonic motion and Lissajou's figures; rigid body statics; plane dynamics of rigid bodies, moments of inertia, conservation of angular momentum, gyroscopic motion. Free use is made of elementary calculus.

**8·012. Physics (College Transfer).** Given during the first term for those college transfer students who already have been allowed partial credit for 8·01 and 8·02 on the basis of a substantial course in general physics taken prior to their transfer. The course is not to be taken by any student under requirement to take or to repeat 8·01 and 8·02. It is designed to supplement the transfer students' training in amount necessary to cover the requirements of 8·01 and 8·02. Free use is made of the calculus.

**8·02. Physics (Mechanics and Heat).** Lectures, laboratory and recitations. The course is divided into two parts: (*a*) Mechanics of continuous media preceded by a study of gravitational field of force and orbital motion. (*b*) The first and second laws of thermodynamics and elementary kinetic theory of gases.

Under (*a*) is included hydrostatics surface phenomena in liquids, hydrodynamics, static and dynamic elasticity and wave motion. Under (*b*) applications of the first law to perfect gases, thermal properties of liquids, solids and gases, conduction of heat, change of state, Van der Waal's equation of state. Emphasis is placed on the formulation of the principles, their molecular interpretation, and their connection to Newton's laws.

**8·03. Physics (Electricity).** A study of the laws of electrostatics, followed by a discussion of steady flow in conductors, properties of conductors, electrical energy and power, magnets and magnetic fields, galvanometers and their uses, meters, capacitance and inductance, and gaseous conduction. The calculus is used freely, and many types of problems are discussed.

**8·034. Physics (College Transfer).** Given during the second term for those college transfer students who already have been allowed partial credit for 8·03 and 8·04 on the basis of a substantial course in general physics taken prior to their transfer. The course is not to be taken by any student under requirement to take or to repeat 8·03 and 8·04. It is designed to supplement the student's training in amount necessary to cover the requirements of 8·03 and 8·04. Free use is made of the calculus.

**8·04. Physics (Electricity, Optics, and Modern Physics).** Continuation of 8·03, with special emphasis on sinusoidal induced e.m.f.s and simple alternating-current circuits and phenomena. Electrical resonance, free and damped oscillations, and electric waves are discussed. Discussion of waves in general leads to optics, the geometrical optics of lenses and optical systems, and the physical optics of interference and diffraction. Spectra are treated, their explanation in terms of the structure of the atom is given, and various branches of modern physics are discussed.

**8·05. 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 matters of especial interest to students of architecture.

**8·07. Precision of Measurements.** A discussion of the principles underlying the treatment of experimental data and the planning of investigations involving measurements. The course is intended as an introduction to research or thesis work. Textbook: *Goodwin's Precision of Measurements and Graphical Methods.*

**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** (B). 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** (A). An advanced subject consisting of selected experiments followed by a laboratory investigation of problems connected with the industrial application of heat such as thermal conductivity, thermal expansion, specific heat, ceramics, etc.

**8·15. Photography.** An elementary course in photography intended primarily as an elective for students not in Course VIII. It is concerned principally with such applications of photography as record photography, artistic photography, stereoscopic photography, color photography and motion pictures.

**8·152. Advanced Photography.** A laboratory course in photography open only to students with credit for 8·161. The experiments are concerned chiefly with the actual determination of the various characteristics of photographic materials and are designed to give practice in photographic technique.

**8·161. Optics.** Fundamental principles of geometrical, physical and physiological optics. Includes refraction at spherical surfaces, thick lenses, the limitation of rays by apertures, lens aberrations, the resolving power of optical instruments, diffraction, interference, polarization, radiation, light sources, the eye, photometry, color, photoelectricity, the design and construction of optical instruments, stereoscopy, and a detailed description of the performance of well-known optical systems such as telescopes, microscopes, photographic objectives, and projection systems.

**8·162. Optical Measurements.** Laboratory exercises illustrating the principles, methods and manipulation of optical instruments.

**8·171. Advanced Optics** (B). A course covering the same general subject matter as 8·161 in a more advanced manner.

**8·173. Color Measurements** (B). A course in the theory of methods of measuring and specifying color in both the objective and subjective sense and the application of such methods to industrial problems. The experiments are designed to illustrate the photometric and chromatic properties of the human eye and to give experience in the technique of spectrophotometry and colorimetry.

**8·174. Motion Picture Photography** (B). A lecture course of a semi-professional character intended primarily for students planning to enter the motion picture industry. The subject matter of the course is included in the Journal of Transactions of the Society of Motion Picture Engineers.

**8·181. Optics Seminar** (A). A discussion of important problems in photography and optics, including a review of the current literature and the results of researches in these fields at the Institute.

**8·191. Photomicrography and the Theory of the Microscope** (B). 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. (Not offered 1932–33.)

**8·193. Advanced Geometrical Optics** (A). 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. (Not offered 1932–33.)

**8·194. Advanced Physical Optics** (A). 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. (Not offered 1932–33.)

**8·201. Electricity and Magnetism.** An intermediate course covering the mathematical theory and experimental aspects of electrostatics, magnetostatics, steady and variable currents, and electron theory. Textbook: *Page and Adams, Principles of Electricity.*

**8·202. Electronic Laboratory.** A course in intermediate electrical and electronic measurements, to accompany 8·201.

**8·21. Elements of Electronic Phenomena** (B). An introduction to modern electron theory including an elementary treatment of Maxwell-Boltzmann and Fermi-Dirac statistics with applications of these theories to thermionic and photoelectric emission from metals and to gas discharge phenomena.

**8·212. Experimental Electronics** (B). The theory and use of modern experimental apparatus as applied to electronic investigations. This includes experiments with the Compton quadrant electrometer, the FP–54 vacuum tube "Electrometer," the cathode ray oscillograph and the thyratron, as well as experiments of a fundamental nature on thermionic emission, photoelectric effect, and gas discharge phenomena.

**8·213. Advanced Electronics** (A). A comprehensive introduction to the fundamental investigations of thermionic and photoelectric emission of electrons from metals and of the general problems associated with gas discharge phenomena. Both the theoretical and the experimental aspects of these problems are discussed in detail. (Given at the option of the instructor.)

**8·214. Advanced Electronics** (A). Continuation of 8·213.

**8·26. Polar Molecules** (B). Debye's theory of dielectrics and its application to related phenomena. Theory of dispersion and scattering of light, Kerr effect, electrostriction and electrocaloric effects. The dipolmoment and the structure of molecules. Textbook: *P. Debye, Polar Molecules.* (Not offered 1932–33.)

**8·27. X-rays and Crystal Physics** (B). 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.

**8·28. X-ray Diffraction** (A). The theory of X-ray diffraction and its application to the study of the structure of matter.

Elementary theory of X-ray diffraction in crystals, the Lorentz factor, temperature effect, integrated intensity, the Darwin theory of diffraction in mosaic and perfect crystals. Atomic scattering and F curves. The Fourier method of determining the electron distribution in crystals and in the atom. The Scherrer particle-size equation. X-ray scattering in liquids and gases.

**8·29. Lattice Theory of the Solid State** (A). The methods and results of crystallography and the X-ray investigations of crystal structure will be discussed. The following topics will be considered: 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.* (Not offered 1932–33.)

**8·30. Special Problems in Crystal Physics** (B). An advanced problem in X-ray diffraction or crystal physics, with assigned reading and consultation.

**8·311. Atomic Structure.** Lectures and discussions on the phenomena leading to modern theories of the structure of matter and the nature of radiation.

The photoelectric effect, properties of electrons and positive nuclei, optical and X-ray spectra, radioactivity, current models of the atom and their use in explaining the structure of the periodic table, and related topics will be among those considered.

**8·312. Atomic Structure Laboratory.** Experiments on selected topics in modern physics.

**8·32. Line Spectra** (B). Deals with the characteristics of atomic spectra and their description in terms of quantum numbers, their interpretation in terms of current theories of atomic structure, and their use in explaining the chemical properties of the elements.

**8·341, 8·342. Spectroscopy Seminary** (A). Discussion and reports by students of special topics in spectroscopy.

**8·343. Special Topics in Spectroscopic Research** (A). Supervised experimental work in the Spectroscopy Laboratory, designed to be taken concurrently with the Spectroscopic Seminary (8·341, 8·342) by students who desire to carry out special investigations which do not come under the head of thesis work.

**8·35. Excitation of Spectra** (A). Lectures on fundamental processes of excitation and consideration of the most important related current literature. Laboratory experiments illustrating some of the principal topics discussed in the classroom. Excitation by absorption, by electron impact and by radiationless transfer of energy. Arc, spark and furnace spectra. Complex excitation. Mixed gas discharges. Optical and electrical methods of critical potential measurements. Line intensities under different conditions of excitation.

**8·36. Radiation Measurements** (B). Aims to familiarize the student with modern instruments and methods employed in the measurement and analysis of ultra-violet, visible and infra-red radiation. The lectures cover the theory, construction and characteristics of selective detectors (*e.g.* photoelectric cells) and of non-selective detectors (*e.g.* thermopiles). The theory and practice of qualitative and quantitative spectral energy analysis are considered in detail. The laboratory instruction includes comparison of the characteristics of detectors, calibration of detectors in absolute units, analysis of radiation by various methods and practice with radiometric instruments. Special emphasis is placed on line intensity measurements during the last half of the course.

**8·361. Radiation Measurements Laboratory, Advanced** (A). In general the student will work with the instructor on some part of the latter's current research.

**8·45. Introduction to Physical Science.** A non-mathematical representation of the methods and ideas of theoretical physics, illustrated by lecture demonstrations of various phases of modern physics.

**8·461, 8·462. Introduction to Theoretical Physics** (B). Elementary presentation of topics in mechanics, vibrating particles, strings, and membranes, wave propagation, wave mechanics, optics, heat conduction, and electromagnetic theory, arranged to develop the understanding and use of ordinary and partial differential equations, Fourier series, Bessel's functions and other special functions, vector analysis, and potential theory.

**8·471. Historical Development of Physics** (B). A survey of physics up to 1900, intended to correlate the various branches, present them in their historical order, and provide a means of filling in any gaps that there may be in the student's previous training. There will be fairly detailed treatment of such subjects as advanced mechanics, physical optics, electromagnetism, electromagnetic theory of light, thermodynamics, the atomic hypothesis, the kinetic theory. A feature of the course will be oral and written reports by the students on various topics.

**8·472. Recent Developments of Physics** (B). A survey similar to 8·471, of physics since 1900. Electron conduction in gases, thermionic and photoelectric effects, the quantum theory, atomic structure, and wave mechanics. More advanced and mathematical treatment of most subjects than in 8·311.

**8·481. Advanced Mechanics I** (A). The mechanics of particles and rigid bodies treated by the generalized methods of Lagrange and Hamilton. (Not offered 1932–33.)

**8·482. Advanced Mechanics II** (A). A continuation of 8·481, including the transformation theory of dynamics, the elements of perturbation theory and the general theory of orbits, non-holonomic and dissipative systems and the theory of vibrations. (Omitted 1932–33.)

**8·49. Elasticity and Fluid Dynamics.** Theory of static elasticity and elastic vibrations. The general theory of the flow of perfect fluids, steady and turbulent flow of viscous fluids, and wave motion in fluids. (Omitted 1932–33)

**8·491. Boundary Value Problems in Theoretical Physics** (A). Applications of the theory of boundary value problems to vibrations of elastic bodies, to sound and electromagnetic vibrations, and to wave mechanical oscillations. A study of the general methods used in the solution of such problems. (Not offered 1932–33.)

**8·50. Heat and Thermodynamics.** First and second laws of Thermodynamics, with applications to properties of gases, change of state, and chemical equilibrium. Elementary kinetic theory, Maxwell distribution of velocities, and the Maxwell-Boltzmann formula.

**8·512. Statistical Mechanics** (A). A course in the basic principles of statistical mechanics with applications to physical problems. Among the topics treated are the concept of phase space, Lionville theorem, ergodic hypothesis, statistical definition of entropy, canonic and microcanonic ensembles, statistical interpretation of the thermodynamic potentials, classical and quantum statistics of a perfect gas, conditions of degeneracy, elementary statistics of radiation, the H-theorem, and the elements of fluctuation theory.

**8·521. Quantum Mechanics** (A). General principles of wave mechanics. Analogy with optics, Newtonian mechanics as limiting case, Schrodinger's equations, stationary states for particular problems. Orthogonality, matrix representation. Variation method, perturbation method with applications of Zeeman effect, etc. Exclusion principle, resonance effects, in systems with several electrons. Aperiodic phenomena.

**8·522. Theory of Spectra** (A). Application of wave mechanics to the theories of line and band spectra with detailed study of the structure of atoms and molecules, and of molecular binding.

**8·53. Special Topics in Quantum Theory** (A). The subject will change from year to year, including such topics as chemical valence, rates of chemical reactions, collision problems, structure of metals, etc.

**8·541. Electromagnetic Theory** (B). 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.

**8·542. Electromagnetic Wave Propagation** (B). A continuation of 8·541 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.

**8·56. Electromagnetic Wave Theory I** (A). The fundamental circuital laws, energy and energy flow, scalar and vector potentials. Plane waves in isotropic homogeneous conducting and non-conducting dielectrics, boundary conditions, reflection and refraction, spherical waves, Hertz's solution of the electromagnetic equations, diffraction, electron theory, field of a moving point charge, scattering of light.

**8·57. Electromagnetic Wave Theory II** (A). Mechanics of the electron, including such topics as the Lorentz force, electromagnetic mass, and radiation reaction. The pressure of radiation. Introduction to restricted relativity. Minkowski's electromagnetic equations for moving media.

**8·58. Theory of Relativity** (A). Review of restricted relativity, the principle of equivalence, Einstein's law of gravitation, Schwarzschild's solution and its consequences, cosmological considerations, attempts at a unification of electricity and gravitation. Quantum theory and relativity. (Not offered 1932–33.)

**8·591. Theoretical Seminar** (A). Discussion and reports by students on special topics in theoretical physics.

**8·592. Theoretical Seminar** (A). See description under 8·591.

**8·61. Ceramics** (B). 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.

**8·62. Optical Ceramics** (B). 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.

**8·63. Fundamental Ceramic Processes** (A). 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** (A). 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.

**8·801, 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: *Washburn's Principles of Physical Chemistry; Butler's The Fundamentals of Chemical Thermodynamics; Thompson's Theoretical and Applied Electrochemistry.*

**8·82. Electrochemistry** (B). Electrical conduction in liquids, solids and gases, theories of the voltaic cell, polarization and electrolysis, the principles involved in the corrosion, electrodeposition, and refining of metals, and the energy relations underlying the mutual transformations of chemical and electrical energy. Reference: *Thompson's Theoretical and Applied Electrochemistry, and other Standard texts, and Scientific Journals.*

**8·83. Electrochemistry, Advanced.** The application of thermodynamics to electrochemical problems, including electromotive force of reversible cells, electrolytic oxydation and reduction phenomena and high temperature equilibria in electric furnaces. Reference books: *Lewis and Randall's Thermodynamics; Journal articles.*

**8·851, 8·852. Applied Electrochemistry** (B). Consideration of the industrial applications of electrochemistry. Includes the theory and construction of different types of electric furnaces, electrometallurgical processes, accumulators and primary cells, and the electrolytic production of chemical compounds. The work 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** (B). 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** (B). 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: *Neostyled notes.*

**8·89. Electric Furnaces** (B). Intended for fourth year and graduate students who desire to obtain some acquaintance with electric furnace operation, without having had any previous training in applied electrochemistry. 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 Neostyled 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. Electrochemical Colloquium** (B). 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.

The following subject is offered as a General Study. For description see Division of General Studies, page 235.

**G66. Descriptive Astronomy.**

# X. CHEMICAL ENGINEERING

**Subjects 10·00 to 10·99** (see page 75)

**10·11. Problems of the Chemical Engineer.** Describes the field of activity of the chemical engineer and the preparation along both chemical and engineering lines which the practice of the profession requires.

**10·15. Thesis Reports.** Intended to give seniors training in the presentation of the results of technical investigations by oral and written reports. An attempt is made to reproduce the variety of situations which confront the practicing engineer in presenting oral reports to groups with varying degrees of engineering training and experience.

Thesis reports consist of periodic oral and written reports on progress of thesis before fellow students and staff members in chemical engineering.

Committee reports consist of oral reports on some technical problem before student groups from various branches of engineering. The Department of English coöperates with the engineering departments in this work.

**10·17. Industrial Chemistry.** Deals chiefly with the industrial aspects of fuels, combustion and furnaces through the solution of numerous problems. Textbook: *Lewis and Radasch, Industrial Stoichiometry.*

**10·18. Industrial Chemistry.** The more important industrial chemical processes are studied from the point of view of both the chemical reactions forming the basis of the process, and the plant necessary to carry on these reactions. In this way the interrelationships of the different industries as to raw materials, sources of energy, and standard types of apparatus are developed and a general survey of the field obtained. Extensive problem work is included and one hour a week of memoirs presented by individual students upon important topics.

**10·191. Chemical Engineering Literature.** Readings in technical literature in both French and German, including researches in reference books and journals.

**10·192. Chemical Engineering Literature.** Continuation of 10·191.

**10·201. Industrial Chemistry.** Similar to 10·18 except that problems are of a less advanced character.

**10·203. Industrial Chemistry.** Similar to 10·18 except that problems are of a less advanced character.

**10·21. Industrial Chemistry** (B). A continuation of 10·18. Devoted to those industries which deal with amorphous solids, including glass, ceramics, leather, paints, textiles, paper, rubber, etc.

**10·25. Industrial Stoichiometry** (A). Offered for graduates of other institutions where the instruction received in physical and organic chemistry has been similar to that given at the Institute but where the instruction received in industrial chemistry has been descriptive in character. The work involves a thorough study of typical processes of chemical industry by the solution of numerous quantitative problems.

**10·26. Industrial Chemical Laboratory** (B). A study of the evolution of a chemical process from the idea as originally formulated through the successive stages of laboratory development to the design and equipment of the necessary plant.

**10·28. Chemical Engineering.** A study of the thermal properties of matter and the energy relationships underlying mechanical and 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.** Continuation of 10·28.

**10·30. Engineering Equipment.** Intended to give students selecting the Chemical Engineering Practice Option, X-B, instruction and practice in testing engineering equipment such as pumps, fans, turbo-blowers, blowing engines, motors, generators, etc. commonly used in chemical engineering operations. Emphasis will be placed on the determination of the operating characteristics of such equipment under plant conditions.

**10·31, 10·32. Chemical Engineering** (B). These subjects cover the basic principles underlying the unit operations of chemical industry. Because most of these operations involve fundamental problems in flow of heat and flow of fluids, these topics are first discussed in detail. There follows an analysis of the operations of evaporation, distillation, drying, humidification, filtration, subdivision of solids, hydraulic classification and similar topics. 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.*

**10·38. Chemical Engineering.** This subject offered for officers of the Ordnance Department includes a brief survey of the fundamentals of physical chemistry and chemical engineering and their application to the industrial operations involved in the manufacture of propellants and high explosives.

**10·41, 10·50. Special Topics in Chemical Engineering.** The purpose of each of these 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). 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). A detailed study of the basic principles of drying of solids and gases. Particular attention is given the fundamental mechanism of the drying of solids, with quantitative problems illustrating the application of the theoretical equations for the diffusion of liquids through solids. The work includes a study of those phases of Mechanical Separation, such as pressing, centrifuging, etc., which are frequently involved in industrial drying operations.

**10·43. Evaporation** (A). 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.

**10·46. Absorption and Extraction** (A). The basic principles of equilibria, mechanism and rate of interaction are studied in detail. Quantitative applications include the absorption of single gases, such as sulfur dioxide, ammonia and hydrochloric acid, and complex mixtures, such as light oil, casing-head gasoline, refinery gases, and the like. Particular attention is paid to graphical methods.

Includes a study of the basic principles of adsorption phenomena followed by problems in decolorization of oils, sugar syrups and the like; solvent recovery by adsorption and the leaching of various solids.

**10·50. Heat Transmission** (A). 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.** (A). Offered for graduates of other schools whose training in Chemical Engineering has been along somewhat different lines from that given in 10·31 and 10·32. Emphasis is placed on basic theories in flow of fluids and flow of heat and application is made to problems of an advanced character. Attention is paid to recent developments in Chemical Engineering.

**10·53. Chemical Engineering Design** (A). Open only to students who have taken the fieldwork of 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** (A). 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.

**10·55. Economic Balance** (A). A shorter course of the same character as 10·54, offered primarily for students of the School of Chemical Engineering Practice who have completed the field station work.

**10·62. Applied Chemical Thermodynamics** (A). Presents and illustrates those elements of thermochemistry and thermodynamics of most importance in the field of chemical engineering.

**10·63. Applied Colloid Chemistry** (A). A study of the application of colloid chemistry to various chemical industries, including a brief survey of the general principles of colloidal chemistry, with special reference to their industrial application, a discussion of various colloid problems involved in the industries, and a consideration of the important research problems in applied colloid chemistry now pressing for solution.

**10·65. High Pressure Processes** (A). A study of the principles involved in the use of high pressures and catalysts in certain chemical reactions, such as the synthesis of ammonia, synthesis of mixtures of aliphatic compounds, alcohols and hydrocarbons from water gas, hydrogenation of coal and oils, cracking of mineral oils, etc., together with a discussion of industrial applications, equipment requirements, and opportunities for research.

**10·68. Materials of Chemical Engineering** (A). Designed to assist in the selection of equipment for use in Chemical Engineering processes. Major emphasis is placed on resistance to corrosion, and considerable time is devoted to theories of corrosion and methods of prevention. The strength of materials and other factors are discussed in relation to the choice of the most economic design.

**10·70. Principles of Combustion** (A). Open to graduate students who have majored in a non-chemical branch of engineering or science and who wish to specialize in the engineering rather than the chemical phase of fuel engineering. As emphasis will be placed on the application of fundamental principles in combustion reactions, the subject matter will include instruction in physical and organic chemistry of particular importance in fuel engineering. Numerous problems, illustrating the quantitative application of these principles in fuel processing and utilization, will be assigned.

**10·71. Fuel Engineering** (A). An advanced subject in fuel engineering for students with an adequate background of physical and organic chemistry and thermodynamics. The subject includes such material as the mechanism of the combustion reactions, and the application of combustion principles to problems of design or use of equipment for fuel processing and utilization.

**10·72. Fuel Engineering Practice** (A). At the Lackawanna Plant of the Bethlehem Steel Co. (near) Buffalo, N. Y., an opportunity is provided for a study of fuel engineering under unusually favorable conditions. Coal is processed in modern coke ovens to produce metallurgical coke for blast furnaces. By-product fuels from these processes include coke breeze, coke oven gas, tar, benzol and blast furnace gas. The fuel engineer has the problem of the effective utilization of these fuels in meeting the requirements of blast furnace stoves, soaking pits, reheating furnaces, open hearth furnaces, lime kilns, coke ovens, boiler furnaces and internal combustion engines.

Within the Buffalo area, gas plants, petroleum refineries, central power stations and industrial plants furnish a wide diversification of fuel problems. Arrangements have been made for inspection trips and plant tests to round out the student's training in those phases of fuel engineering not encountered in the steel plant.

**10·73. Fuel Engineering Design** (A). This subject, open only to men who have completed the work in Fuel Engineering Practice or who have had an equivalent industrial experience, involves the design, selection and layout of equipment needed in the solution of a major problem in fuel engineering.

**10·74. Furnace Design** (A). A study of principles and calculations of furnace design and construction dealing with rates of heat transfer and with flow of gases in furnaces. The quantitative design and layout of several furnaces, retorts or still-settings will be carried out.

**10·76. Seminar in Radiant Heat Transmission** (A). Will stress the theory and derivations incident to heat transfer in furnaces. Among the subjects considered will be the general law of total radiation in its differential form, its applications to radiation between finite solid surfaces with evaluation for special shapes of engineering importance, the law of spectral energy distribution of radiation, its application to radiation from luminous and non-luminous gases, powdered coal flame radiation, and optical pyrometry.

**10·78. Fuel Engineering Laboratory** (B). Open only to men who have had 10·70, Principles of Combustion, or its equivalent. Instruction will be given in those phases of analytical chemistry and physical measurements which are of special interest to the fuel engineer, *viz.*, analysis of gaseous, liquid and solid fuels, and products resulting from their processing and utilization; analysis of boiler feed water and its treatment with special reference to its foaming, scaling and corroding properties; determination of heats of combustion; determination of total carbon content of fuels for carbon balances in plant testing; special measurements such as the fusion temperature of ash, true temperature of gases and flames, etc.

**10·79. Automotive Fuels** (B). (1) 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. (2) 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. (3) Lubrication and lubricants, including a brief discussion of sources of supply and methods of manufacture. The theories of lubrication of journal bearings.

**10·81. School of Chemical Engineering Practice — Bangor Station** (A). At this station emphasis is placed on the study of electrolysis, drying, humidification, evaporation, absorption and causticization. This work is carried out in the plants of the Eastern Manufacturing Company at South Brewer, Maine, manufacturers of writing papers and sulphite pulp and of the Penobscot Chemical Fibre Company at Oldtown, Maine, manufacturers of soda and sulphite pulp. Offered from July to December and from January to May, inclusive, and may be taken only in conjunction with two of the other field stations.

**10·82. School of Chemical Engineering Practice — Boston Station** (A). 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** (A). 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 or 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 or 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 or 10·85.

**10·90. Experimental Research Problem** (A). Designed to meet the needs of special and graduate students who wish to carry out some minor investigation in a particular field. Subject and hours arranged to fit individual requirements.

**10·911, 10·912. Research Conferences** (A). Regular conferences are held with research students by the Staff of the Research Laboratory of Applied Chemistry and of the Laboratories of Chemical Engineering in which the work is conducted.

**10·941. Organization and Methods of Industrial Research** (A). A series of lectures on the methods of conducting scientific research, including such subjects as research organizations, problem selection, literature surveys, laboratory methods, notebooks, report writing and research direction. Specific problems on these subjects are assigned to each member of the class who is required to outline in detail, for discussion in class, his solution. Offered primarily for the staff of the Research Laboratory of Applied Chemistry.

**10·942. Organization and Methods of Industrial Research** (A). Continuation of 10·941, with major emphasis on reports and discussion of methods of attack on specific problems of industrial importance.

**10·991, 10·992. Seminar in Chemical Engineering** (A). Offered primarily for students preparing for the oral examination for the Doctor of Science degree. The first term is devoted to a consideration of special topics in applied chemistry and the second term to unit operations in chemical engineering.

## XI. SANITARY ENGINEERING

(See under Civil and Sanitary Engineering, page 152)

# XII. GEOLOGY

**Subjects 12·00 to 12·99** (see page 75)

**12·01. Mineralogy.** Lectures and laboratory work on the fundamentals of crystallography and mineralogy. The introductory study of crystal models is followed by instruction in blowpipe analysis. These preliminaries are then applied to the study of minerals by intensive work in determinative mineralogy. A close acquaintance is made with about one hundred and ten of the commonest minerals. The lectures cover elementary geometrical and physical crystallography and descriptive mineralogy. Textbooks: *Warren, Determinative Mineralogy; Dana, Manual of Mineralogy.*

**12·02. Mineralogy.** Crystallography and mineralogy of a somewhat more advanced character than that of 12·01. The laboratory work consists of the study of some of the less symmetrical crystal classes, simple crystal measurement and projection, followed by intensive determinative work on certain important minerals as well as some less common ones. The lectures include an introduction to the theory underlying our present knowledge of the structure of crystals, the application of this knowledge to mineralogy, and the genesis of certain minerals. Textbooks: *Dana-Ford, Textbook of Mineralogy, Third Edition; Clarke, Data of Geochemistry* (*Bull.* 770, *U. S. Geological Survey*).

**12·05. Mineralogy, Advanced** (A). Seminar hours devoted to the presentation and discussion of literature bearing on certain phases of theoretical mineralogy. Laboratory study of suites of mineral specimens.

**12·15. Petrography.** Lectures on the occurrence and genesis of rocks of all types and laboratory work using the polarizing microscope in the study of thin sections of rocks. Supplemented by field excursions to instructive nearby localities. Textbooks: *Harker, Petrology for Students; Tyrrell, Principles of Petrology.*

***12·17. Petrographic Research** (A). Laboratory study of selected suite or suites of rocks. Seminar hours devoted to presentation and discussion of literature of petrogenesis. Textbook: *Bowen, The Evolution of Igneous Rocks.*

**12·211. Optical Crystallography** (B). Study of the optical properties of crystals with special reference to the identification of crystalline substances with the aid of the polarizing microscope. Students primarily interested in mineralogy and petrography study, in the laboratory, the optical properties of mineral crystals; other students receive instruction on the properties of common inorganic crystals. Textbooks: *Winchell, Elements of Optical Mineralogy, Third Edition, Part I. Larsen, Microscopic Determination of the Nonopaque Minerals* ( *U. S. Geological Survey Bull.* 679).

***12·212. Optical Crystallography, Advanced** (A). A continuation of 12·211, with special reference to advanced technique in the use of the polarizing microscope and its accessories. The instruction includes: the Mallard method of measuring the optic angle, the use of high index immersion melts, the Emmons' variation methods, the theory and technique of the universal stage, the direct determination of the optical constant of crystals, and heavy mineral separation. Textbook: *Winchell, Elements of Optical Mineralogy, Third Edition, Part I; and lecture notes.*

**12·25. Physical Crystallography** (B). This course is intended as an introduction to the study of crystalline material, with special reference to the needs of students of metallography. The subject matter includes: Elementary geometrical crystallography, with laboratory study of crystal models; simple crystal measurement and projection. Crystal structure theory: point groups, space lattices, space groups. Common structural types. The properties of crystals, especially habit, plastic deformation, recrystallization and hardness, and the relation of these properties to crystal structures.

* 12·17 and 12·212 are both not given in the same year; ordinarily these courses will be given in alternate years, but at the request of the graduate students concerned, and at the discretion of the instructor, the order of alternation may be changed.

**12·30. Geology.** General dynamical geology. Textbook: *Grabau, Textbook of Geology, Part I.*

**12·31. Geology.** Continuation of 12·30. Historical geology, and laboratory work in lithology and on the study of geologic structures and maps. Also several geologic field trips are taken. 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** (A). 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 course 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 a real 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, Fourth Edition.*

**12·41. Economic Geology Laboratory** (B). The student is trained in the determination of ore minerals and their relationships in hand specimens and in polished sections. The laboratory results are correlated with the geological occurrence of the ores. Intended as a laboratory supplement to 12·40.

**12·42. Applied Economic Geology** (B). Considers the application of geology to: prospecting for new ore bodies, geophysical prospecting, alluvial prospecting, diamond drill core interpretation, mine sampling and ore estimation. The various methods of underground geological mapping are discussed.

**12·431, 12·432. Economic Geology Laboratory, Advanced** (A). Laboratory study of specimens or suites of specimens from mineral deposits; metallographic or petrographic work, structural problems.

**12·433, 12·434. Economic Geology Seminar, Advanced** (A). Seminar including reading and reports based upon the literature of ore deposits.

**12·44. Economic Geology of Fuels** (B). The origin and the geological occurrence and utilization of deposits of natural gas, petroleum and coal.

**12·46. Economic Geology of Non-Metallic Deposits** (B). Designed to give students in mining and geology a fairly complete orientation in the occurrence of clays, cements, abrasives, fertilizers, barite and other non-metallic deposits. Includes a certain amount of laboratory work.

**12·47. Microstructure of Ores and Metals** (B). Class and laboratory exercises devoted to 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.

**12·48. Engineering Geology and Hydrology** (B). 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 architectural engineering and building construction who have had no previous work in geology. Describes the character and mode of occurrence of materials of construction, and their application to problems of excavation and building.

**12·50. 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** (A). Laboratory work and assigned reading upon some aspect of Stratigraphy or Index Fossils; such as environment of fossil faunas; faunas and strata of particular regions and periods; correlation of faunas; succession of Tertiary mammals; fossil floras.

**12·53. Index Fossils** (A). 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, Second Edition.*

**12·54. Micropaleontology** (A). A study of fossil miscroscopic plants and animals, especially foraminifera.

**12·55. Organic Evolution, Advanced** (A). Study of various phases of organic evolution; such as evolution of man; laboratory work upon series of animals and plants to illustrate laws of evolution; evolution of plants.

**12·581, 12·582. Stratigraphy, Advanced** (A). 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** (B). 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: *Willis, Geologic Structures*, 1929.

**12·61. Diastrophism and Vulcanology** (B). The subject matter is divided into two parts. In the first, the problems of mountain building and major earth movements are considered; the cause of the movements; criteria for their interpretation; and a description of important examples. In the second part, the problem of vulcanology is treated; the genesis and history of volcanoes; the nature of the process of eruption; and the reasons for their distribution. Then the major active volcanic regions of the world are described.

**12·631, 12·632. Geological Seminar, Advanced** (A). Reading and reports based upon various phases of geologic literature. For graduate students.

**12·64. Geology of North America** (A). The physiography, stratigraphy, igneous bodies and general geologic structures of North America.

**12·65. Geology of Europe** (A). Similar in plan to 12·64, but dealing with the continent of Europe.

**12·80. Geology of Coal and Petroleum** (B). Presents in detail the geological occurrences of petroleum and coal deposits and the methods of investigating petroleum and coal properties.

**12·81. Geology of Petroleum, Advanced** (A). The stratigraphy and structure of the oil fields of the world, with special reference to those of the United States, are considered. Application is made of data in known petroliferous provinces to illustrate methods of exploration in the development of new regions.

**12·851, 12·852. Theoretical Geophysics, Advanced** (A). Dynamics of the earth's crust, isostasy, seismology, the terrestrial magnetic and electric fields, and other topics in terrestrial physics. Textbook: *The Earth, Jeffreys.*

**12·86. Elements of Seismology** (B). The course deals chiefly with the origin and propagation of earthquake vibrations and their relation to the structure of the earth. Types of earthquakes are studied as illustrating the seismic behavior of diverse geologic structures. Seismographic instruments, records, and the application of seismology to prospecting and engineering are more briefly considered.

**12·87. Introduction to Geophysical Prospecting.** This orientation course is designed to acquaint the student with the geophysical prospecting methods as a geological tool. The principles, possibilities and limitations of the methods are discussed, and the nature of the problem of interpreting results is indicated through copious field examples.

The following subjects are offered as General Studies. For description see Division of General Studies, page 235.

**G60. Geology.**

**G62. Mineral Resources in Relation to Civilization.**

**G64. Organic Evolution.**

# XIII. NAVAL ARCHITECTURE AND MARINE ENGINEERING

**Subjects 13·00 to 13·99** (see page 75)

**13·01. Naval Architecture** (B). 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.** 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 shipowner and operator than from that of the designer and builder. General theory of naval architecture; ship forms and coefficients, displacement, stability, trim, flooding of compartments, longitudinal strength. Textbook: *Atwood and Pengally, Theoretical Naval Architecture, Longmans, Green and Company,* 1931 *edition, or later.*

**13·02. Naval Architecture** (B). 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; rolling and pitching.

**13·03. Naval Architecture** (B). Rolling, pitching and heaving motions, methods of controlling same. Resistance and propulsion of ships by paddle wheels, screw propellers, and sails. Methods of making power and speed trials, torsion meters, model experiments of hulls and propellers, effect of shallow water on speed and power. Sub-division for safety at sea. Estimation of weights and application to design.

**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, construction of lines, and stability and behavior in a seaway. 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.*

**13·12. Theory of Warship Design.** Completion of the lectures on general design comprising 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; General Design of Warships, Hovgaard; Speed and Power of Ships, D. W. Taylor.*

**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; Modern History of Warships, Hovgaard.*

**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. Docking stresses. Riveted joints. Textbook: *Structural Design of Warships, Hovgaard.*

**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, including calculation of displacement, stability and strength by the methods used by the Bureau of Construction and Repair.

**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** (B). 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.** 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.

**13·42, 13·43, 13·45, 13·46. Ship Design** 13·45, 13·46 (B). 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.** 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.*

**13·54. Marine Engineering** (B). Includes the determination of stresses and the methods of proportioning the parts of reciprocating machinery. The vibration of ships, balancing of engines, inertia forces 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.*

**13·56. Marine Engineering.** An advanced course devoted mostly to the economic aspects of marine engineering; comparison of fuels, and the various types of steam and Diesel propelling machinery for different types of ships and trade routes; the economical operation of propelling machinery and auxiliaries at sea and in port; boilers, main engines, auxiliaries and auxiliary systems.

**13·58. Marine Engineering.** A study of the marine power plant as applied to naval vessels. Discussion and comparison of fuels, boilers, types of modern propelling machinery, auxiliaries, high pressure steam and other improvements in marine engineering.

**13·61. Marine Engine Design** (B). Computations and drawings are made for 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** (B). A continuation of 13·61. Includes the calculation of sizes and layout of main propelling units and auxiliaries of a steamship, together with diagrammatic arrangement of the principal piping systems. Propeller design, engine balancing and similar marine engineering problems are also treated.

**13·64. Marine Engineering Design.** The calculations for power plants of naval vessels, including boilers, main engines, auxiliaries, 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** (B). Following a preliminary résumé of nozzle and blade design, based on fundamental principles, 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. Descriptions of different marine geared turbine installations, of the marine helical reduction gear and turbine auxiliary equipment are also included together with discussion of the application of fan and mechanical similitude laws.

**13·72. Marine Diesel Engines.** A detail study of Diesel engines and motorship auxiliaries; fuel injection, valve gears, types of engines, Diesel fuels; Diesel-electric drive, and calculations for auxiliaries for motorships.

**13·81, 13·82. Ship Operation** (B). The engineering and economic aspects of ship operation, a study of the various items making up the operating disbursements and incomes; calculations for operating expenses and profits on various trade routes, comparison of different types of fuels and machinery for different sizes of ships and various lengths of voyage; influence of size of ship and speed on operating expenses; turn-around and port expenses; cubic and deadweight ships; the design of cargo and passenger vessels from the owner's point of view; tonnage measurements, fuel conservation, repairs and maintenance; study of present and future trade routes, cargo movements, and factors influencing ocean freight rates. Coastwise, inland water transportation and inter relation of land and marine transportation. Numerous problems in both cargo and passenger ship operation are assigned to the student.

**13·83. Terminal Facilities.** A study of ports and port layouts, the handling of stowage 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

**(See under Physics, page 203)**

# XVI. AERONAUTICAL ENGINEERING

**Subjects 16·00 to 16·99** (see page 75)

**16·00. Aerodynamics of Airplane Design.** Application of aerodynamic theory to airplane design and aircraft propellers. Textbook: *Warner, Airplane Design, Vol. I; Weick, Aircraft Propeller Design.*

**16·01. Aerodynamics of Airplane Design** (B). Performance problems and general theory of longitudinal, lateral and directional stability, controllability, and maneuverability of airplanes. Textbook: *Warner, Airplane Design, Vol. I.*

**16·02. Aircraft Structures** (B). Covers the analysis of fittings and details, the use of the Precise Method for spar design, and introduction to methods for determining the deflection of beams and trusses and to the method of least work. The determination of reactions on and stresses in simple space frames is also covered. Textbook: *Niles and Newell, Airplane Structures.*

**16·05. Airplane Structures** (B). Covers the determination of load factors and the assumptions as to load distribution on airplanes, the analysis of structures by least work and by comparison of deflections, the use of methods of analysis currently employed in the design of all-metal aircraft. Textbook: *Niles and Newell, Airplane Structures and notes.*

**16·06. Advanced Airplane Structures** (A). 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** (B). Lectures, discussions and drafting-room exercises devoted largely to the choice of type of airplane to be used for a given service. Several problems are assigned, and each student makes a selection of type, executes a preliminary design, and estimates the airplane weight and performance. Textbook: *Warner and Johnson, Aviation Handbook.*

**16·11, 16·12. Airplane Design Practice** (B). Actual practice in design. Each student carried through the "layout" and calculations for a simple airplane. Textbook: *Niles and Newell, Airplane Structures.*

**16·14. Airplane Design Practice, Advanced** (A). The student selects his own design problem and investigates thoroughly the particular phase of the design which interests him most.

**16·21. Airship Theory** (A). A study of the aerodynamic and aerostatic forces which must be borne by an airship structure, including consideration of airship stability and control. A preliminary study is made of the properties of aerostatic gases and of the general theory of sustentation of lighter-than-air craft. Textbook: *Warner, Aerostatics.*

**16·22. Airship Structures** (A). Methods of stress analysis employed in the design of rigid airships, following a brief discussion of the general arrangment and design of the hull structure and of the external loading conditions.

**16·26. Advanced Aeronautical Problems** (A). This course covers individual advanced work by properly qualified graduate students. Problems are selected in consultation with the instructor, and the hours are arranged to suit the individual case.

**16·30. Aircraft Propeller Design** (A). Theory and practice of propeller design including the study of propeller stresses. Classroom work is supplemented by actual design practice. Textbook: *Weick, Aircraft Propeller Design.*

**16·35. Aircraft Instruments** (A). Discussion of the use of instruments in aircraft, with analysis of the theoretical and practical problems entering into their design.

**16·44. Commercial Operation of Aircraft** (B). Covers the design and operation of airports and airways, and the economic, legal and transportation principles of commercial operating companies and airlines.

**16·52. Airplane Shop Work.** A shop and lecture course on the handling of materials used in airplane construction, and on methods of fabrication including an elementary course in airplane welding, and in fitting design and fabrication, rib and spar making, wing covering, doping, et cetera, and an elementary study of the various airplane types, parts and designs. Textbook: *The Airplane and Its Engine, by Chatfield and Taylor.*

**16·53. Aircraft Production Methods.** A course in which a carefully selected list of factories is visited and their basic processes studied in detail, such processes being of the type which are either directly used in aircraft production or which are allied to such production. Plants such as production machine shops, foundries, forges, mills, metal working shops, production wood working shops, and instrument makers, are included in the list. Each exercise is very carefully outlined in advance and the students enter the factories in small groups in direct charge of an instructor, and are required to submit a definite report on each visit. The course will include a week's visit to Hartford, Connecticut, where the students will spend their time in carefully studying the methods of engine and aircraft production, as developed at the shops of the United Aircraft and Transport Corporation. The pupils will be in residence in Hartford in small groups while the remainder of the men stay in Cambridge.

**16·55. Airplane Design** (B). Drafting board problems and lectures dealing with the detail design of the airplane structure, and power plant installation.

**16·62. Aeronautical Laboratory** (B). Lectures on the methods and equipment used in aeronautical research, and experience in the making of tests in the Institute wind tunnels.

**16·63. Aeronautical Laboratory and Research Methods** (B). A continuation of 16·62, with lectures on more advanced laboratory methods, and on free-flight testing, together with training in the application of these methods.

**16·69. Aeronautical Seminar** (A). Intended primarily for students conducting theses in aeronautics. Consists of a series of meetings with discussions of new publications and of current research work by both graduate students and members of the staff.

**16·73. Advanced Wing Theory** (A). Selected advanced topics in continuation of M44, equivalent to material covered in Glauert's *Aerofoil and Airscrew Theory.*

**16·74. Advanced Wing Theory** (A). Continuation of 16·73 with practical application of its theory and methods.

**16·76. Aeronautics** (B). Aircraft and the general principles of flight.

**16·78. Aeronautics** (B). Contains material on airship design, aerial propeller design and theory, and aeronautical laboratory methods. Intended to be supplementary to 16·76.

**16·83. Airplane Engines** (B). 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.

**16·85. Airplane Engine Design Practice** (B). Lectures and drafting-room exercises covering certain fundamental problems in aircraft engine design.

**16·86. Airplane Engine Design Practice** (B). 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.

**16·90. Meteorology, Introductory** (B). Intended to give a simplified almost non-mathematical treatment of the fundamental physical laws which hold in the atmosphere and their practical working out in the usually observed meteorological phenomena. A brief study of weather maps and polar front analysis is included together with a short discussion of the principles lying under weather forecasting.

**16·911, 16·912. Synoptic Meteorology** (B). 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** (B). Decoding and plotting of the daily weather reports broadcast from the Arlington radio station, analysis of weather maps and practice forecasting for selected areas.

**16·931, 16·932. Dynamic Meteorology** (A). The application of hydrodynamical and thermodynamical methods to the study of the atmosphere in rest and in motion.

**16·941, 16·942. Meteorological Seminar** (A). Weekly reviews and discussions, by staff members and students, of recent meteorological contributions published in current periodicals, and of original research.

**16·95. Meteorological Instruments and Methods of Observation.**

# XVII. BUILDING CONSTRUCTION

**Subjects 17·00 to 17·99** (see page 75)

**17·20. History of Construction.** A series of illustrated lectures on the development of the art of building. The course is designed to show how man's work as a builder may be taken as an index of his cultural attainments; it reviews the history of architecture from the viewpoint of the builder; and the development of architectural forms and detail, in order to familiarize the student with the vocabulary of construction.

**17·21. Building Construction.** A study of the sequence of the construction of a dwelling of the first class. Commencing with the excavation, the materials ordinarily used in dwelling house work and their assembly are studied in the same order and sequence as the work is done in the field. Instruction is given by lectures illustrated with data sheets and from demonstration from models and samples, after which the student makes scale drawings of key details and writes a complete text describing each step of the operation.

**17·22. Building Construction.** A study of the dwelling. A continuation of 17·21.

**17·31. Building Construction and Materials.** 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.

**17·41. Building Construction and Materials.** 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.

**17·42. Building Construction and Materials.** Problem IV. Study of Steel Construction. A continuation of 17·41.

**17·46. Building Construction.** General intensive course in the mechanics of building construction in wood, steel and concrete, arranged for students in other courses who desire to get a general idea of the mechanics of building.

**17·50. Job Management.** A series of lectures on the management and control of an operation in the field. Includes a study of job organization; the time schedule; the progressive and orderly sequence in which the materials should flow to the job; the coördination of the several crafts, their regulation and management; the elimination of the hazard of fire and accident. Under this heading will also be included lectures on Professional Relations; Organized Labor; Business Experience, etc.

**17·51. Structural Analysis.** A lecture and supervised drafting-room course in the graphical analysis of structures as applied to building construction and engineering. This course is intended to establish a connection by graphical and analytical methods between the study of applied mechanics and structural theory. Textbook: *Wolfe, Graphical Analysis.*

**17·52. Structural Analysis.** An analytical continuation of 17·51 including problems of design in wood and reinforced concrete. The principles of mechanics and structures are applied to designs in wood and reinforced concrete. Textbook: *Sutherland and Clifford, Reinforced Concrete Design.*

**17·65. Quantity Surveying and Estimating.** Theory and methods of preparing standardized quantity surveys for building and engineering construction estimates.

**17·73. Materials — Wood.** A study of Wood. Its growth, formation and structure; species and their characteristics; mechanical properties; decay; preservatives and fireproofing; shrinkage and drying; woodworking and finishes; plywood. Textbook: *Koehler, Properties and Uses of Wood.*

**17·74. Materials — Masonry.** A study is made of the physical and chemical properties of such materials as brick, terra cotta, tile cement, lime, plaster, glass, stone, etc., with special emphasis being placed on the scientific application of these materials to building construction. Individual classroom reports constitute a large part of the work. Textbook: *Leighou, Chemistry of Engineering Materials.*

# DRAWING

**Subjects D1 to D99** (see page 75)

**D11. Drawing and Descriptive Geometry.** Instruction in the correct use of drafting instruments and materials, practice in lettering and in making drawings in pencil, including the theory of dimensioning. Objects are studied in plan, elevation and section and in isometric and in oblique projection. A study of the fundamental conceptions of orthographic projection and problems on lines, planes and solids. Neatness and accuracy are required and especial emphasis is placed upon the ability to visualize the problems and the processes of solution. Textbook: *Notes.*

**D12. Drawing and Descriptive Geometry.** A continuation of D11. The making of dimensioned, freehand sketches of machine parts and of accurate detail drawings from the sketches. Tracings on cloth are made from the finished drawings. The study of orthographic projection through its more complex phases, including sections, developments, tangents and intersections of surfaces of revolution. Textbook: *Notes.*

**D13. Descriptive Geometry** (College Class). Intensive work covering in the first term the complete requirements in Descriptive Geometry. Open only to undergraduate students transferring from other colleges with advanced standing who have received full credit in first-year drawing.

**D23. Descriptive Geometry** (College Class). Intensive work covering in the first term the complete requirement in descriptive geometry, open only to graduate students who do not require first-year drawing.

# BUSINESS AND ENGINEERING ADMINISTRATION AND ECONOMICS

In these Departments are grouped the business subjects provided for the Course in Business and Engineering Administration (XV) and the instruction given in general economics to students of all Courses.

**Subjects Ec1 to Ec99** (see page 75)

**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.

**Ec33. Current Economic Problems** (B) Will cover a selection of the more important economic problems of the present day. Among these are the following: the problem of technological unemployment; high wage theory; the problem of full working days; gold standard; banking gold reserves; price fixing; international balances; control of speculation; tariff problem; financing by bonds vs. taxation. Instruction will be carried on through the seminar method rather than by lectures.

**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, and foreign exchange.

**Ec45. Industrial Relations** (B). Covers in general the same field as Ec46, 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.

**Ec46. Industrial Relations** (B). 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. Outside lecturers coöperate in this course.

**Ec471, Ec472. Personnel Management** (A). Principles and technique of personnel work, sometimes called human engineering. Problems that arise in practice in recruiting, training and maintaining a labor force. Comparative studies of the methods and practices in selection, 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. Other topics for investigation will include methods of wage payment; benefit plans, including pensions and insurance; health and welfare work; housing; labor legislation, including safety supervision and workmen's compensation.

**Ec48. Measurement of Human Aptitudes.** (Seminar) (B). Deals with the applications of statistical methods in the measurement of human aptitudes. A certain amount of practice in the giving of tests and correlation of data will be afforded. The subject is especially designed for students who may undertake work of a scientific nature relating to personnel.

**Ec50. Accounting.** Systematic recording of financial data is a requisite of business; its basis double entry bookkeeping. But more important for management, stockholders and the general public is analysis directed toward useful conclusions. Instruction, therefore, deals with balance sheets, profit and loss statements, surplus, depreciation reserves, methods of report analyses, etc. Actual corporation reports and records are studied.

**Ec51. Industrial Accounting** (B). The application of accounting control to industry. Includes the principles of cost analysis as applied to problems of manufacturing, distribution and administration. Material used is based on a wide variety of business situations.

**Ec521. Analysis of Business Statements** (A). Aims to develop analytical ability in the interpretation of business statements and reports. Will include analysis of actual statements, study of type and information needed for complete analysis, adequacy of accounting methods used, structure and content of statements. Points of view of the creditor, the investor and the manager will be considered. Will include study of statements of financial condition, statements of earnings, operating and cost reports, both published statements and internal reports. Particular emphasis is placed upon the importance of adequate standards for comparison.

**Ec522. Control Through Business Records** (A). Control of any but the smallest business depends upon an adequate system for the gathering of information needed by executives. Examines the fundamental principles behind records systems and the extent to which various actual systems meet the requirements for which they were set up. Periodic reports, budgets, costs, cash control, internal check, inter-company and branch office control, voucher procedure, inventory records, pay roll procedure, expense control, sales records, machine accounting and special problems of control in various industries will be considered. A general study of some complete record system or a detailed study of some special problem of control will be required of each student.

**Ec53. Building Finance** (B). Describes the financing of new building projects as well as the financing of the building constructor. A general survey of the financial policy of corporations and a more detailed study of the valuation of real estate, methods of appraisal, depreciation, financing by first and second mortgages, mortgage companies, building and loan associations, construction loans and the use of bank credit. Special attention is devoted to those aspects of building finance involved in the constructor's effort to secure new business.

**Ec56. Corporations.** Deals primarily with business ownership organization and control. The economic and legal aspects of corporations receive much attention and some time is devoted to other forms of business. Consideration is given to the procedure and problems of promotion and incorporation, relationships of the parties in the corporation, and combinations of corporations in our large industrials. The development of anti-trust laws and the regulation of business by the Federal Trade Commission constitute an important part of the work. The closing weeks of the course are devoted to the study of public utility corporations with special reference to regulation and rates.

**Ec57. Corporation Finance and Investments.** Deals with the fundamental principles of financial organization and management. The various types of corporate securities are examined, the financial problems of the promoter, the incorporators and the later financial management are studied and illustrations are drawn from concrete cases. The latter part of this subject considers more specifically the different kinds of investment securities with exercises in investment analysis, and a discussion of brokerage, speculation and the methods of the exchanges. Lecturers from investment houses assist in this branch of the subject.

**Ec581. Financial Administration of Industry.** (A) Covers the fundamental principles of financial organization and management but emphasis is placed on the ordinary problems of business finance which arise in the day to day work of average manufacturing and trading enterprises. Among the topics developed are the promotion and organization of corporations, holding companies and their uses, problems of capitalization, the marketing of securities, the administration of income, expansion and reorganization. Attention is given to the relations of corporations with such financial institutions as banks, commercial paper houses, and credit agencies. Other topics considered are working capital requirements, analysis of securities, financial statements and their interpretation, corporation income tax reports, credits and collections, insurance, price policies and budgetary control.

**Ec582. Financial Administration of Industry** (A). Deals chiefly with the practical problems of internal financial management as those problems emerge in concrete situations. Based upon the principles developed in Ec581, the course proceeds with an analysis of the specific problems confronting business managers in the manufacturing, mercantile and public utility fields. The case method is used throughout and the cases represent actual business situations. Oral and written reports constitute an important part of the work.

**Ec591. Public Utility Organization and Finance** (A). A study of the ownership organization and financial management of public utility corporations. The subject matter includes a brief study of corporations in general, followed by the application of the general principles of finance and management to public utility enterprises. Among the topics considered are: capitalization, the marketing of securities, the managing of income, surplus and dividend policies, accounting practices and the interpretation of financial statements. Special attention is given to questions connected with public utility holding companies.

**Ec592. Public Utility Regulation and Rates** (A). Deals with the nature and scope of public utilities, their legal organization, the development of the agencies of regulation, the work of the Commissions and the history of judicial review. Among the topics studied are: Valuation for rate making, the rate of return to investors, depreciation policies, rate structures, taxation, public relations, and public ownership. Lectures, recitations and reports constitute the method of study and each student is required to attend and report upon certain hearings before the Massachusetts Public Utilities Commission, when such hearings are in progress.

**Ec61, Ec62. Business Law** (B). This subject acquaints the student with the legal system in its relation to the problems and policies of business administration, and deals with those rules of general law that have frequent and direct application to the more familiar business transactions and business relations. Covers A: business transactions; (1) the relation of buyer and seller, (*a*) general principles of contracts, (*b*) sales of personal property; (2) the relation of debtor and creditor, (*a*) guaranty and suretyship, (*b*) mortgages, pledges and conditional sales, (*c*) mechanics' liens, (*d*) negotiable instruments, (*e*) bankruptcy; B: business relations; (1) employer and employee, (*a*) contracts of employment, (*b*) agency, (*c*) workmen's compensation; (2) types of business organization, (*a*) sole proprietorships, (*b*) partnerships and unincorporated associations, (*c*) corporations.

**Ec63. Business Law and Organization** (B). 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.

**Ec64. Business Law.** This subject acquaints the student with the legal system in its relation to the problems and policies of business administration, and deals with those rules of general law that have frequent and direct application to the more familiar business transactions and business relations. When considering business transactions, he learns of the relation of buyer and seller, the general principles of contracts, sales of personal property, the relation of debtor and creditor, mortgages, pledges, and conditional sales. When studying business relations, he investigates legal relationships between employer and employee, contracts of employment, agency, workmen's compensation, and types of business organization.

**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** (A). Determination of historical trends and periodic fluctuations of economic time series with applications to the making of index numbers of business conditions. Some of the other topics included are association, correlation, and applications of elementary probability to sampling and inspection. Either term may be taken independently of the other.

**Ec681, Ec682. Business Cycles** (A). A study of the fluctuations in the different phases of business. In this is involved statistical interpretation, theories of the business cycle, studies of the intercausation of the different types of business changes, the interpretation and experimental tests of forecasting methods.

**Ec70. Business Management.** Deals with problems of production and distribution of manufactured goods. Topics considered are: organization, layout, buildings and equipment, location, purchasing, quality control, storage, transportation, and salvage. The practices of production and marketing are studied in parallel as far as possible by comparison of the factory with the retail establishment.

**Ec71. Business Management** (B). Deals with the application of the principles of scientific management to production and distribution. Topics covered include research, both technical and commercial; standardization and simplification; production control; sales forecasting; quotas; budgets and incentives for production and sales. By parallel study of production and marketing practices, the development of similar principles in both fields is emphasized.

**Ec72. Business Management** (B). Deals with the management and administration of business enterprises. Subjects considered are: technique of executive control; sales management, determination of selling policies and advertising; administrative problems.

**Ec751. Manufacturing Analysis** (A). Deals with the conduct of professional engineering analyses of management methods in a manufacturing establishment. Schedules are prepared for the critical investigation of such functions as organization, arrangement and maintenance of buildings and equipment, product research and design, purchasing, traffic control, storage of materials and product, intrafactory transportation, quality control, salvage, time study and production control. Library research, field interviews and inspections, and a brief thesis are requirements of the course which is conducted as a seminar.

**Ec761. Industrial Marketing** (A). An advanced course in the methods and problems of marketing goods to manufacturers and other industrial users. Deals with the basic problems presented by this type of marketing, and compares them with the problems involved in marketing manufactured goods for consumption. Special emphasis is given to the coördination of selling methods and to the fundamentals underlying sales policies. Specific problems of individual concerns engaged in this type of marketing form the basis for class discussion.

**Ec762. Retail Marketing.** (A) The subject is designed primarily for students who plan to enter concerns marketing their goods through retail stores. It covers such topics as: retail store organization, merchandise planning and control, relations with supply source, advertising and sales promotion, control of expenses, and general retail management problems. The case method of instruction is used. Opportunity is provided for contact with executives of large retail stores.

**Ec781, Ec782. Standards of Measurement in Industrial Management** (A). Required for graduate students majoring in Course XV. Measurement in management is a new conception of the relation of executive responsibilities to the success of any industrial enterprise through the recognition of the principle that a qualitative unit of measure is essential to the scientific regulation of any activity. Classroom discussions based on original investigations will be devoted to a study of the relationship and behavior of the fundamental factors in administrative and executive management, with the objective of evolving basic criteria, and practical standards for industry to provide the student with a background of coördinated knowledge which will aid him, when in business, in making the best executive decisions. Typical measures to be studied relate to economics and markets, human behavior, leadership and business ethics, laws and functions of management, organization, administration of industry, efficiency of management, financial ratios, economic lot sizes, economic life of equipment, economic quality control, human effort and fatigue, budgetary control, purchasing, and office management.

**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.

**Ec90, Ec91. Investment Analysis** (A). Various methods of analyzing financial reports of companies whose securities are placed upon the market. Risks versus yield of junior and senior obligations; yields and risk of common stock; problems raised by convertible securities; measurements of risks and yield of the securities of new enterprises; of the securities of established enterprises in expanding, stationary and dwindling industries; relation of price to earnings; risk and yield of securities of holding companies and investment trusts; railroad records and derivative ratios; analysis and interpretation of statements of public utility and industrial corporations; measurement of trends within an industry; tests of ratios applicable to investments and of systems of rating.

**Ec95. Industrial Traffic Management** (A). A detailed study of the organization and operation of a traffic management department of an industrial plant. The course deals with industry's conception, interpretation and use of such matters as freight classifications, rate structures, routes, carrier-shipper relations, common carrier liabilities, general and special services, national and state common carrier regulations and protective insurance. Due consideration is given to the types of transportation agencies such as rail, water, air, motor truck, mail, parcel post and express. Seminar discussions are supplemented with classroom conferences conducted by traffic managers from representative industries.

**Ec98. Industrial Research Methods.** Presents the technique essential to the proper conduct of thesis investigations in industry.

**Ec99. Industrial Problems** (B). This course will coördinate the previous subjects which the student has taken. The work will consist of a series of readings and problems illustrating the application of underlying principles to specific business situations. The emphasis will be upon the formulation of a well rounded administrative policy as distinguished from the previous functional approach. In this way, the interdependence and interrelations of Marketing, Finance, Accounting, Production, and Statistics will be indicated.

The following subjects are offered as general studies. For description of G25 see Division of General Studies, page 235.

**Ec46. Industrial Relations.** **G25. Investment Finance.**

# ENGLISH AND HISTORY

## Subjects E1 to E99 (see page 75)

**E1. English (Entrance).** For description see entrance requirements.

**E11. English.** Provides training in oral and written English. In addition to the class exercises, the students meet in small groups for the presentation of short informal talks; there are frequent themes based on the student's experience and on supplementary reading, and conferences in which the written work of the individual student is corrected by the instructor.

**E12. English.** A continuation of E11, with provision for special types of writing and of reading in accordance with the interests of different groups of students.

**E15. English Composition.** A course in composition to be taken by any third or fourth year student whose written work in his professional courses shows that he needs further training.

**E21. English and History.** The subject matter of the course is in the field of history, a choice being offered among several options. As in the first year, the writing of themes, practice in public speaking, and individual conferences on written work form an integral part of the course.

**E22. English and History.** Deals with the chief ideas of nineteenth century and contemporary thought as expressed in the literature of the period. An alternative course is offered for men properly qualified. The writing of themes, practice in public speaking, and individual conferences on written work form an integral part of the course.

**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 to a non-professional audience. 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 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. Lectures, 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 a 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 235.

**G41. Contemporary English Literature.**

**G42. Contemporary European Literature.**

**G43. American Literature.**

**G44. The Philosophic Dramas of Literature.**

**G45. The Bible as Literature.**

G46. Public Speaking.
G47. Committee Reports.
G48. Appreciation of Music.
G50. Fine Arts in Modern Life.
G51. Biography in Science.
G54. Science and Civilization.
G55. French Revolution and Napoleon.
G56. Beethoven and Wagner.
G591, G592. Problems of Modern Philosophy.

# GENERAL STUDIES

This division includes those subjects of a general and essentially non-vocational character which are offered for the purpose of giving the student an opportunity to broaden his education. They are designed to introduce him to fields of thought and interests outside of his chosen professional work.

Sixteen units of general study subjects are required, eight of which may be selected by the Department, others elected by the student. 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.

European Civilization and Art 4·461, 4·462 and Industrial Relations Ec46 are offered as general studies.

Elementary or Intermediate Language in excess of the entrance requirement, included in certain courses, may be accepted as general studies up to eight units. In other courses students may elect such language subjects as general studies, but only up to eight units.

## SOCIAL, POLITICAL, ECONOMIC AND BUSINESS SUBJECTS

| First Term | | Second Term | |
|---|---|---|---|
| G3. | International Law and American Foreign Policy. | G6. | Psychology of Social Adjustment. |
| G5. | Psychology; General Principles. | G10. | Development of Transportation. |
| G31. | Humanics. | G25. | Investment Finance. |
| | | G32. | Humanics. |
| | | G98. | Military History and Policy of the United States. |
| | | Ec46. | Industrial Relations. |

## SCIENCE

| | | | |
|---|---|---|---|
| G1. | History of Science. | G2. | History of Science. |
| G60. | Geology. | G63. | Economic Geography. |
| G62. | Mineral Resources in Relation to Civilization. | G64. | Organic Evolution. |
| G71. | Principles of Biology and Heredity. | G66. | Descriptive Astronomy. |
| | | G75. | Biological Reproduction. |
| | | G76. | History of Philosophy. |

## FOREIGN LITERATURE

| | | | |
|---|---|---|---|
| G821. | French. | G822. | French. |
| G831. | French. | G832. | French. |
| G921. | German. | G922. | German. |
| G931. | German. | G932. | German. |

## LITERATURE, ENGLISH, HISTORY AND FINE ARTS

| First Term | | Second Term | |
|---|---|---|---|
| G41. | Contemporary English Literature. | G43. | American Literature (Not offered in 1932–33) |
| G42. | Contemporary European Literature. (Not offered in 1932–33) | G44. | Philosophic Dramas of Literature. (Not offered in 1932–33) |
| G46. | Public Speaking. | G45. | The Bible as Literature. |
| G47. | Committee Reports. | G47. | Committee Reports. |
| G51. | Biography in Science. | G48. | Appreciation of Music. |
| G55. | French Revolution and Napoleon. (Not offered in 1932–33) | G50. | Fine Arts in Modern Life. |
| | | G51. | Biography in Science. |
| | | G54. | Science and Civilization. |
| G591. | Problems of Modern Philosophy. (Not offered in 1932–33) | G56. | Beethoven and Wagner. (Not offered in 1932–33) |
| | | G592. | Problems of Modern Philosophy |
| 4·461. | European Civilization and Art. | 4·462. | European Civilization and Art. |

### Subjects G1 to G99 (see page 75)

**G1. History of Science.** The history of science from its beginnings. The Babylonians and Egyptians, the development and decline of Greek Science; the transmission of science into Western Europe; the science of the renaissance. The course centers around the physical and biological sciences, but attention is paid to technical arts and sciences. Emphasis is placed on the development of scientific spirit and method.

**G2. History of Science.** A continuation of G1 covering in some detail the history of the various sciences to the end of the eighteenth century. Nineteenth century science is studied along the two lines of its most important developments — geology, biology, and the theory of evolution; chemistry, physics, and the atomic nature of matter.

**G3. International Law and American Foreign Policy.** Lectures with textbook as an outline. Designed to help a student to an intelligent understanding of international relations from the standpoint of American interest. One report will be required on a current international topic based on outside reading and chosen by the student with the approval of the instructor. Selected reports will at times be presented orally and discussed.

**G5. Psychology.** General principles of psychology.

**G6. Psychology of Social Adjustment.** The psychology of social adjustment; personality, normal and abnormal; the individual in the group; social pressures and social sanctions; personal adjustment in the family, the vocational group and the community.

**G10. Development of Transportation** (B). A series of thirty lectures on the history and development of transportation from the beginning down to the present day. It deals with land, water and air transportation, and includes, as transportation agencies, the railways, highways, ocean, coastwise and inland waters, and commercial airplanes. The influence of these various means of transportation upon the industrial, economic and social development of the world forms the fundamental thesis of this course. The interrelation of the arts, general sciences and transportation is emphasized.

**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. Students in Course XV will receive no credit for G25 as this subject is covered by Ec57.

**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. Typical situations together with an account of what was actually done, will be presented as a basis for other problems to which the student will be asked to think out a solution. In addition to these problems, actual situations will be handled in the classroom. Selected students will act as foreman, superintendent, etc., in cases dealing with discipline, requests for promotion, and other problems which an executive must meet adequately. The person taking the part of the employee is brought in from industry and the technique of the students handling the situation is subsequently criticized by actual business executives.

**G32. Humanics.** A continuation of G31.

**G41. Contemporary English Literature.** Treats of a number of the most important English men of letters from 1890 to the present time.

**G42. Contemporary European Literature.** An introductory study of some of the chief figures in European Literature of the past century and today. (Not offered 1932–33.)

**G43. American Literature.** American writers, particularly those of the ninteenth and twentieth centuries, discussed with emphasis on their relation to contemporary life. (Not offered 1932–33.)

**G44. The Philosophic Dramas of Literature.** The study of a selected number of the most important poems and dramas of literature. The choice will be made from among the following: The Book of Job, Prometheus Bound, The Divine Comedy, Hamlet, Paradise Lost, Faust, The Ring by Richard Wagner, The Dynasts. (Not offered 1932–33.)

**G45. The Bible as Literature.** A study of the historical background and the literary treatment of the material of the Old and New Testaments.

**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 required. Many musical illustrations are performed in the classroom. The lectures and textbook endeavor to give simply and clearly the knowledge needed by an intelligent listener. Textbook: *Scholes, Listener's Guide to Music; Landormy, History of Music.*

**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.

**G54. Science and Civilization.** The position and importance of science in the history of civilization. The emphasis is on the major influences of science upon the development of our present-day civilization.

**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. (Not offered 1932–33.)

**G56. Beethoven and Wagner.** An introduction to the lives and the works of the two most significant composers of the past 150 years. (Not offered 1932–33.)

**G591. Problems of Modern Philosophy.** The self and the will. Lectures and discussions, outside readings and reports. (Not offered 1932–33.)

**G592. Problems of Modern Philosophy.** Idealism and realism. The same methods as in G591.

**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. Mineral Resources in Relation to Civilization.** The physical environment of the human race is first considered from a general viewpoint. The following resources of the earth are then discussed: Sources of power; minerals used in industry, including iron and other metals; cements, clays, salts and other non-metallic natural products. The items broadly covered are geology, prospecting, mining, beneficiation, economics and reserves.

**G63. Economic Geography.** Deals with the seas and the land masses of the world, with the geography of the human races, with the world's resources in mineral wealth and its resources of plant and animal origin; also with the distribution of commodities, with manufactured products, with the economic basis of world trade and with national control of raw materials.

**G64. Organic Evolution.** A discussion of evolution, what it is and how it is shown in the organic world. There is especial reference to the evolution of man, his physical ancestry, his inherited impulses, and the development of his cultural environment. Textbook: *Shimer, Evolution and Man.*

**G66. Descriptive Astronomy.** A general survey of the facts and theories relative to the solar system and the sidereal universe illustrated by slides. Textbook: *Duncan, 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, Third Edition*, 1930.

**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. Reference book: *Outlines of Modern Biology, Plunkett, Henry Holt Company*, 1930.

**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.** Outline of the history of French literature. Reading of illustrative specimens and some masterpieces complete: Chanson de gestes, medieval theatre, Villon, Montaigne, Rabelais, Corneille, Racine, Moliere, Voltaire, Rousseau, the Romantic School and subsequent movements.

**G921, G922. German.** Practice in understanding spoken German, expression in German of scientific ideas, general and technical. Reading of texts on science and industry. Each term may be taken independently.

**G931, G932. German.** A brief survey of some period of school of German literature with the reading of some masterpieces. A brief outline of the history of German literature is given, but the attention is chiefly centered on such topics as Goethe and Schiller, the novel, the modern theatre. Each term may be taken independently.

**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 or of the political or other factors leading up to the events referred to except where a clear understanding of the situation requires it. Required of students registered in any Advanced R. O. T. C. Unit. Ordinarily taken during the second term senior year, but may be taken during second term junior year.

## XVIII. MATHEMATICS

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

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

In the second year the student may choose between the kinetics and applied mechanics common to the engineering group of courses, and the chemistry required in the chemistry group. Any student who has completed satisfactorily the work of the first two years in any of the professional courses in the Institute or their equivalent, provided always that a creditable record has been obtained in mathematics and physics, may be admitted to the third year in this course. Such a student will have to make up the course in Higher Algebra and Geometry, but extra work done in the second year will be credited to him in place of elective work of the third year.

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. In all cases he should present a consistent choice of elective subjects with the approval of the department.

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

**Subjects M1 to M99** (see page 75)

**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 algebraic functions; derivatives; differentials; maxima and minima; applications to simple problems in geometry and mechanics, such as the determination of velocity, acceleration, areas, volumes and pressure. A brief discussion of the analytic geometry of the straight line and the conic sections, and the plotting of the curves in rectangular coördinates. Textbook: *Woods and Bailey, Elementary Calculus, Revised Edition.*

**M12. Calculus.** Differentiation and graphical representation of trigonometric, inverse trigonometric, logarithmic and exponential functions, with applications to simple problems of geometry and mechanics, including related velocities, maxima and minima, simple harmonic motion, and curvature; series. Textbook: *Woods and Bailey, Elementary Calculus, Revised Edition.*

**M21. Calculus.** Partial differentiation; integration of functions of one variable including use of tables; definite integrals; geometrical applications to areas and lengths of plane curves, volumes of 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, Revised Edition.*

**M22. Differential Equations.** A treatment of ordinary differential equations including the principal types of first and second order equations, simultaneous equations, and linear equations with constant coefficients. The work is illustrated by numerous applications to geometry, chemistry, physics and mechanics. 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** (B). 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.

**M36, M37. Advanced Calculus** (A). Fundamental principles, power series, partial differentiation, implicit functions, Gamma and Beta functions, line, surface and space integrals, vectors, ordinary differential equations, Bessel functions, partial differential equations, calculus of variation, elliptic integrals.

**M38. Advanced Calculus.** This is a course especially designed for naval officers in Course XIII-A and consists of topics selected from the subject matter of M36 and M37.

**M41. Differential Equations.** Especially adapted to the needs of students in chemical engineering.

**M43, M44. Theoretical Aeronautics** (B). Elementary dynamics of particles, fluids, and solid bodies, with applications to aeronautics.

**M451, M452. Fourier's Series and Integral Equations** (A). 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.

**M54. Mathematical Laboratory** (B). Practical instruction in numerical, graphical and mechanical calculation and analysis as required in the engineering or applied mathematical sciences, numerical solution of equations; graphical methods; nomography and the construction of graphical charts; curve fitting to empirical data; approximate methods of integration, differentiation and interpolation; the use and principles of construction of instruments employed in calculation, and many kindred topics. Textbook: *Lipka, Graphical and Mechanical Computation.*

**M551, M552. Functions of a Real Variable** (A). The first term is primarily devoted to a formulation of the fundamental concepts of infinitesimal analysis more precise than the intuitive treatment in the elementary calculus course. Among the topics treated are real numbers, functions, continuity, derivative, integral, sequences of functions, equi-continuity, uniform convergence, existence theorems, Taylor's series, Fourier series.

**M561, M562. Functions of a Complex Variable** (A). A study of the elementary functions for complex values of the variable. Development and application of the fundamental theorems of the analytic function theory. Elements of the theory of the Gamma function, the elliptic functions, and other special functions.

**M571, M572. Differential Equations** (A). Presupposing the formal solution of differential equations as given in undergraduate courses, this subject deals with the following topics: existence theorems of the various types, Cauchy polygons, Picard successive approximations, power series and majorant functions; the properties of functions defined by differential equations, especially linear differential equations; and partial differential equations. An idea of the direction of the subject can be had by consulting Goursat-Hedrick, "A Course in Mathematical Analysis," Volume II, part 2, and Bieberbach, "Differentialgleichungen." (Not offered 1932–33.)

**M581, M582. Continuous Groups** (A). A study of the basic concepts of group-theory, such as group, sub-group, invariant sub-group, finite and infinitesimal transformations; one-parameter groups and their applications to differential equations and geometry; r-parameter groups, structure constants, the fundamental theorems of Lie; invariant theories associated with continuous groups; differential invariants and applications to systems of partial differential equations.

**M62. Modern Algebra** (A). Polynomials, determinants, linear equations, linear transformation, matrices, bilinear, quadratic, and Hermitian forms, introduction to fields and algebras.

**M631, M632. Differential Geometry** (A). 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.

**M641, M642. Advanced Differential Geometry** (A). This subject, a continuation of M632, contains some of the modern developments in differential geometry, especially those involving tensor calculus, and is particularly useful for students who wish to do research work in this field. (Not offered 1932–33.)

**M651, M652. Analytical Mechanics** (A). Analytical dynamics of particles and rigid bodies is treated mainly by Lagrange's equations in generalized coördinates and Hamilton's canonical equations. Contact Transformation, the Hamilton-Jacobi theory, the theory of vibrations, and non-holonomic systems are among the topics discussed.

**M661, M662. Algebra of Quantum Theory** (A). An introduction to the non-commutative algebras employed by Dirac, Weyl, Heisenberg and others, including the theory of group characters. Slater's matrices, and homopolar valence. Lectures, problems and assigned reading. Familiarity with quantum theory is not prerequisite.

**M671, M672. Potential Theory** (A). In the first term, the elementary theory. Logarithmic, Newtonian, potential. Potentials of simple and double distribution. Laplace's and Poisson's equations. Harmonic functions. Connection with function theory in the case of two dimensions. Harnack's theorems. Boundary value problems for the circle and the sphere. Poisson's integral. Spherical harmonics. Applications to physics. In the second term, general treatment of the boundary value problems of potential theory. Integral equations. The method of Perron-Remak. Green's function. Applications to conformal mapping.

**M681, M682. Calculus of Variations** (A). Extension of the theory of maxima and minima as begun in calculus. The determination of functions, curves or surfaces with given maximum or minimum properties. Applications to geometry and physics; geodesics, minimal surfaces, isoperimetric properties of circle and sphere, Fermat's principle of least time (optics), Hamilton's principle, catenary, brachistochrone. Reference books: *Bolza, Lectures on the Calculus of Variations; Bliss, Calculus of Variations; Goursat, Cours d'Analyse, vol. 2, chapter XXIII; Courant-Hilbert, Methoden der Mathematischen Physik, chapter IV.*

**M70. History of Science** (B). Same as G1 with two extra hours preparation. (Not offered 1932–33.)

**M76. Theory of Probability** (A). Permutations and combinations. Elementary principles of the theory of probabilities. Bernoulli's Theorem. Bayes' Theorem. Distributive functions and continuous variables. Averages. Curve fitting. Textbook: *Th. C. Fry, Probability and Its Engineering Uses.* (New York, Van Nostrand Co., 1928.)

**M77. Vector Analysis** (B). A treatment of the vector functions and operations required in theoretical work on electricity.

**M781, M782. Advanced Geometry** (A). Coördinate systems in plane, space and $n$ dimensions. Properties of conics and quadrics. Projective geometry. Non-Euclidean geometry. $N$-dimensional geometry. Textbook: *Woods, Higher Geometry.* (Not offered 1932–33.)

**M791, M792. Theoretical and Applied Elasticity** (A). The fundamental mathematical theory of elasticity in three dimensions; elastic work of deformation, stress equations; stress functions; Mohr's stress diagram; bending of bars, plates, and tubes; instability; vibration of elastic systems; modern theory of strength; plasticity. Principles and methods used in practical engineering problems; principles of minimum energy and of virtual velocities; method of deflections, Ritz's method and the application of calculus of variation.

Reference books: *Love, Theory of Elasticity; Föppl, Drang und Zwang; Timoshenko and Lessells, Applied Elasticity.*

**M851, M852. Modern Mechanical Theories** (A). 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. (Not offered 1932–33.)

**M90. Mathematical Reading** (A). Designed to give the student an opportunity to read advanced mathematical treatises under the supervision of some member of the department. The treatise chosen and the time allowed will be determined by the needs in each particular case. This course is for graduate students who may find it desirable to do advanced work not provided for in the regular courses. Undergraduates will be allowed to take the subject only under very exceptional circumstances.

The following subjects are offered as General Studies. For description see Division of General Studies, page 235.

**G1. History of Science.**

**G76. History of Philosophy.**

# MILITARY SCIENCE AND TACTICS

**Subjects MS1 to MS99** (see page 75)

**MS11. Military Science.** (Required in all courses.) Consists of nine weeks of infantry drill, three weeks of instruction in rifle marksmanship, and three weeks of lectures on elementary infantry subjects.

**MS12. Military Science.** (Required in all courses.) Consists of ten weeks of infantry drill and ceremonies and five weeks of lectures on elementary subjects of military training.

**MS21. Military Science.** (Required in all courses.) Consists of six weeks of topography and map reading; six weeks of lectures on field fortification and signal communications; and three weeks devoted to branch instruction. Opportunity is given the student to choose the unit in which he desires to continue his training. Those who do not report their choice of a unit by the beginning of the second term will be arbitrarily assigned to a unit.

**MS221. Military Science. Coast Artillery.** Elements of heavy artillery; fire control instruments; target characteristics; ammunition; aiming and laying of guns; service of the piece.

**MS222. Military Science. Engineer Corps.** Engineer organization and training; military bridges; military explosives and demolitions; scouting and patrolling.

**MS223. Military Science. Signal Corps.** Tactical principles; principles of signal communication; Signal Corps equipment; codes and ciphers.

**MS224. Military Science. Ordnance Department.** Ordnance matériel.

**MS225. Military Science. Air Corps.** Air corps fundamentals of employment; aerial gunnery; aerial photography; and engineering fundamentals of the airplane.

**MS226. Military Science. Chemical Warfare Service.** Weapons; chemical agents; chemical warfare drill and command.

**MS31. Military Science, Advanced.** Drill and command. Students are given instruction in the duties and responsibilities of noncommissioned officers and junior officers in Infantry drill; in the training of recruits; and in saber and command exercises.

**MS311. Military Science. Coast Artillery, Advanced.** Position-finding, fire control, and gunnery for seacoast artillery; determination of firing data; conduct of fire; observation of fire; and analysis of drill and practice.

**MS312. Military Science. Engineer Corps, Advanced.** Organization and duties of engineers; administration and supply; scouting and patrolling; combat principles; field fortifications.

**MS313. Military Science. Signal Corps, Advanced.** Various types of codes and ciphers, their uses, and methods employed to break them down; Signal Corps tactics; message centers; administration and supply; military law; Reserve Corps regulations.

**MS314. Military Science. Ordnance Department, Advanced.** Organization and duties of the Ordnance Department; company administration; tactics.

**MS316. Military Science, Advanced.** Chemical Warfare Service. Organization, administration, and duties of the Chemical Warfare Service.

**MS32. Military Science, Advanced.** Drill and command. Students are assigned to companies and are given instruction in the duties and responsibilities of company officers and noncommissioned officers.

**MS321. Military Science. Coast Artillery, Advanced.** Position finding, gunnery, and fire control for antiaircraft artillery.

**MS322. Military Science, Engineer Corps, Advanced.** Military roads and bridges; fortifications; engineer combat principles; military law.

**MS323. Military Science. Signal Corps, Advanced.** Theoretical and applicatory instruction on all telephone and telegraph equipment in use by the Signal Corps; applicatory instruction on Signal Corps field radio sets; instruction in International Morse code; pistol and pistol equipment.

**MS324. Military Science. Ordnance Department, Advanced.** Army organization; industrial mobilization; ordnance problems.

**MS325. Military Science. Air Corps, Advanced.** Airplane instruments; aerial navigation; meteorology; parachutes; pistol marksmanship.

**MS326. Military Science. Chemical Warfare, Advanced.** Tactics and technique of Chemical Warfare Service.

**MS41. Military Science, Advanced.** Drill and command. Students are assigned to companies and are given instruction in the duties and responsibilities of junior officers in Infantry drill and in the training of men in the enlisted grades.

**MS411. Military Science. Coast Artillery, Advanced.** Coast artillery matériel, organization, and employment.

**MS415. Military Science. Air Corps, Advanced.** Administration and supply; duties of squadron officers; special roles of each class of aviation; military law.

**MS42. Military Science, Advanced.** Drill and command. Students are assigned to companies and are occupied primarily in imparting instruction and in the development of qualities of command and leadership in other students.

**MS421. Military Science. Coast Artillery, Advanced.** Tactical employment of fixed, mobile, and antiaircraft artillery.

The following subject is offered as a General Study. For description, see Division of General Studies, page 235.

**G98. Military History and Policy of the United States.**

## MODERN LANGUAGES

Several courses are offered in both French and German; one in Spanish, and one in Italian. Those in French and German are of Elementary, Intermediate and Advanced grade. In the Elementary and Intermediate courses a careful foundation is laid for reading, writing and speaking the foreign language. Great care is taken to secure a good pronunciation, a mastery of the working essentials of grammar, a reasonable vocabulary for the expression of common ideas, training of the ear, and a broad reading vocabulary. The reading texts include scientific matter, fiction, drama, historical or descriptive works of a nature to open up to the student the genius, institutions and social point of view of the country studied. Occasional illustrated lectures are given to supplement the class exercises and stimulate interest. The advanced courses for students in Architecture are planned to give a more ready command of the language, an acquaintance with great examples of literary art, and a familiarity with architectural literature. The General Study courses offer the student an opportunity to carry his study beyond the Intermediate grade, increasing his practical command of the language, reading ability, and acquaintance with the greatest writers.

The one-year elective courses in Elementary Spanish and Elementary Italian are parallel to the courses in Elementary French and German. They give a training in pronunciation, essentials of grammar, and reading of varied matter. On completion a student should be able to make intelligent contact with the foreign country, be able to read correspondence and translate reading matter of moderate difficulty. In all 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 German = German Cp. 2; Elementary Italian = Italian Cp. 2; Elementary Spanish = Spanish Cp. 2; Intermediate French = French B or French Cp. 3; Intermediate German = German B or German Cp. 3.

**Subjects L1 to L99** (see page 75)

**L11, L12. German, Elementary.** The necessary foundation for the study of the German Language and literature, or for scientific studies. It will also enable students to fulfill the entrance requirements in Elementary German. It consists of training in pronunciation, elementary grammar, acquisition of useful vocabulary and reading of easy matter, some of which dealing with science. Textbooks: *Vos, Essentials of German, Holt; Wright, German Science Reader, Holt; Riehl, Der Fluch der Schönheit.*

**L13. German, Elementary.** Similar to L11.

**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. Textbooks: *Herzog, Die Burgkinder, Heath; Wesselhoeft, German Composition, Heath; Greenfield. Technical and Scientific German, Heath.*

**L23, L24. German (Aeronautical).** For students in Course XVI. Review of grammatical principles. Readings adapted to the needs of aeronautical students. Textbooks: *Langsdorff, Das Leichtflugzeug, Bechold Verlag; Pfister, Der Bau des Flugzeuges, Hefte* 1, 2, 3, *Volckmann Nachfolger, Berlin; Langsdorff, Das Segelflugzeug, published by J. F. Lehmann.*

**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. Textbooks: *Selected texts from the Goeschen Scientific Series.*

**L51, L52. French, Elementary.** Designed to give the necessary foundation for the study of the French language and 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, part of which deals with French institutions and the history of France. The last term will include the reading of some technical French. Textbooks: *Aldrich, Foster, Roulé, Elementary French; Hills and Dondo, La France; selected scientific matter.*

**L61, L62. French, Intermediate.** Designed to enable students to meet the entrance requirements in intermediate French. Recitations partly conducted in French. A continuation of the study of grammar, pronunciation, and useful conversational forms; drill in composition and in translation into French of connected passages; reading of matter dealing with French geography, history and industrial activity; some standard modern authors; reading of scientific French. Textbooks: *Barton and Sirich, French Review Grammar; Williams, Technical and Scientific French; Buffum, French Short Stories; some selected plays; Kullmer and Gérard, Sketch Maps of France.*

**L63, L64. French, Advanced.** Planned to meet the needs of Course IV. Emphasis is laid upon good pronunciation, and the ability to express in French matters dealing with travel and architecture. Most of the reading matter will deal with architecture and allied subjects. Textbooks: such books as *Galland, French Composition; L'Art Egyptien, L'Art Grec et l'Art Romain, L'Art Roman, L'Art Gothique* (*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.** For Course IV, second year. Reading of French prose of a varied nature, part of which deals with an outline of French civilization and with the description of French cities, cathedrals, chateaux, etc. Practice in writing French, in pronunciation and conversational phrases useful for travel. Textbooks: *Comfort, Practical French Composition;* such reading matter as *Emile Gebhart, Florence: Besnard, Le Mont-Saint-Michel; La Renaissance Italienne, La Renaissance Française, Le Style Louis XIII, Le Style Louis XIV* (*Grammaire des Styles*)*; Hugo, Notre Dame de Paris; Demaison, La Cathédrale de Reims.*

**L71, L72. French, Aeronautical.** For students in Course XVI. Review of grammatical principles. Reading of scientific matter dealing with aeronautics, engines, electricity, etc. Textbooks: *Barton and Sirich, French Review Grammar and Composition; Williams, Technical and Scientific French; L'Aviation* (*Encyclopédie par l'image*)*; Larrouy, Le Ballonet L'Avion; L'Aéronautique* (*Revue Mensuelle*).

**L81, L82. Spanish, Elementary.** Pronunciation, elementary grammar, easy reading matter, practice in conversational phrases useful for travel. Textbooks: such books as *Hills and Ford, First Spanish Course; Wilkins, Beginner's Spanish Reader; Romera-Navarro, Historia de España; Carrión and Aza, Zaragüeta.*

**L91, L92. Italian, Elementary.** Pronunciation, elementary grammar, easy reading matter, practice in conversational phrases useful for travel. Textbooks: *Russo, Elementary Italian Grammar; Tutt, Italian Reader; Capocelli, L'Italia nel Passato e nel Presente.* Offered in alternate years. (Not offered in 1932–33.)

The following subjects are offered as General Studies. For description see Division of General Studies, page 235.

| | | | |
|---|---|---|---|
| **G821. French.** | **G831. French.** | **G921. German.** | **G932. German.** |
| **G822. French.** | **G832. French.** | **G922. German.** | **G932. German.** |

## DEPARTMENT OF HYGIENE

The gymnasium of the Institute is located in the Walker Memorial Building and affords ample accommodation for the training of classes in gymnastics.

The gymnasium is open to all students free of charge, and the instruction is especially arranged to fit individual needs. Bronze medals, known as the Cabot Medals for Improvement in Physical Development, are awarded to the five or six men showing the greatest physical improvement for the year. These medals 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. By using this building the Walker Gymnasium is left free for the regular gymnastics for which it was designed.

The Athletic Field gives an opportunity for track-team contests and interclass games. This field is provided with a quarter-mile running track, straightaway tracks for one hundred-yard and two hundred-twenty-yard dashes, tennis courts, etc. It is under the direction of an Advisory Council on Athletics, composed of alumni and undergraduate students.

**PT1, PT2. Physical Training.** All first-year men take two examinations during the first month — one at Walker Memorial by the Physical Director, from which anthropometric charts are plotted, and the other a health examination at the Medical Department by a physician. The class is then divided into sections for gymnastic exercise, each section having two hours a week for the last ten weeks of the first term and two hours a week for the first ten weeks of the second term, under the direction of the Physical Director. All first-year students are required to take these exercises. Regular exercises on the various athletic teams may be substituted for gymnastic work by consulting the Physical Director.

# SUBJECTS OF INSTRUCTION TABULATED

The number at the left is the subject number.

The numbers under the names 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.

(A) following the year, indicates that the subject is primarily for Graduate students. (B) indicates subjects for Graduate as well as Undergraduate students.

Some "B" subjects will not be credited to graduate students in Courses in which there are required subjects of the undergraduate schedule. (See Bulletin of the Graduate School for such restrictions.)

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........ *D12* (Not open to 1st yr.) | I | 2 | **1** | 2 | .. | 2 | Hosmer<br>Howard |
| 1·01 | Surv. & Top. Draw. *D12* (Not open to 1st yr.) | I | 2 | **2** | 0 | 4 | 0 | Howard |
| 1·02 | Surveying........ *D12* | III$_3$, VI, XV$_1$c<br>VI-A$_{2,3}$<br>II, IV-A<br>IX-B<br>XV$_1$b | 3<br>2<br>2<br>2<br>3 | S<br>S<br>**1**<br>**2**<br>**2** | 2<br>2<br>2<br>2<br>2 | ..<br>..<br>..<br>..<br>.. | 2<br>2<br>2<br>2<br>2 | Hosmer<br>Howard |
| 1·021 | Surveying........ *D12* (Not open to students of other courses except on petition) | XVII | 4 | **2** | 2 | 2 | 1 | Howard |
| 1·04 | Surveying........ *D12* (Not open to 1st and 2d yr.) | (Elective) | 3 | S | 2 | 20 | 2 | Howard |
| 1·041 | Surveying........ *D12* | VII$_3$, XI, XV$_1$a | 3 | S | 1 | 11 | 1 | Howard |
| 1·042 | Surveying........ *D12* | XVII | 3 | S | 1 | 10 | 1 | Howard |
| 1·05 | Plane Surveying... *1·00, 1·01* (Not open to 1st or 2d yr.) | I | 3 | S | 1 | 5 | 1 | Howard |
| 1·06 | Geod. & Top. Sur.. *(1·05)* | I | 3 | S | 1 | 5 | 0 | Hosmer |
| 1·07 | Geodetic Surveying *1·13, 1·06* | (Elective) | 4(B) | S | 0 | 10 | 0 | Hosmer |
| 1·10 | Surveying........ *M4, D12* (Not open to 1st or 2d yr. except on petition) | III$_{1,2}$<br>XII | 3<br>4 | S<br>S | 5<br>5 | 18<br>18 | 1<br>1 | Eberhard |
| 1·12 | Astron. & Sph.Trig. *M4, 1·00* | I | 2 | **2** | 3 | .. | 4 | Hosmer |
| 1·13 | Geodesy.......... *M22, 1·12* | I | 3 | **1** | 2 | .. | 2 | Hosmer |
| 1·131 | Geodesy.......... *1·13* | I$_4$ | 4(B) | **1** | 3 | .. | 6 | Hosmer |
| 1·132 | Geod. Astron.&Nav. *1·131* | I$_4$a | 4(B) | **2** | 3 | .. | 6 | Hosmer |
| 1·133 | Geodetic Lab...... *1·131, 8·07* | I$_4$ | 4(B) | **2** | 0 | 2 | 0 | Hosmer |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 1·134 | Adj. of Observations *M26, 1·131* | $I_4$ | 4(B) | **2** | 3 | .. | 6 | Hosmer |
| 1·135 | Seismology........ *M22, 8·201* | $I_4$ | 4(B) | **2** | 1 | .. | 3 | Hosmer |
| 1·137 | Instrument Des.... *8·201, 8·162* | $I_4$ | 4(B) | **1** | 0 | 3 | 3 | Hosmer |
| 1·138 | Seismological Lab.. *8·201, 1·135* | $I_4$ | 4(B) | **2** | 0 | 4 | 0 | Hosmer |
| 1·14 | Geodesy Adv...... *1·13* | (Elective) | G(A) | **2** | 2 | .. | 4 | Hosmer |
| 1·15 | Navigation....... | (Elective) | 3 | **2** | 2 | .. | 2 | Howard |
| 1·16 | Aerial Surveying... *1·06* | (Elective) | G(B) | **2** | 2 | .. | 2 | Hosmer |
| 1·18 | Map Read. & Top. Draw.......... *D12* (Not open to 1st yr.) | XI | 2 | **1** | 0 | 2 | 0 | Howard |
| 1·20 | Railway Fieldwork *(1·05) for* I *(1·041) for* XI, $XV_1$a | I, XI, $XV_1$a | 3 | S | 1 | 4 | 0 | Babcock |
| 1·21 | Rail. & High. Eng. *M21, 1·20* | $I_{1,2}$ | 3 | **1** | 2 | .. | 4 | C. B. Breed |
| 1·211 | Rail. & High. Eng. *M21, 1·20 for* $I_3$, *M21, 1·041 for* $VII_3$, XI, $XV_1$a | $I_3$, $VII_3$, XI, $XV_1$a | 3 | **1** | 1 | .. | 3 | C. B. Breed |
| 1·22 | Rail. & High. Eng.. *1·21 or 1·211* | $I_{1,2,3}$, $VII_3$, XI, $XV_1$a | 3 | **2** | 2 | .. | 2 | C. B. Breed |
| | | I-A | 4 | S | 2 | .. | 2 | |
| 1·23 | Eng. Drafting..... *1·20 (1·21)* | $I_{1,2}$ | 3 | **1** | 0 | 4 | 0 | Babcock |
| 1·24 | Eng. 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, $I_2$, $XV_1$a, Mil. Eng. | 4(B) | **1** | 2 | .. | 3 | C. B. Breed |
| 1·26 | Rail. Main. & Sig.. *(1·25)* | $I_2$a, I-A | 4(B) | **1** | 2 | .. | 2 | Babcock |
| 1·27 | Railway Trans..... *1·26* | $I_2$a, I-A | 4(B) | **2** | 2 | .. | 4 | C. B. Breed |
| 1·28 | Railway Design.... *1·24 (1·27)* | $I_2$a | 4(B) | **2** | 0 | 5 | 0 | C. B. Breed |
| 1·301 | Rail. Trans., Adv... *1·27, 1·28 or 1·281* | (Elective) | G(A) | **1** | 2 | .. | 4 | C. B. Breed |
| 1·302 | Rail. Trans., Adv... *1·301* | (Elective) | G(A) | **2** | 2 | .. | 4 | C. B. Breed |
| 1·31 | Adv. Rail. Des.... *1·28 or 1·281 (1·301)* | (Elective) | G(A) | **1** or ✦ **2** | | | | Babcock |
| 1·32 | Des. of Harbor Works *1·48* | (Elective) | G(A) | **1** | 3 | .. | 6 | Spofford |
| 1·35 | Roads & Pave..... *1·21 or (1·211)* | $I_{1,2}$, XI | 3 | **2** | 2 | .. | 1 | C. B. Breed |
| 1·36 | Test. High Mat.... *1·35, 2·36* | $I_2$b | 4(B) | **2** | 0 | 1 | 1 | C. B. Breed |
| 1·37 | Highway Trans.... *1·25 (1·36), 5·37* | $I_2$b | 4(B) | **2** | 2 | .. | 4 | C. B. Breed |
| 1·371 | Pave. & Highway Trans.......... | (Elective) | G(B) | S | 3 | .. | 6 | C. B. Breed |
| 1·38 | Highway Design... *1·24 (1·37)* | $I_2$b | 4(B) | **2** | 0 | 3 | 0 | Babcock |
| 1·39 | Graphic Statics.... *8·02* (Not open to 1st yr.) | I | 2 | **1** | 1 | 2 | 1 | Mitsch |
| 1·40 | Structures........ *2·20 or 2·211* | I, IV-A, $VII_3$, IX-B XI, $XV_1$a, XVII | 3 | **2** | 3 | .. | 5 | Fife |
| | | Mil. Eng. | 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, $XV_1$a Mil. Eng. | 4(B) | **1** | 4 | .. | 8 | Spofford |
| 1·411 | Structures......... *1·40, 1·43* | I-A, $VII_3$ | 4 | **1** | 4 | .. | 8 | Spofford |
| 1·42 | Structures........ *1·41* | $I_{1,2,3}$, Mil. Eng. | 4(B) | **2** | 4 | .. | 8 | Spofford |
| 1·421 | Structures........ *1·41* | $I_4$, XI, $XV_1$a | 4 | **2** | 2 | .. | 4 | Spofford |
| 1·422 | Structures........ *1·41* | IV-A | 4 | **2** | 2 | .. | 4 | Spofford |

✦Time specially arranged.

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 1·43 | Materials......... | $I_{1,2,3}$, XI | 3 | 1 | 1 | .. | 2 | Fife |
| 1·44 | Stat. Structures... *2·20* | $III_{1,2}$ | 4 | 2 | 2 | .. | 3 | Fife |
| 1·45 | Structures........ *2·20 or equiv.* | XIII-A | G | 1 | 3 | .. | 6 | Fife |
| 1·46 | Structural Design.. *1·45* | XIII-A | G | 2 | 0 | 2 | 0 | Mirabelli |
| 1·472 | Struc. Th. & Des... *1·471* | XVII | 4 | 1 | 3 | 2 | 6 | Fife |
| 1·473 | Struc. Th. & Des... *1·472* | XVII | 4 | 2 | 3 | 2 | 6 | Fife |
| 1·48 | Foundations...... *2·20* | $I_{1,2,3}$, IV-A, XI $XV_{1}a$, XVII | 4(B) | 1 | 3 | .. | 4 | Gilboy |
| 1·491 | Soil Mechanics.... *2·20* | (Elective) | G(A) | 1 | 3 | .. | 6 | Gilboy |
| 1·492 | Soil Mechanics.... *1·491* | (Elective) | G(A) | 2 | 3 | .. | 6 | Gilboy |
| 1·501 | Bridge Design..... *(1·41)* | $I_{1,2}$ | 4(B) | 1 | 0 | 7 | 0 | Mirabelli |
| 1·502 | Bridge Design..... *1·501 (1·42)* | $I_{1,2,a,b}$ | 4(B) | 2 | 0 | 5 | 0 | Mirabelli |
| 1·510 | Structural Des..... *1·501, 16·76 (1·42)* | $I_{2}c$ | 4(B) | 2 | 0 | 7 | 0 | Mirabelli |
| 1·511 | Bridge Design..... *(1·41)* | $I_{3}$ | 4(B) | 1 | 0 | 4 | 0 | Mirabelli |
| 1·512 | Bridge Design..... *1·511 (1·421)* | $I_{3}$ | 4(B) | 2 | 0 | 6 | 0 | Mirabelli |
| 1·52 | Structural Design.. *(1·421)* | XI | 4 | 2 | 0 | 6 | 0 | Mirabelli |
| 1·53 | Structural Design.. *(1·411)* | I-A | 4 | 1 | 0 | 4 | 0 | Mirabelli |
| 1·54 | Structural Design.. *1·421* | $XV_{1}a$ | 4 | 2 | 0 | 4 | 0 | Mirabelli |
| 1·551 | Struct. Des. Adv... *(1·561)* | (Elective) | G(A) | 1 | 0 | 6 | 0 | Wilbur |
| 1·552 | Struct. Des. Adv... *(1·562)* | (Elective) | G(A) | 2 | 0 | 6 | 0 | Wilbur |
| 1·561 | Structures, Adv.... *·1·42 or 1·421 or 1·422, 1·502 or 1·512 or 4·922* | (Elective) | G(A) | 1 | 3 | .. | 9 | Spofford |
| 1·562 | Structures, Adv.... *1·561* | (Elective) | G(A) | 2 | 3 | .. | 9 | Spofford |
| 1·57 | Secondary Stresses. *(1·41 or 16·01)* | (Elective) | G(A) | 2 | 2 | .. | 4 | Fife |
| 1·581 | Reinf. Con. Design. *1·42 or 1·421* | (Elective) | G(A) | 1 | 0 | 6 | 2 | Mitsch |
| | | Mil. Eng. | 4 | 1 | 0 | 6 | 2 | |
| 1·582 | Reinf. Con. Design. *1·581* | (Elective) | G(A) | 2 | 2 | .. | 4 | Mitsch |
| 1·60 | Hydrog. Survey... *M12 (1·05, 1·06)* | $I_{1,2,3}$, $VII_{3}$, XI, $XV_{1}a$ | 3 | S | 1 | 4 | 0 | Liddell |
| 1·62 | Hydraulics........ *2·15 or equiv.* | $I_{1,2,3}$, $VII_{3}$, IX-B, XI | 3 | 2 | 3 | .. | 5 | G. E. Russell |
| 1·63 | Hydraulics........ *2·15 or equiv.* | IV-A, XIII, $XV_{1}b$ | 4 | 1 | 2 | .. | 3 | G. E. Russell |
| | | $I_{4}$, XIII | 3 | 1 | 2 | .. | 3 | |
| | | $III_{1,2,3}$, $XV_{1}a$ | 4 | 2 | 2 | .. | 3 | |
| | | $XV_{1}c$, XVII | 3 | 2 | 2 | .. | 3 | |
| 1·64 | Hydraulics........ *2·15 or equiv.* | II, VI, VI-A, (A) | 4 | 1 | 3 | .. | 6 | G. E. Russell |
| | | VI-A (B) | 4 | 2 | 3 | .. | 6 | |
| 1·65 | Hydraulic Mach... *1·62 or equiv.* | $I_{1}$, XI | 4 | 2 | 2 | .. | 2 | Liddell |
| 1·66 | Hydraulics, Adv... *1·62 or equiv.* (Open to undergraduates only by petition.) | (Elective) | G(A) | 2 | 2 | .. | 6 | G. E. Russell |
| 1·67 | Design of High Masonry Dams.. *1·42* | (Elective) | G(A) | 2 | 2 | 3 | 6 | Wilbur |
| 1·68 | Th. of Hydraulic Models......... *1·62 or equiv.* | (Elective) | G(A) | 1 | 1 | .. | 3 | Reynolds |
| 1·691 | River Hyd. Lab.... *1·62, 1·68* | (Elective) | G(A) | 1 | 0 | 9 | 0 | Reynolds |
| 1·692 | River Engineering. *1·62 or equiv.* | (Elective) | G(A) | 2 | 2 | 0 | 4 | Reynolds |
| 1·70 | Water Power Eng.. *1·62* | $I_{3}$ | 4(B) | 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..<br>*1·70, 1·41* | $I_2$ | 4(B) | **2** | 2 | 4 | 3 | Barrows |
| 1·731 | Wat. Pr. Eng., Adv.<br>*1·42, 1·71 (1·851)* | (Elective) | G(A) | **1** | 3 | .. | 6 | Barrows |
| 1·732 | Wat. Pr. Eng., Adv.<br>*1·731 (1·852)* | (Elective) | G(A) | **2** | 3 | .. | 6 | Barrows |
| 1·75 | Hyd. & San. Eng...<br>*1·62* | $I_1$, $VII_2$, XI | 4(B) | **1** | 4 | .. | 5 | Camp |
| 1·76 | Sanitary Eng. ....<br>*1·75* | $I_1$ | 4(B) | **2** | 2 | .. | 3 | Camp |
| 1·77 | San. Eng. of Bldgs..<br>*1·63* | (Elective) | G(B) | **2** | 2 | .. | 4 | Camp |
| 1·78 | Sanitary Eng......<br>*1·75* | $VII_2$, XI | 4(B) | **2** | 3 | .. | 4 | Camp |
| 1·79 | Hyd. & San. Des...<br>*1·75* | $I_1$ | 4(B) | **2** | 0 | 2 | 0 | Camp |
| 1·801 | Sanitary Design...<br>*(1·75)* | $VII_2$, XI | 4(B) | **1** | 0 | 4 | 0 | Camp |
| 1·802 | Sanitary Design...<br>*(1·76 or 1·78)* | $VII_2$, XI | 4(B) | **2** | 0 | 6 | 0 | Camp |
| 1·811 | San. Eng., Adv....<br>*1·75* | (Elective) | G(A) | **1** | 3 | .. | 6 | Camp |
| 1·812 | San. Eng., Adv....<br>*1·811, 1·76* | (Elective) | G(A) | **2** | 3 | .. | 6 | Camp |
| 1·851 | Wat. Pr. Des., Adv.<br>*1·731* | (Elective) | G(A) | **1** | 0 | 8 | 0 | Barrows |
| 1·852 | Wat. Pr. Des., Adv.<br>*1·851 (1·732)* | (Elective) | G(A) | **2** | 0 | 8 | 0 | Barrows |
| 1·881 | San. Des., Adv.....<br>*(1·811)* | (Elective) | G(A) | **1** | 0 | 6 | 0 | Camp |
| 1·882 | San. Des., Adv.....<br>*(1·812)* | (Elective) | G(A) | **2** | 0 | 6 | 0 | Camp |
| 1·902 | Rail. Oper. Prac.... | I-A | 4 | **S** | 0 | h. p. w.<br>48 | 0 | Babcock |
| 1·903 | Rail. Oper. Prac.... | I-A | 4 | **2** | 0 | 48 | 0 | Babcock |
| 1·904 | Rail. Oper. Prac. | I-A | G | **1** | 0 | 48 | 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 | Applied Kinematics | I, II, IV-A, VI, VI-A | | | | | | |
| | *D12, M12, 8·01* | IX-B, XIII, XIII-C | | | | | | |
| | | XV$_1$, XVI, XVII | 2 | **1** | 3 | 2 | 3 | Merrill |
| | | XV$_2$, III$_1$, | 2 | **2** | 3 | 2 | 3 | |
| 2·03 | Mechanisms...... | II (A. O.) | 4 | **1** | 4 | 4 | 3 | Swett |
| | *2·891* | | | | | | | |
| 2·04 | Mech. Eng. Equip.. | II | 2 | **2** | 3 | .. | 3 | Eames |
| | *2·00* | | | | | | | |
| 2·05 | Mech. of Machines. | II | 3 | **1** | 3 | .. | 2 | Townsend |
| | *2·00* | | | | | | | |
| 2·06 | Mech. of Machines. | II(T.D.) | G(B) | **1** | 2 | .. | 2 | Townsend |
| | *2·00* | | | | | | | |
| 2·07 | Auto. Machinery... | II(T.D.) | G(A) | **1** | 3 | .. | 3 | Swett |
| | *(2·05 or 2·06), 2·20* | | | | | | | |
| 2·08 | Auto. Machinery... | II(T.D.) | G(A) | **2** | 1 | 3 | 4 | Swett |
| | *2·07* | | | | | | | |
| 2·09 | Des. of Auto. Mach. | II(T.E.) | G(A) | **2** | 0 | 12 | 0 | Dole |
| | *2·05, 2·20, 2·850* | | | | | | | |
| 2·10 | Mech. Eng. Draw.. | II | 2 | **1** | 0 | 6 | 0 | James |
| | *(2·00)* | | | | | | | |
| 2·102 | Mech. Eng. Draw.. | XVI | 2 | **2** | 0 | 4 | 0 | James |
| | *2·00 (2·15)* | | | | | | | |
| 2·12 | Machine Drawing.. | IX-B, XVI | 2 | **1** | 0 | 6 | 0 | James |
| | *D12* | III$_3$ | 3 | **S** | 0 | 6 | 0 | |
| | | III, XV$_1$b | 3 | **1** | 0 | 6 | 0 | |
| | | III$_4$, XV$_1$c | 3 | **2** | 0 | 6 | 0 | |
| 2·13 | Machine Drawing.. | II | 3 | **S** | 1 | 7 | 0 | |
| | *D12* | | | | | | | |
| 2·15 | Applied Mechanics. | I, II, IV-A, VI, VI-A | 2 | **2** | 3 | .. | 5 | Johnston |
| | *(M21) (8·02)* | VII$_3$, IX-B, X, XI | | | | | | |
| | | XIII, XIII-C, XV$_1$ | | | | | | |
| | | XVI, XVII | | | | | | |
| | | III | 3 | **1** | 3 | .. | 5 | |
| 2·151 | App. Mech. (Kin.). | (Elective) | 2 | **1** or **2** | 1 | .. | 2 | Johnston |
| | *2·16* | | | | | | | |
| 2·20 | App. Mechanics... | I, II, VI | | | | | | |
| | *2·15* | VI-A (B), VI-C | | | | | | |
| | | VII$_3$, IX-B, X, XI | | | | | | |
| | | XIII, XIII-C, XV$_1$, XVI | | | | | | |
| | | XVII | 3 | **1** | 3 | .. | 6 | Johnston |
| | | III | 3 | **2** | 3 | .. | 6 | |
| | | IV-A, VI-A(A) | 3 | **S** | 3 | .. | 6 | |
| | | Mil. Eng. | 4 | **S** | 3 | .. | 6 | |
| 2·21 | App. Mechanics... | II, XIII | 3 | **2** | 3 | .. | 5 | Fuller |
| | *2·20* | Mil. Eng. | 4 | **S** | 3 | .. | 5 | |
| | | IV-A | 3 | 1 | 3 | .. | 5 | |
| 2·22 | App. Mechanics... | VI, VI-A(A) | 3 | **2** | 3 | .. | 5 | Fuller |
| | *2·20* | VI-A(B) | 4 | **S** | 3 | .. | 5 | |
| 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 | 4(B) | **1** | 2 | .. | 4 | Riley |
| | *2·20* | II(T.D.) | G(B) | **1** | 2 | .. | 4 | |
| | | XVI (Elective) | 4(B) | **2** | 2 | .. | 4 | |
| 2·252 | Dyn. of Mach., Adv. | II(G.E.Co.) | G(A) | **1** | 2 | .. | 5 | Riley |
| | *2·251 or equiv.* | | | | | | | |
| 2·254 | Dynamics of Eng. . | II(A.E.) | G(A) | **1** | 2 | .. | 4 | Riley |
| | *2·251* | (Elective) | G(A) | **1** | 2 | .. | 4 | |
| 2·255 | Dyn.of Aircraft Eng. | (Elective) | G(A) | **1** | 2 | .. | 2 | Riley |
| | *2·254 or equiv.* | | | | | | | |
| 2·256 | Dynamics of Rota.. | II(T.D.) | G(A) | **2** | 1 | .. | 2 | Riley |
| | *2·251* | | | | | | | |
| 2·26 | Mech. of Eng...... | II | 4(B) | **2** | 3 | .. | 6 | Fuller |
| | *2·21* | | | | | | | |
| 2·271 | Th. of Elasticity... | II(A.O.) | 4 | **S** | 5 | .. | 9 | Fuller |
| | *2·891* | | | | | | | |
| 2·281 | Adv. Mech. & Th. Elas............ | (Elective) | G(A) | **1** | 3 | .. | 9 | Fuller |
| | *2·26* | | | | | | | |
| 2·282 | Adv. Mech. & Th. Elas............ | (Elective) | G(A) | **2** | 3 | .. | 9 | Fuller |
| | *2·281* | | | | | | | |
| 2·283 | Mechanics, Adv.... | II(G.E.Co.) | G(A) | **1** | 1 | .. | 3 | Fuller |
| 2·284 | Th. of Elasticity... | II(G.E.Co.) | G(A) | **2** | 3 | .. | 8 | Fuller |
| 2·291 | Theoret. Mech..... | XIII-A | G(A) | **1** | 3 | .. | 6 | Hencky |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 2·292 | Theoret. Mech..... | XIII-A | G(A) | **2** | 3 | .. | 6 | Hencky |
| 2·295 | Applied Hydrodyn. *1·62 or 1·64* | (Elective) | G(A) | **1** | 4 | .. | 8 | Spannhake |
| 2·296 | Gen. Th. of Hyd. Turb. & Pumps *2·295* | (Elective) | G(A) | **2** | 4 | .. | 8 | Spannhake |
| 2·30 | Materials of Eng... *(2·20)* | XIII-C, $XV_1$ | 3 | **2** | 2 | .. | 2 | H.W.Hayward |
| | | II, Mil. Eng. | 4 | **1** | 2 | .. | 2 | |
| | | II, IV-A, XVI | 3 | **1** | 2 | .. | 2 | |
| | | XIII-C | 4 | **2** | 2 | .. | 2 | |
| 2·301 | Materials of Eng... | II(T.D.) | G | **1** | 1 | .. | 2 | H.W.Hayward |
| 2·305 | Mater. & Test..... *2·284, 2·36, 3·703* | II(G.E.Co.) | G(B) | **2** | 0 | 7 | 3 | H.W.Hayward |
| 2·32 | Photoelasticity..... *2·271 or (2·271)* | (T.D.) | G | **2** | 1 | 2 | 1 | Maeser |
| 2·331 | Engineering Metals *2·35, 3·712* | (Elective) | 4(B) | **2** | 2 | .. | 2 | Zimmerman |
| 2·332 | Engineering Metals Problems *2·35, 3·712* | (Elective) | G(A) | **2** | 2 | 6 | 4 | Zimmerman |
| 2·341 | Rheology......... *2·21, 2·30, 5·683* | (Elective) | G(A) | **1** | 2 | .. | 4 | Hencky |
| 2·342 | Rheology......... *2·341* | (Elective) | G(A) | **2** | 2 | .. | 4 | Hencky |
| 2·35 | Testing Mat. Lab.. *2·20* | II | 4(B) | **1** | 1 | 3 | 2 | H.W.Hayward |
| 2·36 | Testing Mat. Lab.. *2·20* | XVI | 3 | **2** | 1 | 3 | 2 | |
| | | III, IV-A, XIII, $XV_1$b, XVII | 4 | **1** | 0 | 2 | 1 | H.W.Hayward |
| | | Mil. Eng., XIII-C | 4 | **2** | 0 | 2 | 1 | |
| | | $I_{1,2,3}$, VI-A(A), X, XIII-C, XI, $XV_1$a, c, | 3 | **2** | 0 | 2 | 1 | |
| | | VI-A(B) | 4 | S | 0 | 2 | 1 | |
| 2·362 | Testing Mat. Lab. Conc........... *2·30* | IV-A | 4 | **1** | 0 | 3 | 2 | H.W.Hayward |
| 2·363 | Testing Mat. Lab. Conc. | Mil. Eng., XVII | 4 | **1** | 0 | 2 | 0 | Adams |
| 2·38 | Phys. Test. of Met. | (Elective) | | S | 0 | 2 | 0 | Cowdrey |
| 2·391 | Reinf. Con. Des. .. *2·21* | IV-A | 4(B) | **1** | 2 | 5 | 0 | Peabody |
| 2·392 | Reinf. Con. Des. .. *2·391* | IV-A | 4(B) | **2** | 2 | 4 | 0 | Peabody |
| 2·393 | Reinf. Con. Des. .. Adv. *2·392* | (Elective) | G(A) | **1 or 2✦** | | | | Peabody |
| 2·394 | Concrete Research. *2·362* | (Elective) | G(A) | **1 or 2✦** | | | | Peabody |
| 2·395 | Conc. Bldgs. Des. & Spec......... *2·20* | Mil. Eng. | 4 | **2** | 2 | .. | 4 | Peabody |
| 2·40 | Eng. Thermodyn... *(M21), 8·02* | II, $III_3$, VI, VI-A(B) IX-B, XIII, XIII-C $XV_2$, XVI | 3 | **1** | 4 | .. | 5 | Berry |
| | | II(T.D.) | G | **1** | 4 | .. | 5 | |
| | | VI-A(A) | 3 | S | 4 | .. | 5 | |
| | | (Elective) | 3 | **2** | 4 | .. | 5 | |
| 2·41 | Boilers & Engines.. *8·02* | II | 3 | **1** | 2 | .. | 2 | Miller |
| 2·42 | Eng. Thermodyn... *2·40* | II, VI, VI-A(A), IX-B XIII, XIII-C, $XV_2$,XVI | 3 | **2** | 4 | .. | 5 | Berry |
| | | II(T.D.) | G | **2** | 4 | .. | 5 | |
| | | VI-A(B) | 4 | S | 4 | .. | 5 | |
| | | (Elective) | 3 | **1** | 4 | .. | 5 | |
| 2·43 | Refrigeration...... *2·40* | II | 4(B) | **1** | 2 | .. | 4 | Berry |
| 2.46 | Heat Engineering.. *(M21), 8·02* | $XV_1$, XVII | 3 | **1** | 4 | .. | 7 | Miller |
| | | $I_{1,2,3}$, XI, I-A | 4 | **1** | 4 | .. | 7 | |
| | | Mil. Eng. | 4 | S | 4 | .. | 7 | |
| 2·461 | Thermodynamics.. | II(A.O.) | 4 | **1** | 3 | .. | 6 | Miller |
| 2·47 | Heat Engineering.. *2·46* | $XV_1$, XVII | 3 | **2** | 2 | .. | 3 | Miller |
| | | $I_{1,2,3}$, I-A, XI | 4 | **2** | 2 | .. | 3 | |
| | | Mil. Eng. | 4 | S | 2 | .. | 3 | |
| 2·48 | Int. Com. Engines. | XIII-A | 4(B) | **2** | 1 | .. | 2 | Riley |
| 2·49 | Refrigeration...... *2·43* | (Elective) | 4(B) | **2** | 3 | .. | 5 | Berry |

✦ Time specially arranged.

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 2·491 | Refrigeration<br>*8·02* | VII$_2$ | 4 | 1 | 1 | .. | 2 | W. H. Jones |
| 2·501 | Refrigeration, Adv.<br>*2·43* | (Elective) | G(A) | 1 | 3 | .. | 9 | Berry |
| 2·502 | Heat Trans., Adv.<br>*2·43* | (Elective) | G(A) | 2 | 3 | .. | 9 | Berry |
| 2·503 | Heat Eng., Adv.<br>*2·43* | II(G.E.Co.) | G(A) | 1 | 3 | .. | 8 | Berry |
| 2·504 | Refrigeration Eng.<br>*2·43* | (Elective) | G(A) | 2 | 3 | .. | 3 | Svenson |
| 2·505 | Storage & Trans. of Foodstuffs<br>*2·43* | (Elective) | G(A) | 1 | 3 | .. | 6 | W. H. Jones |
| 2·506 | Des. of Refrig. Pl.<br>*2·505* | (Elective) | G(A) | 2 | 2 | .. | 4 | W. H. Jones |
| 2·51 | Torpedoes<br>*2·40* | II(T.D.) | G(A) | 2 | 2 | .. | 4 | Taft |
| 2·58 | Power Plant Design<br>*2·41, 2·42* | II | 4(B) | 2 | 0 | 4 | 0 | Miller |
| 2·581 | Power Plants, Adv.<br>*2·58 or equiv.* | (Elective) | G(A) | 1 | 3 | .. | 6 | Holt |
| 2·59 | Mech. Eq. Bldg., H. & V.<br>*8·02* | IV-A, VII$_3$, XVII | 4 | 2 | 3 | 1 | 3 | Holt |
| 2·591 | Adv. Heat & Vent.<br>*2·43, 2·854* | (Elective) | G(A) | 1 | 3 | .. | 6 | Holt |
| 2·592 | Heat. & Vent. Des.<br>*2·781, 2·854* | (Elective) | G(A) | 2 | 8 | .. | 0 | Holt |
| 2·593 | Air Conditioning<br>*2·43, 2·854* | (Elective) | G(A) | 1 | 2 | .. | 4 | Holt |
| 2·594 | Refrig. & Air. Con. Lab.<br>*2·593* | (Elective) | G(A) | 2 | 0 | 4 | 2 | Jones<br>Holt |
| 2·595 | Mech. Eq. Bldg. | IV | 4 | 1 | 2 | .. | 2 | Holt |
| 2·601 | Engineering Lab.<br>*2·40 or 2·46* | II | 4 | 1 | 0 | 4 | 4 | Eames |
| 2·602 | Engineering Lab.<br>*2·601* | II | 4(B) | 2 | 0 | 3 | 3 | Eames |
| 2·603 | Engineering Lab.<br>*2·601* | (Elective) | 4 | 2 | 0 | 3 | 3 | Eames |
| 2·611 | Engineering Lab.<br>*2·40 or 2·46* | III$_3$, XIII, XIII-C, XVI | 3 | 2 | 0 | 2 | 1 | Eames |
| 2·612 | Engineering Lab.<br>*2·611* | XIII, XIII-C | 4 | 1 | 0 | 2 | 2 | Eames |
| 2·614 | Engineering Lab.<br>*2·40 or 2·46* | XV$_1$b | 4 | 1 | 0 | 4 | 3 | Eames |
| 2·615 | Engineering Lab.<br>*2·601 or 2·614* | XIII, XV$_1$b | 4 | 2 | 0 | 2 | 2 | Eames |
| 2·62 | Engineering Lab.<br>*2·40 or 2·46* | IX-B | 4 | 1 | 0 | 4 | 2 | Eames |
| | | XV$_2$ | 4 | 2 | 0 | 4 | 2 | |
| 2·621 | Engineering Lab.<br>*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 | |
| 2·622 | Engineering Lab. | X | 4 | 2 | 0 | 3 | 3 | Eames |
| 2·63 | Eng. & Hyd. Lab.<br>*2·40 or 2·46* | I$_{1,2}$, XI | 4 | 2 | 0 | 2 | 2 | Eames |
| | | I-A | 4 | 1 | 0 | 2 | 2 | |
| 2·631 | Eng. & Hyd. Lab.<br>*2·40 or 2·46* | I$_3$, Mil. Eng. | 4 | 2 | 0 | 3 | 3 | Eames |
| 2·64 | Refrigeration Lab.<br>*2·43 & 2·601* | (Elective) | 4(B) | 2 | 0 | 2 | 2 | Jones |
| 2·66 | Automobile Lab.<br>*2·601 (2·79)* | (Elective) | 4(B) | 2 | 0 | 2 | 2 | Fales |
| 2·661 | Main. & Op. of Auto. Eq.<br>*2·79* | II, II(A.E.) | G(B) | 1 | 2 | .. | 2 | Fales |
| 2·671 | Engine Testing<br>*2·66* | II(A.E.) | G(B) | 1 | 0 | 4 | 2 | Fales |
| 2·672 | Motor Veh. Test.<br>*2·801 & 2·671* | II, II(A.E.) | G(A) | 2 | 1 | 4 | 3 | Fales |
| 2·681 | Auto. Engine Lab. | (Elective) | G(B) | 1 | 0 | 4 | 4 | Fales |
| 2·691 | Auto. Engine Lab.<br>*2·601* | II(T.D.) | G(B) | 2 | 0 | 2 | 0 | Fales |
| 2·70 | Machine Design<br>*D12, 2·20* | II | 3 | 2 | 1 | 3 | 0 | Townsend |
| 2·71 | Machine Design<br>*2·70* | II | 4(B) | 1 | 2 | 3 | 0 | Swett |
| 2·721 | Machine Design<br>*2·20* | XV$_1$b | 4 | 1 | 2 | 2 | 0 | Swett |

| No. | Subject | Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|---|
| 2·722 | Machine Design... | *2·721* | (Elective) | 4 | **2** | 2 | 2 | 0 | Swett |
| 2·741 | Machine Des., Adv. | *2·71* | II | G(A) | **1** | 3 | 5 | 2 | Haven |
| 2·742 | Machine Des., Adv. | *2·71* | II | G(A) | **2** | 3 | 5 | 2 | Haven |
| 2·743 | Machine Des., Adv. | *2·71* | II(G.E.Co.) | G(A) | **2** | 3 | 5 | 0 | Haven |
| 2·761 | Machine Design... | | II(T.D.) | G(A) | **1** | 2 | 4 | 2 | Haven |
| 2·762 | Machine Design... | *2·761* | II(T.D.) | G(A) | **2** | 2 | 4 | 2 | Haven |
| 2·77 | Engine Design .... | *2·251, 2·71* | (Elective) | 4(B) | **2** | 2 | 4 | 2 | Riley |
| 2·781 | Industrial Plants... | *(2·26)* | II | 4(B) | **2** | 3 | .. | 3 | Peabody |
| 2·782 | Industrial Plants .. | *(2·781)* | (Elective) | 4(B) | **2** | 0 | 4 | 0 | Peabody |
| 2·79 | Gasoline Auto..... | *2·40 or 2·47* | (Elective) | 4(B) | **2** | 4 | .. | 4 | Park |
| 2·801 | Automotive Eng... | *2·79, 2·251* | II, II(A.E.) | G(A) | **1** | 3 | 0 | 6 | Park |
| 2·802 | Automotive Eng... | *2·801* | II, II(A.E.) | G(A) | **2** | 3 | 0 | 6 | Park |
| 2·811 | Automotive Design | *(2·801)* | II, II(A.E.) | G(A) | **1** | 0 | 8 | 0 | Park |
| 2·812 | Automotive Design | *(2·802)* | II, II(A.E.) | G(A) | **2** | 0 | 10 | 0 | Park |
| 2·850 | Automatic Mach... | *2·70* | (Elective) | 4(B) | **2** | 2 | .. | 2 | Swett |
| 2·851 | Fire Protec. Eng... | *2·00* | (Elective) | 4(B) | **2** | 2 | .. | 2 | Schwarz |
| 2·852 | Locomotive Eng... | *2·20, 2·47* | I-A | G(B) | **S** | 3 | .. | 3 | Dole |
| 2·853 | Locomotive Eng... | *2·251* | (Elective) | 4(B) | **2** | 2 | .. | 2 | Dole |
| 2·854 | Mech.Eq.of Bldgs.. | *2·40 or 2·46* | (Elective) | 4(B) | **2** | 2 | .. | 2 | Holt |
| 2·855 | Steam Tur. Eng. .. | *2·42* | (Elective) | 4(B) | **2** | 2 | .. | 2 | Taft |
| 2·858 | Inspection Meth.... | *2·951* | (Elective) | 4(B) | **2** | 2 | .. | 2 | Buckingham |
| 2·87 | Textile Eng....... | *2·00* | (Elective) | 4(B) | **2** | 2 | 4 | 2 | Haven |
| 2·871 | Textile Laboratory | | II$_3$a(Elective) | | any | 0 | 6 | 0 | Haven |
| 2·872 | Des. of Cot. Mach.. | *2·251, 2·71, or 2·711* | II(T.E.) | G(A) | **1** | 3 | .. | 6 | Haven |
| 2·873 | Des. of Wool Work. Mach.......... | *2·251, 2·71 or 2·711* | II(T.E.) | G(A) | **2** | 3 | .. | 6 | Schwarz |
| 2·874 | Dyn. of Tex. Mach. | *2·251* | II(T.E.) | G(A) | **1** | 2 | .. | 2 | Haven |
| 2·875 | Tex. Tech. Anal.... | *2·87* | II(T.E.) | G(A) | **1** | 2 | .. | 3 | Haven |
| 2·876 | Prin. of Fabric. St.. | *2·87* | II(T.E.) | G(A) | **1** | 2 | .. | 4 | Schwarz |
| 2·877 | Tex. Microscopy... | *8·04* | (Elective) | 4(B) | any | 2 | 3 | 2 | Schwarz |
| 2·88 | Ordnance Eng..... | *2·21* | II Ord. | 4(B) | **2** | 3 | 2 | 3 | Fuller |
| 2·891 | Mechanics........ | *M72* | II(A.O.) | 4 | **S** | 3 | .. | 0 | Fuller |
| 2·90 | Forge Shop....... | | II | 2 | **2** | 0 | 3 | 0 | Sheppard |
| 2·901 | Forging.......... | | XIII | 2 | **1** | 0 | 2 | 0 | Sheppard |
| | | | III$_4$, XIII-C | 2 | **2** | 0 | 2 | 0 | |
| | | | III$_3$ | 3 | **2** | 0 | 2 | 0 | |
| | | | XV$_1$b | 3 | **S** | 0 | 2 | 0 | O'Neill |
| 2·91 | Foundry......... | | II | 2 | **1** | 0 | 3 | 0 | |
| | | | III$_4$ | 3 | **2** | 0 | 3 | 0 | |
| | | | III$_3$, XIII | 2 | **2** | 0 | 3 | 0 | |
| | | | XV$_1$b, c | 3 | **S** | 0 | 3 | 0 | |
| 2·911 | Foundry.......... | | XIII-A | 4 | **S** | 0 | 2 | 0 | O'Neill |
| 2·912 | Structural Castings | | IV-A | 3 | **2** | 0 | 1 | 0 | O'Neill |
| 2·92 | Pattern Making... | *2·91* | II | 2 | **2** | 0 | 3 | 0 | |
| 2·922 | Pattern Making... | | XIII-A | 4 | **S** | 0 | 2 | 0 | O'Neill |
| 2·941 | Mach. Tool Lab.... | | VI, VI-A | 2 | **1** | 1 | 3 | 0 | Littlefield |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 2·951 | Mach. Tool Lab.... | II, XIII | 3 | **1** | 2 | 4 | 0 | English |
| | | $XV_1$,c | 3 | S | 2 | 4 | 0 | |
| 2·952 | Mach. Tool Lab.... *2·951* | II, XIII | 3 | **2** | 1 | 3 | 0 | English |
| 2·96 | Mach. Tool Lab.... | IX-B | 2 | **2** | 1 | 2 | 0 | English |
| | | XIV | 2 | **1** | 1 | 2 | 0 | |
| | | $III_4$ | 3 | **2** | 1 | 2 | 0 | |
| 2·961 | Mach. Tool Lab.... | XIII-C | 4 | **2** | 1 | 1 | 0 | English |
| 2·971 | Mach. Tool Lab. .. | $XV_1$b | 3 | S | 1 | 2 | 0 | English |
| 2·972 | Mach. Tool Lab.... | $XV_1$b | 3 | **1** | 1 | 2 | 0 | English |
| 2·98 | Production Meth... *2·952* | II | 4 | **2** | 1 | .. | 1 | Littlefield |
| 2·981 | Manuf. Proc........ *2·952* | II(A.E.) | G(A) | **1** | 3 | .. | 3 | Littlefield |
| 2·982 | Prep. for Manuf.... *2·71 or 2·721, or 6·03* | (Elective) | 4(B) | **2** | 3 | .. | 3 | Buckingham |
| 2·983 | Production Des.... | (Elective) | 4(B) | **2** | 2 | .. | 2 | Buckingham |
| 2·99 | Met.&Dim.Eng.St. *2·951* | (Elective) | G(A) | **1** | 3 | .. | 6 | Buckingham |

# MINING AND METALLURGY — 3·00–3·99

| 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...<br>*1·10, 3·04, 12·01* | III$_1$ | 3 | 1 | 5 | .. | 4 | Hutchinson |
| 3·02 | Mining Methods...<br>*3·01* | III$_1$ | 3 | 2 | 5 | .. | 5 | Hutchinson |
| 3·03 | Econ. of Mining...<br>*3·02, or 3·05; 3·08; 3·21 or 3·23* | III$_1$ | 4(B) | 1 | 4 | .. | 4 | Hutchinson |
| 3·031 | Econ. of Mining...<br>*3·02, or 3·05; 3·21 or 3·23* | III$_2$ | 4(B) | 1 | 2 | .. | 2 | Hutchinson |
| 3·04 | Mining, Prin. of...<br>*3·03 or 3·031* | III$_{1,2}$ | 4(B) | 2 | 3 | .. | 4 | Hutchinson |
| 3·05 | Mining, Elem. of.. | III$_{2,3}$, XIIa | 3 | 1 | 2 | .. | 2 | Hutchinson |
| 3·061 | Mining Eng., Adv..<br>*3·04* | (Elective) | G(A) | 1✦ | | | | Hutchinson |
| 3·062 | Mining Eng., Adv..<br>*3·04* | (Elective) | G(A) | 2✦ | | | | Hutchinson |
| 3·08 | Mining Practice...<br>*1·10* | III$_{1,2}$ | 3 | S | 0 | 3 | 0 | Hutchinson |
| 3·101 | Mine Vaulation....<br>*3·04, 3·08* | (Elective) | G(A) | 1 | 3 | .. | 8 | Hutchinson |
| 3·102 | Mine Valuation....<br>*3·101* | (Elective) | G(A) | 2 | 3 | .. | 8 | Hutchinson |
| 3·12 | Econ. of Min., Adv.<br>*3·04* | (Elective) | G(A) | 2✦ | | | | Hutchinson |
| 3·13 | Geophys. Pros. El..<br>*M21, 3·04* | III$_{1,2}$ | 4(B) | 1 | 2 | 2 | 0 | Foster |
| 3·21 | Ore Dressing......<br>*12·01 (3·22)* | III$_1$ | 3(B) | 2 | 3 | .. | 2 | Locke |
| 3·22 | Ore Dressing Lab...<br>*3·31, 5·13 (3·21)* | III$_1$ | 3(B) | 2 | 1 | 4 | 2 | Locke |
| 3·23 | Ore Dressing......<br>*12·01* | III$_{2,3}$, XIIa | 3 | 2 | 1 | 2 | 2 | Locke |
| 3·241 | Ore Dressing, Adv..<br>*3·21, 3·22; or 3·23* | (Elective) | G(A) | 1✦ | | | | Locke |
| 3·242 | Ore Dressing, Adv..<br>*3·21, 3·22; or 3·23* | (Elective) | G(A) | 2✦ | | | | Locke |
| 3·251 | Th. & Prac. of Flot.<br>*3·21, 3·22; or 3·23* | (Elective) | G(A) | 1✦ | | | | Locke |
| 3·252 | Th. & Prac. of Flot.<br>*3·21, 3·22; or 3·23* | (Elective) | G(A) | 2✦ | | | | Locke |
| 3·26 | Ore Dress. Econ....<br>*3·21, 3·22; or 3·23* | (Elective) | G(A) | 1 or 2✦ | | | | Locke |
| 3·271 | Ore Dressing Des...<br>*3·21, 3·22; or 3·23* | (Elective) | G(A) | 1✦ | | | | Locke |
| 3·272 | Ore Dressing Des...<br>*3·21, 3·22; or 3·23* | (Elective) | G(A) | 2✦ | | | | Locke |
| 3·31 | Fire Assaying.....<br>*12·01, 5·12* | III$_{1,2}$ | 3 | 1 | 2 | 4 | 2 | Bugbee |
| 3·32 | Fire As. & Met. Lab.<br>*5·12* | (Elective) | 4 | 1 | 2 | 2 | 2 | Bugbee |
| 3·331 | Fire Assaying, Adv.<br>*3·31, 5·12* | (Elective) | G(A) | 1✦ | | | | Bugbee |
| 3·332 | Fire Assaying, Adv.<br>*3·31, 5·12* | (Elective) | G(A) | 2✦ | | | | Bugbee |
| 3·41 | Met.; Copper, Lead<br>*3·60, 5·13, 12·01* | III$_3$b, $_4$b | 4(B) | 1 | 5 | 5 | 3 | C. R. Hayward |
| 3·411 | Met.; Copper, Lead<br>*3·60, 5·13, 12·01* | III$_3$a, $_4$a | 4(B) | 1 | 4 | 2 | 3 | C. R. Hayward |
| 3·412 | Met.; Copper, Lead<br>*5·13, 12·01* | III$_1$ | 4(B) | 1 | 3 | 2 | 3 | C. R. Hayward |
| 3·42 | Met.; Gold & Silver<br>*3·31, 3·23* | III$_3$ | 4(B) | 2 | 2 | 3 | 2 | Bugbee |
| 3·421 | Met.; Gold & Silver<br>*3·31, 3·23* | III$_1$ | 4(B) | 2 | 2 | 1 | 1 | Bugbee |
| 3·422 | Met.: Gold & Silver.<br>*5·02* | III$_4$ | 4(B) | 2 | 2 | .. | 2 | Bugbee |
| 3·43 | Met.; Iron & Steel.<br>*3·60, 5·02* | III$_3$a, $_4$a | 4(B) | 1 | 7 | .. | 3 | Waterhouse |
| 3·431 | Met.; Iron & Steel.<br>*3·60, 5·02* | III$_3$b, $_4$b | 4(B) | 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. | III$_1$ | 4 | **1** | 2 | .. | 1 | Waterhouse |
| | *5·02* | III$_2$ | 3 | **1** | 2 | .. | 1 | |
| 3·44 | Met.; Gen. Zinc & Min. Met....... | III$_{3,4}$ | 4(B) | **2** | 4 | .. | 3 | C. R. Hayward |
| | *3·411, 3·431* | | | | | | | |
| 3·45 | Met.; Heat Tr. Steel | III$_3$ | 4(B) | **2** | 2 | .. | 1 | Waterhouse |
| | *3·431, 3·61, 8·12* | | | | | | | |
| 3·46 | Met. of Com. Met. | XII | 4 | **2** | 3 | .. | 3 | C. R. Hayward |
| | *5·02* | | | | | | | |
| 3·501 | Met.; Iron & Steel, Adv............ | (Elective) | G(A) | **1**✦ | | | | Waterhouse |
| | *3·43* | | | | | | | |
| 3·502 | Met.; Iron & Steel, Adv............ | (Elective) | G(A) | **2**✦ | | | | Waterhouse |
| | *3·43* | | | | | | | |
| 3·511 | Metal. Plant Design | (Elective) | G(A) | **1** | 13 | .. | 0 | Waterhouse |
| | *3·41, 3·42, 3·43* | | | | | | | |
| 3·512 | Met. Plant. Design. | (Elective) | G(A) | **2** | 13 | .. | 0 | Waterhouse |
| | *3·41, 3·42, 3·43* | | | | | | | |
| 3·52 | Gen. Metal., Adv.. | (Elective) | G(A) | **2**✦ | | | | C. R. Hayward |
| | *3·44* | | | | | | | |
| 3·53 | Non-Fer. Met., Adv. | (Elective) | G(A) | **1**✦ | | | | C. R. Hayward |
| | *3·41, 3·23, 3·44* | | | | | | | |
| 3·541 | Gold & Silver Met., Adv............ | (Elective) | G(A) | **1**✦ | | | | Bugbee |
| | *3·42* | | | | | | | |
| 3·542 | Gold & Silver Met., Adv............ | (Elective) | G(A) | **2**✦ | | | | Bugbee |
| | *3·42* | | | | | | | |
| 3·56 | Metal. Plants..... | (Elective) | 4(B) | **2** | 3 | .. | 3 | Waterhouse |
| | *3·41, 3·42, 3·43* | | | | | | | |
| 3·60 | Metal. Pl. Visits... | III$_{3,4}$ | 4(B) | S | 0 | 3 | 1 | C. R. Hayward |
| 3·61 | Metallography.... | III$_3$ | 3 | **2** | 2 | 2 | 1 | Williams |
| | *5·12, 8·04* | III$_2$V, XIV | 4 | **1** | 2 | 2 | 1 | |
| 3·615 | Metallography..... | II(T.D.) | G | **1** | 1 | 2 | 2 | Williams |
| | *(3·701)* | | | | | | | |
| 3·62 | Metallography.... | III$_4$ | 3(B) | **1** | 4 | 6 | 4 | Williams |
| 3·641 | Phys. Metal. (Non-Fer.)........... | III$_4$ | 4(B) | **1** | 2 | 3 | 2 | Williams |
| | *3·62* | | | | | | | |
| 3·642 | Phys. Metal. (Fer.) | III$_4$ | 4(B) | **2** | 2 | 3 | 2 | Homerberg |
| | *3·641* | | | | | | | |
| 3·643 | Light Alloys | (Elective) | 4(B) | **2** | 2 | 0 | 4 | Williams |
| | *3·61 or 3·62* | | | | | | | |
| 3·651 | Phys. Metal., Adv. | (Elective) | G(A) | **1**✦ | | | | Williams |
| | *3·61 or 3·62* | | | | | | | |
| 3·652 | Phys. Metal., Adv. | (Elective) | G(A) | **2**✦ | | | | Williams |
| | *3·61 or 3·62* | | | | | | | |
| 3·656 | X-Ray Metal..... | III$_4$ | 3 | **2** | 2 | 1 | 3 | J. T. Norton |
| | *M22, 8·04, 3·61 or 3·62* | XIV | 4 | **2** | 2 | 1 | 3 | |
| 3·657 | X-Ray Met., Adv.. | (Elective) | 4(B) | **2**✦ | | | | J. T. Norton |
| | *3·656, 8·27* | | | | | | | |
| 3·66 | App. of Metallog... | (Elective) | G(A) | **1 or 2** | 0 | 5 | 0 | Homerberg |
| | *3·61 or 3·62* | | | | | | | |
| 3·67 | Physics of Metals.. | III$_4$ | 4(B) | **2** | 2 | .. | 4 | J. T. Norton |
| | *3·61, 3·62, 8·04, M22* | | | | | | | |
| 3·673 | Physics of Metals.. Adv. | (Elective) | G(A) | **1**✦ | | | | J. T. Norton |
| | *3·656, 3·67* | | | | | | | |
| 3·68 | Metall. of Welding. | (Elective) | 4(B) | **2** | 2 | 2 | 2 | Walsted |
| | *3·61 or 3·62* | | | | | | | |
| 3·69 | Corrosion & Heat Resisting Alloys. | (Elective) | 4(B) | **2** | 2 | 0 | 4 | Williams |
| | *3·61 or 3·62* | | | | | | | Pratt |
| 3·71 | Heat Treatment... | II Ord. | 4 | **2** | 1 | 3 | 2 | Zavarine |
| | *2·30, 2·36 or (2·36)* | III$_4$ | 3 | **2** | 1 | 3 | 2 | |
| 3·712 | Eng. Heat Treat... | II | 4 | **1** | 0 | 2 | 0 | Zavarine |
| | *2·30* | | | | | | | |
| 3·713 | Heat Treatment... | II(T.D.) | G | **1** | 1 | 2 | 2 | Zavarine |
| | *(3·651)* | | | | | | | |
| 3·714 | Heat Treatment... | II(A.E.) | G | **1** | 1 | 3 | 2 | Zavarine |
| | *3·71 or 3·712* | (Elective) | 4 | **2** | 1 | 3 | 2 | |
| 3·731 | Phys. Metallurgy.. | II(T.D.) | G | **1** | 1 | .. | 2 | Williams |

✦Time specially arranged.

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 3·732 | Phys. Metallurgy . .<br>*3·731* | II(T.D.) | G | **2** | 1 | 7 | 2 | Williams |
| 3·74 | Th. of Metal Hard.<br>*3·62* | (Elective) | G(A) | **2** | 2 | . . | 4 | Zavarine |
| 3·81 | Petrol. Eng., El. . . .<br>*1·10, 3·04, 12·30* | $III_2$ | 3 | **1** | 5 | . . | 4 | Mann |
| 3·82 | Petrol. Eng., El. . . .<br>*3·81* | $III_2$ | 3 | **2** | 5 | . . | 4 | Mann |
| 3·84 | Outline of Pet. Pd. . | (Elective) | 4 | **2** | 3 | . . | 1 | Mann |
| 3·85 | Petroleum Prod. . . .<br>*3·82* | $III_2$ | 4(B) | **1** | 4 | . . | 2 | Mann |
| 3·86 | Petroleum Prod. . . .<br>*3·85* | $III_2$ | 4(B) | **2** | 3 | . . | 2 | Mann |
| 3·89 | Oil Field Visits . . . .<br>*1·10* | $III_2$ | 3 | **S** | 0 | 3 | 0 | Mann |
| 3·901 | Oil & Gas Land Val.<br>*3·86, 3·89* | (Elective) | G(A) | **1** | 3 | . . | 8 | Mann |
| 3·902 | Oil & Gas Land Val.<br>*3·901* | (Elective) | G(A) | **2** | 3 | . . | 8 | Mann |
| 3·911 | Petrol. Eng., Adv. .<br>*3·86* | (Elective) | G(A) | **1**✦ | | | | Mann |
| 3·912 | Petrol. Eng., Adv. .<br>*3·86* | (Elective) | G(A) | **2**✦ | | | | Mann |
| 3·921 | Oil & Gas Law . . . .<br>*3·86* | (Elective) | G(A) | **1** | 2 | . . | 4 | Mann |
| 3·922 | Oil & Gas Law . . . .<br>*3·86* | (Elective) | G(A) | **2** | 2 | . . | 4 | Mann |

✦Time specially arranged.

## ARCHITECTURE

| 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.<br>*4·021* | IV | 2 | 2 | 0 | 4 | 0 | W. F. Brown |
| 4·031 | Freehand Drawing.<br>*4·022* | IV | 3 | 1 | 0 | 4 | 0 | W. F. Brown |
| 4·032 | Freehand Drawing.<br>*4·031* | IV | 3 | 2 | 0 | 4 | 0 | W. F. Brown |
| 4·041 | Freehand Drawing.<br>*4·032* | IV | 4 | 1 | 0 | 4 | 0 | W. F. Brown |
| 4·042 | Freehand Drawing.<br>*4·041* | IV | 4 | 2 | 0 | 4 | 0 | W. F. Brown |
| 4·051 | Free Dr. & Fig. Comp. ..........<br>*4·042* | IV | 5(B) | 1 | 0 | 6 | 0 | W. F. Brown |
| 4·052 | Free. Dr. & Fig. Comp. ..........<br>*4·051* | IV | 5(B) | 2 | 0 | 6 | 0 | W. F. Brown |
| 4·053 | Free Dr. ..........<br>*4·052* | IV | G(A) | 1 | 0 | 6 | 0 | W. F. Brown |
| 4·054 | Free Dr. ..........<br>*4·053* | IV | G(A) | 2 | 0 | 6 | 0 | W. F. Brown |
| 4·06 | Graphics ......... | IV | 1 | 1 | 2 | 4 | 0 | Zisman |
| 4·071 | Modeling .........<br>*4·722* | IV | 3 | 1 | 0 | 3 | 0 | Selmar-Larsen |
| 4·072 | Modeling .........<br>*4·071* | IV | 3 | 2 | 0 | 3 | 0 | Selmar-Larsen |
| 4·081 | Color, Comp. Th. & App. ..........<br>*4·732* | IV | 4 | 1 | 1 | .. | 3 | Beckwith |
| 4·082 | Color, Comp. Th. & App. ..........<br>*4·081* | IV | 4 | 2 | 1 | .. | 3 | Beckwith |
| 4·091 | Color, Comp. Th. & App. ..........<br>*4·082* | IV | 5(B) | 1 | 1 | .. | 4 | Gardner |
| 4·092 | Color, Comp. Th. & App. ..........<br>*4·091* | IV | 5(B) | 2 | 1 | .. | 4 | Gardner |
| 4·11 | Shades & Shadows.<br>*4·06* | IV | 1 | 1 | 0 | 3 | 0 | Gardner |
| 4·12 | Perspective .......<br>*4·06 or (D311)* | IV | 1 | 1 | 1 | 2 | 0 | Zisman |
| 4·13 | Perspective .......<br>*D12* | IV-A | 2 | 1 | 2 | .. | 2 | W.H.Lawrence |
| 4·20 | Office Practice .....<br>*4·712* | IV | 2 | S | 1 | 6 | 0 | Bridge |
| 4·211 | Office Practice .....<br>*4·712, 4·20* | IV | 2 | 1 | 0 | 3 | 0 | Bridge |
| 4·212 | Office Practice .....<br>*4·211* | IV | 2 | 2 | 0 | 3 | 0 | Bridge |
| 4·22 | Office Practice .....<br>*D12, D22* | IV-A | 3 | S | 0 | 6 | 0 | Bridge |
| 4·241 | Prof. Relations .... | IV | 4(B) | 1 | 1 | .. | 1 | Austin |
| 4·242 | Prof. Relations ....<br>*4·241* | IV | 4(B) | 2 | 1 | .. | 1 | Austin |
| 4·25 | Estimating ........<br>*4·212 or 4·22 and 4·812 or 4·912*<br>(Not offered to students below the 4th year.) | IV-A | 4 | 2 | 1 | .. | 3 | Jenrick |
| 4·311 | Theory of Arch. ... | IV | 1 | 1 | 1 | .. | 0 | Zisman |
| 4·312 | Theory of Arch. ...<br>*4·311* | IV | 1 | 2 | 1 | .. | 0 | Zisman |
| 4·321 | Theory of Arch. ...<br>*4·312* | IV | 2 | 1 | 1 | .. | 1 | Beckwith |
| 4·322 | Theory of Arch. ...<br>*4·321* | IV | 2 | 2 | 1 | .. | 1 | Beckwith |
| 4·331 | Theory of Arch. ...<br>*4·322* | IV | 3 | 1 | 2 | .. | 0 | H.W. Gardner |
| 4·332 | Theory of Arch. ...<br>*4·331* | IV | 3 | 2 | 2 | .. | 0 | H.W. Gardner |
| 4·341 | Theory of Arch. ...<br>*4·332* | IV | 4 | 1 | 1 | .. | 1 | Cash |
| 4·342 | Theory of Arch. ...<br>*4·341* | IV | 4 | 2 | 1 | .. | 1 | Cash |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 4·411 | Architectural Hist.. | IV | 1 | **1** | 2 | 1 | 3 | Putnam |
| 4·412 | Architectural Hist..<br>*4·411* | IV | 1 | **2** | 2 | 1 | 3 | Putnam |
| 4·413 | Architectural Hist.. | IV-A | 2 | **1** | 2 | .. | 2 | Putnam |
| 4·414 | Architectural Hist..<br>*4·413* | IV-A | 2 | **2** | 2 | .. | 2 | Putnam |
| 4·421 | Architectural Hist..<br>*4·412* | IV | 2 | **1** | 1 | 1 | 1 | Putnam |
| 4·422 | Architectural Hist..<br>*4·421* | IV | 2 | **2** | 1 | 1 | 1 | Putnam |
| 4·423 | Architectural Hist..<br>*4·414* | IV-A | 3 | **1** | 1 | .. | 1 | Putnam |
| 4·424 | Architectural Hist..<br>*4·423* | IV-A | 3 | **2** | 1 | .. | 1 | Putnam |
| 4·461 | Euro. Civ. & Art...<br>*4·422* | IV, IV-A | 3 | **1** | 3 | .. | 4 | Sumner |
| 4·462 | Euro. Civ. & Art...<br>*4·461* | IV, IV-A | 3 | **2** | 3 | .. | 4 | Sumner |
| 4·471 | Euro. Civ. & Art...<br>*4·462* | IV | 4 | **1** | 3 | .. | 4 | Sumner |
| 4·472 | Euro. Civ. & Art...<br>*4·471* | IV | 4 | **2** | 3 | .. | 4 | Sumner |
| 4·481 | Euro. Civ. & Art...<br>*4·472* | IV | 5(B) | **1** | 2 | .. | 3 | Sumner |
| 4·482 | Euro. Civ. & Art...<br>*4·481* | IV | 5(B) | **2** | 2 | .. | 3 | Sumner |
| 4·491 | Euro. Civ. & Art...<br>*4·482* | IV | G(A) | **1** | 2 | .. | 4 | Seaver |
| 4·492 | Euro. Civ. & Art...<br>*4·491* | IV | G(A) | **2** | 2 | .. | 4 | Seaver |
| 4·52 | Philosophy of Arch. | IV | 5(B) | **2** | 1 | .. | 1 | Walker |
| 4·53 | Architectural Hum.<br>*4·241* | IV | 5(B) | **1** | 1 | .. | 1 | Emerson |
| 4·61 | Town Planning.... | IV | 3 | **1** | 2 | .. | 3 | T. Adams |
| 4·712 | Design I......... | IV | 1 | **2** | 0 | 12 | 0 | Zisman |
| 4·721 | Design II.........<br>*4·712* | IV | 2 | **1** | 0 | 11 | 0 | Beckwith |
| 4·722 | Design II.........<br>*4·721* | IV | 2 | **2** | 0 | 11 | 0 | Beckwith |
| 4·731 | Design III........<br>*4·722* | IV | 3 | **1** | 0 | 13 | 0 | H. W. Gardner |
| 4·732 | Design III........<br>*4·731* | IV | 3 | **2** | 0 | 15 | 0 | H. W. Gardner |
| 4·741 | Design IV........<br>*4·732* | IV | 4 | **1** | 0 | 17 | 0 | Gunther |
| 4·742 | Design IV........<br>*4·741* | IV | 4 | **2** | 0 | 29 | 0 | Gunther |
| 4·751 | Design V.........<br>*4·742* | IV | 5(B) | **1** | 0 | 30 | 0 | Carlu |
| 4·752 | Design V.........<br>*4·751* | IV | 5(B) | **2** | 0 | 12 | 0 | Carlu |
| 4·761 | Design...........<br>*4·752* | IV | G(A) | **1** | 0 | 36 | 0 | Carlu |
| 4·762 | Design...........<br>*4·761* | IV | G(A) | **2** | 0 | 36 | 0 | Carlu |
| 4·78 | Planning Principles.<br>*4·413, 4·414* | IV-A | 3 | **2** | 1 | 3 | 8 | Clapp |
| 4·80 | Building Construct. | IV-A | 3 | **1** | 1 | .. | 1 | P. W. Norton |
| 4·811 | Construct. Design..<br>*2·232* | IV | 3(B) | **1** | 2 | 5 | 0 | P. W. Norton |
| 4·812 | Construct. Design..<br>*4·811* | IV | 3(B) | **2** | 2 | 5 | 0 | P. W. Norton |
| 4·90 | Structural Drawing<br>*D12* | IV-A | 2 | **2** | 1 | 3 | 0 | P. W. Norton |
| 4·911 | Structural Anal....<br>*2·20* | IV-A | 3 | **1** | 4 | 8 | 0 | W.H.Lawrence |
| 4·912 | Structural Anal....<br>*4·911* | IV-A | 3 | **2** | 2 | 6 | 0 | W.H.Lawrence |
| 4·921 | Structural Design..<br>*4·912, 1·40, 4·90* | IV-A | 4 | **1** | 1 | 4 | 0 | W.H.Lawrence |
| 4·922 | Structural Design..<br>*4·921* | IV-A | 4 | **2** | 2 | 7 | 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, Gen....<br>*5·00* | All courses except IV | 1 | 1 | 4 | 3 | 4 | H. M. Smith |
| 5·02 | Chemistry, Gen....<br>*5·01* | All courses except IV | 1 | 2 | 4 | 3 | 4 | H. M. Smith |
| 5·04 | Chemistry, Gen.... | IIA.O. | 4 | S | 3 | .. | 3 | Wareham |
| 5·05 | Atom. St., Elem.... | (Elective) | | 2 | 1 | .. | 1 | Blanchard |
| 5·061 | Inorg. Chemistry..<br>*5·13* | V | 4(B) | 1 | 2 | .. | 3 | Schumb |
| 5·062 | Inorg. Chem.......<br>*5·061* | V | 4(B) | 2 | 2 | .. | 3 | Schumb |
| 5·07 | Inorg. Chem., Adv.<br>*5·062* | (Elective) | G(A) | 1 | 2 | .. | 3 | Schumb |
| 5·10 | Qualitative Anal...<br>*5·02* | V, X, XIV, $XV_2$<br>(Elective) | 2<br>2 | S<br>1 | 3<br>3 | 11<br>11 | 4<br>4 | Hamilton |
| 5·11 | Qualitative Anal...<br>*5·02* | III, VII, VIII, IX-A<br>XI, XII | 2 | 1 | 2 | 5 | 2 | Hamilton |
| 5·12 | Quantitative Anal..<br>*5·10 or 5·11* | V, X, XIV, $XV_2$<br>III, VII, IX-A, XI, XII | 2<br>2 | 1<br>2 | 2<br>2 | 5<br>5 | 2<br>2 | Hamilton |
| 5·13 | Quantitative Anal..<br>*5·12* | $III_{1,3,4}$, XII<br>V, X, $XV_2$ | 3<br>2 | 1<br>2 | 2<br>2 | 5<br>5 | 2<br>2 | Hamilton |
| 5·141 | Anal. Chemistry...<br>*5·13* | V | 3 | 1 | 3 | .. | 2 | Gill<br>Woodman |
| 5·142 | Anal. Chemistry...<br>*5·141* | V | 3 | 2 | 3 | .. | 1 | Hamilton |
| 5·16 | Anal. Chemistry...<br>*5·13* | X-A | 4 | 2 | 1 | 3 | 1 | Hamilton |
| 5·18 | Qual. Anal., Adv...<br>*5·10* | (Elective) | G(A) | 1 | 1 | 8 | 1 | Hall |
| 5·20 | Chem. of Wat. Sew.<br>*5·12* | VII | 3 | 2 | 1 | 3 | 1 | Woodman |
| 5·23 | Sanitary Chem......<br>*5·12* | XI | 3 | 2 | 1 | 6 | 1 | Woodman |
| 5·25 | Chemistry of Foods<br>*5·12* | $VII_{1,2}$ | 3 | 1 | 1 | 4 | 1 | Woodman |
| 5·251 | Chemistry of Foods<br>*5·12* | (Elective) | 4(B) | 1 or 2 | 1 | 2 | 1 | Woodman |
| 5·26 | Food Analysis.....<br>*5·12* | (Elective) | 4(B) | 1 or 2 | 0 | 5 | 0 | Woodman |
| 5·30 | Proximate Anal....<br>*5·12, (5·41)* | (Elective) | 4(B) | 1 or 2 | 1 | 5 | 2 | Gill |
| 5·31 | Gas Analysis.......<br>*5·12* | XIV<br>$III_1$ | 2<br>3 | 2<br>1 | 1<br>1 | 0<br>0 | 1<br>1 | Gill |
| 5·33 | Study of War Gases | V.C.W.S. | 3 | 2 | 1 | .. | 1 | Gill |
| 5·35 | Applied Chem.....<br>*5·02* | XIII, XIII-C | 4 | 2 | 1 | .. | 2 | Gill |
| 5·37 | Chem. of Road Mat.<br>*5·02* | $I_2$b | 4(B) | 1 | 1 | 3 | 0 | Gill |
| 5·38 | Lub. & Fuel OilTest<br>*5·02* | (Elective) | 4 | 1 or 2 | 1 | 2 | 1 | Gill |
| 5·381 | Oil Tst.&Pet.Refin.<br>*5·02* | $III_2$ | 3 | 1 | 2 | 3 | 2 | Gill |
| 5·39 | Special Methods...<br>*5·12, 8·02* | (Elective) | 3 | 1 | 0 | 2 | 1 | Gill<br>Woodman |
| 5·41 | Organic Chem. I...<br>*5·12, 8·04* | V, $VII_3$, VIII, IX-A, X, XIV, $XV_2$<br>$VII_{1,2}$ | 3<br>3 | 1<br>S | 4<br>4 | ..<br>.. | 3<br>3 | Mulliken |
| 5·412 | Organic Chem.....<br>*5·04* | IIA.O. | 4 | S | 3 | 3 | 3 | Mulliken |
| 5·413 | Organic Chem.....<br>*5·412* | IIA.O. | 4 | 2 | 3 | 3 | 0 | Mulliken |
| 5·414 | Organic Chem. Lab<br>*5·12 (5·41)* | V | 3 | 1 | 0 | 9 | 0 | Mulliken |
| 5·416 | Organic Chem. Lab.<br>*5·12 (5·41)* | X, $XV_2$ | 3 | 1 | 0 | 9 | 0 | Mulliken |
| 5·418 | Organic Chem. Lab.<br>*5·12 (5·41)* | IX-A, XIV | 3 | 1 | 0 | 6 | 0 | Mulliken |
| 5·42 | Organic Chem. I...<br>*5·41* | V, X | 3 | 2 | 3 | .. | 2 | Mulliken |
| 5·424 | Organic Chem. Lab.<br>*5·414* | V | 3 | 2 | 0 | 11 | 0 | Mulliken |
| 5·425 | Organic Chem. Lab.<br>*5·414* | Chem. War. | 3 | 2 | 0 | 9 | 0 | Mulliken |
| 5·426 | Organic Chem. Lab.<br>*5·416* | X | 3 | 2 | 0 | 5 | 0 | Mulliken |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 5·428 | Organic Chem. Lab.<br>*5·41* | VII$_{1,2}$ | 3 | S | 0 | 10 | 0 | Mulliken |
| 5·43 | Powder & Expl....<br>*5·42* | VC.W.S.,<br>X Ord., X.C.W.S. | 4 | 2 | 2 | .. | 2 | Underwood |
| | | (Elective) | G(A) | 2 | 2 | .. | 2 | |
| | | Chem. War. | G | 2 | 2 | .. | 2 | |
| 5·51 | Organic Chem. II..<br>*5·42* | (Elective) | G(A) | 1 | 2 | .. | 2 | Norris |
| 5·52 | Organic Chem. II..<br>*5·42* | (Elective) | G(A) | 2 | 2 | .. | 2 | Norris |
| 5·53 | Organic Chem. III.<br>*5·42* | (Elective) | G(A) | 1 | 3 | .. | 6 | Mulliken |
| 5·541 | Organic Chem. IV.<br>*5·42* | (Elective) | G(A) | 1 | 2 | .. | 4 | Davis |
| 5·542 | Organic Chem. IV.<br>*5·541* | (Elective) | G(A) | 2 | 2 | .. | 4 | Davis |
| 5·55 | Organic Qual. Anal.<br>*5·42, 5·414* | (Elective) | G(A) | 1 | 0 | 10 | 0 | Mulliken |
| 5·56 | Tech.Org.Chem....<br>*5·41* | (Elective) | G(A) | 2 | 2 | .. | 2 | Underwood |
| 5·57 | Chemistry of Dyes.<br>*5·42* | (Elective) | G(A) | 2 | 2 | .. | 2 | Mulliken |
| 5·581 | Org. Lab., Adv.....<br>*5·42, 5·424* | (Elective) | G(A) | 1 | 0 | 5 | 1 | Morton |
| 5·582 | Org. Lab., Adv.....<br>*5·42, 5·424* | (Elective) | G(A) | 2 | 0 | 5 | 1 | Morton |
| 5·584 | Mol. Str. of Org. Chem. Comp.... | (Elective) | G(A) | 2 | 2 | .. | 4 | Ashdown |
| 5·591 | Recent Adv. in Org. Chem..........<br>*5·42* | (Elective) | G(A) | 1 | 1 | .. | 1 | Huntress |
| 5·592 | Recent Adv. in Org. Chem..........<br>*5·42* | (Elective) | G(A) | 2 | 1 | .. | 1 | Huntress |
| 5·61 | Phys. Chem. I.....<br>*M21, 8·03, 5·13* | V, X | 3 | 1 | 4 | 1 | 5 | Sherrill |
| 5·611 | Physical Chem. I..<br>*M21, 8·03, 5·13* | III$_3$, XII(b) | 4 | 1 | 4 | .. | 4 | Millard |
| | | III$_4$, XV$_2$ | 3 | 1 | 4 | .. | 4 | |
| 5·62 | Phys. Chem. II....<br>*5·61* | V, X | 3 | 2 | 3 | 1 | 5 | Sherrill |
| 5·63 | Phys. Chem. III...<br>*5·62* | V | 4(B) | 1 | 3 | 1 | 4 | Sherrill |
| 5·64 | Phys. Chem. IV...<br>*5·63* | V | 4(B) | 2 | 3 | .. | 4 | Sherrill |
| 5·683 | Phys. Chem., Elem.,<br>*5·02, 8·04* | XVI | 3 | 1 | 2 | .. | 2 | Millard |
| | | Mil. Eng. | 4 | 1 | 2 | .. | 2 | |
| | | II (T.D.) | G | 1 | 2 | .. | 2 | |
| 5·684 | Phys. Chem., Elem.<br>*M21, 5·12, 8·04* | VII$_{1,2}$ | 3 | 1 | 3 | .. | 3 | Gillespie |
| 5·71 | Physical Chem.....<br>*M21, 8·03, 5·13* | (Elective) | G(A) | 1 | 4 | .. | 6 | Sherrill |
| 5·72 | Physical Chem.....<br>*5·71* | (Elective) | G(A) | 2 | 4 | .. | 6 | Sherrill |
| 5·73 | Free Energy.......<br>*5·63 or 5·72* | (Elective) | G(A) | 1 | 2 | .. | 4 | Sherrill |
| 5·741 | Kin. Th. of Gas, Liq. & Sol....... | (Elective) | G(A) | 1 | 2 | .. | 4 | Keyes |
| 5·742 | Kin. Th. of Gas, Liq. & Sol.......<br>*5·741* | (Elective) | G(A) | 2 | 2 | .. | 4 | Keyes |
| 5·75 | Thermodynamics.. | (Elective) | G(A) | 2 | 2 | .. | 2 | Keyes |
| | | II (T.D.) | G | 2 | 2 | .. | 2 | |
| 5·76 | Thermodyn.&Chem.<br>*5·62* | (Elective) | G(A) | 1 | 3 | .. | 6 | Gillespie |
| 5·77 | Thermodyn.&Chem.<br>*5·76* | (Elective) | G(A) | 2 | 2 | .. | 4 | Beattie |
| 5·78 | Quantum Th. Ap.<br>*(5·63)* | (Elective) | G(A) | 1 | 2 | .. | 4 | Beattie |
| 5·79 | Th. of Solutions...<br>*5·76* | (Elective) | G(A) | 2 | 2 | .. | 4 | Scatchard |
| 5·81 | Chem. Literature I.<br>*L12 and L52 or L22* | V | 3 | 1 | 3 | .. | 2 | Hall |
| 5·82 | Chem. Literature II<br>*5·81, 5·41, 5·61* | V | 3 | 2 | 1 | .. | 1 | Huntress |
| 5·83 | History of Chem...<br>*5·41* | V | 4(B) | 2 | 2 | .. | 2 | Davis |
| 5·842 | Optical Methods...<br>*5·12, 8·02* | (Elective) | 4(B) | 1 or 2 | 0 | 2 | 1 | Woodman |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 5·843 | Eng. Chemistry.... *5·02* | (Elective) | 4 | 1 or 2 | 2 | .. | 2 | Gill |
| 5·844 | Eng. Chemistry.... | XVII | 2 | 1 | 5 | .. | 1 | Gill |
| 5·851 | Meth. of Electro-chem. Anal...... *5·12* | (Elective) | G(A) | 2 | 1 | 3 | 2 | Hall |
| 5·852 | Org. Phys. Chem... *5·64, 5·42* | (Elective) | G(A) | 2 | 1 | .. | 1 | Morton |
| 5·855 | Th. & App. of Cat. *5·41* | (Elective) | G(A) | 2 | 2 | .. | 2 | Underwood |
| 5·89 | Chemistry........ *(5·42, 5.62, 10·203 or 10·19, 5·424 or 5·426)* | V, X | 3 | 2 | 0 | 0 | 6 | Millard |
| 5·90 | Logic of Sci. Inq... | (Elective) | G(A) | 1 | 1 | .. | 2 | Davis |
| 5·911 | Journal Meet. in Inorg. Chem..... | (Elective) | G(A) | 1 | 1 | .. | 1 | Schumb |
| 5·912 | Journal Meet. in Inorg. Chem..... | (Elective) | G(A) | 2 | 1 | .. | 1 | Schumb |
| 5·921 | Journal Meet. in Org. Chem...... *5·42* | (Elective) | G(A) | 1 | 1 | .. | 1 | Norris |
| 5·922 | Journal Meet. in Org. Chem...... *5·42* | (Elective) | G(A) | 2 | 1 | .. | 1 | Norris |
| 5·931 | Journal Meet. in Phys. Chem..... | (Elective) | G(A) | 1 | 1 | .. | 1 | Scatchard |
| 5·932 | Journal Meet. in Phys. Chem..... | (Elective) | G(A) | 2 | 1 | .. | 1 | Scatchard |
| 5·941 | Research Conf..... *5·42, 5·63* | (Elective) | G(A) | 1 | 1 | .. | 1 | Norris |
| 5·942 | Research Conf..... *5·42, 5·63* | (Elective) | 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.......... | (Elective) | 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.... | VI, VI-A, XIV | 2 | 2 | 5 | .. | 4 | Lansil |
| | *(M22) 8·03* | | | | | | | |
| 6·01 | Elec. Eng. Prin.... | VI, VI-C, XIV | 3 | 1 | 3 | .. | 4 | Lansil |
| | *6·00* | VI-A(A) | 3 | S | 3 | .. | 4 | |
| | | VI-A(B) | 3 | S | 2 | .. | 5 | |
| 6·02 | Elec. Eng., Prin.... | VI, VI-C, XIV | 3 | 2 | 5 | .. | 6 | R.R.Lawrence |
| | *6·00, M22* | VI-A(B) | 3 | 1 | 5 | .. | 6 | |
| 6·021 | Elec. Eng., Prin...... | VI-A(A) | 3 | 1 | 2 | .. | 4 | R.R.Lawrence |
| | *6·00, M22* | | | | | | | |
| 6·023 | Elec. Eng. Prin.... | VI-A(A) | 3 | 2 | 5 | .. | 6 | R.R.Lawrence |
| | *6·021* | | | | | | | |
| 6·03 | Elec. Eng. Prin.... | VI, VI-C | 4 | 1 | 6 | .. | 8 | R.R.Lawrence |
| | *6·02* | | | | | | | |
| 6·031 | Elec. Eng. Prin.... | VI-A(B) | 3 | 2 | 2 | .. | 5 | R.R.Lawrence |
| | *6·02* | | | | | | | |
| 6·032 | Elec. Eng. Prin.... | VI-A(A) | 4 | S | 2 | .. | 5 | R.R.Lawrence |
| | *6·023 or 6·031* | VI-A(B)$_{2}$ | 4 | 1 | 2 | .. | 5 | |
| | | VI-A(B)$_{1, 2}$ | 4 | S | 3 | .. | 4 | |
| 6·04 | Elec. Eng. Prin.... | VI | 4(B) | 2 | 6 | .. | 9 | Woodruff |
| | *6·03* | | | | | | | |
| 6·041 | Elec. Eng. Prin.... | VI-A(A)$_{1, 2}$ | 4 | 1 | 3 | .. | 5 | Woodruff |
| | *6·032* | VI-A(B)$_{1, 2}$ | 4 | 1 | 2 | .. | 6 | |
| 6·042 | Elec. Eng. Prin.... | VI-A(A)$_{1, 2}$ | 4 | 2 | 2 | .. | 6 | Woodruff |
| | *6·041* | VI-A(B)$_{1, 2}$ | 4 | 2 | 3 | .. | 5 | |
| 6·09 | Elec. Eng. Prin.... | XIV | 4 | 1 | 3 | .. | 6 | R.R.Lawrence |
| | *6·02* | | | | | | | |
| 6·20 | Power Trans. Eq... | (Elective) | 4(B) | 2 | 3 | .. | 6 | Woodruff |
| | *6·03* | | | | | | | |
| 6·21 | Ind. App. El. Power | (Elective) | 4(B) | 2 | 3 | .. | 6 | Dawes |
| | *6·03* | Mil. Eng. | 4 | 2 | 3 | .. | 6 | |
| 6·221 | Central Stations... | (Elective) | 4(B) | 1 | 3 | .. | 6 | Mulligan |
| | *2·42* | | | | | | | |
| 6·222 | Central Stations... | (Elective) | 4(B) | 2 | 3 | .. | 6 | Mulligan |
| | *6·03* | | | | | | | |
| 6·241 | Electric Railways.. | (Elective) | 4(B) | 1 | 3 | .. | 6 | Entwistle |
| | *6·01 (6·03)* | | | | | | | |
| 6·242 | Electric Railways.. | (Elective) | 4(B) | 2 | 3 | .. | 6 | Entwistle |
| | *6·241* | | | | | | | |
| 6·251 | Elec. Mach. Des... | (Elective) | 4(B) | 1 | 3 | .. | 6 | Dwight |
| | *(6·03)* | | | | | | | |
| 6·252 | Elec. Mach. Des... | (Elective) | 4(B) | 2 | 3 | .. | 6 | Dwight |
| | *6·03* | | | | | | | |
| 6·26 | Elec. Insulation and its Behavior .... | (Elective) | 4(B) | 1 | 2 | 3 | 4 | Moon |
| | *M31* | | | | | | | |
| 6·27 | Illumination ...... | (Elective) | 4(B) | 1 | 2 | 3 | 4 | Moon |
| | *8·02* | | | | | | | |
| 6·281 | Prin. Wire Com. .. | (Elective) | 4(B) | 1 | 3 | .. | 6 | C. E. Tucker |
| | *(6·02)* | | | | | | | |
| 6·282 | Prin. Radio Com... | (Elective) | 4(B) | 2 | 3 | .. | 6 | Gager |
| | *6·02* | | | | | | | |
| 6·29 | Storage Batteries.. | (Elective) | 4 | 1 or 2 | 1 | .. | 1 | R.R.Lawrence |
| | *6·00* | | | | | | | |
| 6·301 | Elec. Com., Prin... | VI-C | 3 | 1 | 3 | .. | 6 | Guillemin |
| | *6·00* | | | | | | | |
| 6·302 | Elec. Com., Prin... | VI-C | 3 | 2 | 3 | .. | 6 | Guillemin |
| | *6·301 (6·02)* | | | | | | | |
| 6·311 | Elec. Com., Prin... | VI-C | 4(B) | 1 | 3 | .. | 5 | Bowles |
| | *6·302, 6·02 or equiv.* | VI-A(B)$_{2}$ | 4(B) | S | 3 | .. | 5 | |
| 6·312 | Elec. Com., Prin... | VI-A(B)$_{2}$, VI-C | 4(B) | 2 | 3 | .. | 5 | Guillemin |
| | *6·302 and 6·02* | VI-A(A)$_{2}$ | 4 | 2 | 2 | .. | 6 | |
| 6·330 | Elec. Com. Lab.... | VI-A(A)$_{2}$ | 4 | 1 | 0 | 4 | 4 | Gager |
| | *(6·39T), 6·311* | VI-A(B)$_{2}$ | 4 | 2 | 0 | 4 | 4 | |
| 6·331 | Elec. Com. Lab.... | VI-C | 4 | 1 | 0 | 5 | 6 | Gager |
| | *(6·311)* | | | | | | | |
| 6·332 | Elec. Com. Lab.... | VI-C | 4 | 2 | 0 | 3 | 4 | Gager |
| | *6·331* | | | | | | | |
| 6·39T | Eng. Electronics... | VI-A(A) | 4 | 1 | 2 | 3 | 4 | Gray |
| | | VI-A(B)$_{1, 2}$ | 4 | 2 | 2 | 3 | 4 | |
| 6·40 | Elec. Eng. Elem.... | I$_{1, 2, 3}$, XI, XV$_{1}$, a, c, XVII | 3 | 1 | 4 | .. | 6 | Hudson |
| | ***(8·04)*** | II, IX-B, XV$_{1}$b, $_{2}$ | 3 | 2 | 4 | .. | 6 | |
| | | III, X, XIII, XIII-C, XVI, Mil. Eng. | 4 | 1 | 4 | .. | 6 | |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 6·42 | Elec. Eng. Elem.... | II(A.O.) | 4 | 1 | 5 | .. | 5 | Hudson |
| 6·43 | Gen. & Dist. Elec. Energy.........<br>*6·40* | XVIb | 4 | 2 | 4 | .. | 6 | Balsbaugh |
| 6·44 | Elec. Trans. & Con.<br>*6·40* | $I_3$ | 3 | 2 | 2 | .. | 4 | Balsbaugh |
| 6·48 | Elec. Eq. Bldgs....<br>*8·04* | XVII<br>(Elective) | 3<br>3, 4 | 2<br>2 | 1<br>1 | ..<br>.. | 2<br>2 | Hudson |
| 6·501 | Elec. Eng. Seminar | (Elective) | G(A) | 1 | 2 | .. | 6 | Dahl |
| 6·502 | Elec. Eng. Seminar | (Elective) | G(A) | 2 | 2 | .. | 6 | Dahl |
| 6·511 | Elec. Circuits.....<br>*6·04, M31* | (Elective) | G(A) | 1 | 3 | .. | 7 | Wildes |
| 6·512 | Elec. Circuits.....<br>*6·511* | (Elective) | G(A) | 2 | 3 | .. | 7 | Wildes |
| 6·513 | Elec. Circuits.....<br>*6·512* | (Elective) | G(A) | 2 | 3 | .. | 7 | Wildes |
| 6·521 | Alt.Cur.Machinery<br>*6·04, M31* | (Elective) | G(A) | 1 | 2 | 3 | 5 | Lyon |
| 6·522 | Alt.Cur.Machinery<br>*6·04, M31* | (Elective) | G(A) | 2 | 2 | 3 | 5 | Lyon |
| 6·531 | Org. & Adm. Pub. Service Co......<br>*6·04, Ec32* | (Elective) | G(A) | 1 | 3 | .. | 7 | Jackson |
| 6·532 | Org. & Adm. Pub. Service Co......<br>*6·04, Ec32* | (Elective) | G(A) | 2 | 3 | .. | 7 | Jackson |
| 6·541 | Power Gen.Stations<br>*6·03, Ec32* | (Elective) | G(A) | 1 | 3 | .. | 6 | Mulligan |
| 6·542 | Power Gen.Stations<br>*6·03, Ec32* | (Elective) | G(A) | 2 | 3 | .. | 6 | Mulligan |
| 6·551 | Railroad Elec. Trac.<br>*6·03, 6·242, Ec32* | (Elective) | G(A) | 1 | 3 | .. | 6 | Entwistle |
| 6·552 | Railroad Elec. Trac.<br>*6·551* | (Elective) | G(A) | 2 | 3 | .. | 6 | Entwistle |
| 6·561 | Adv. Network Th..<br>*6·312* | (Elective) | G(A) | 1 | 2 | 3 | 5 | Guillemin |
| 6·562 | Adv. Network Th..<br>*6·561* | (Elective) | G(A) | 2 | 2 | .. | 5 | Gullemin |
| 6·571 | Illumination......<br>*8·02* | (Elective) | G(A) | 1 | 2 | 3 | 4 | Moon |
| 6·572 | Illumination......<br>*6·571* | (Elective) | G(A) | 2 | 2 | 3 | 4 | Moon |
| 6·58 | Op. Circuit Anal...<br>*6·04 or 6·312, M31* | (Elective) | G(A) | 1 ✦<br>2 | 3 | .. | 7 | M.F.Gardner |
| 6·59 | Communications Laboratory.....<br>*6·332 or equiv.* | (Elective) | G(A) | 1 or 2✦ | | | | Bowles |
| 6·62 | Elec. Com. Prin....<br>*6·312 or equiv.* | (Elective) | G(A) | 2 | 2 | 3 | 5 | Bowles |
| 6·651 | Elec. Power Dist...<br>*6·04* | (Elective) | G(A) | 1 | 3 | .. | 6 | Balsbaugh |
| 6·652 | Elec. Power Dist...<br>*6·04* | (Elective) | G(A) | 2 | 3 | .. | 6 | Balsbaugh |
| 6·661 | Elec. Mach. Dev. Prin............<br>*6·03* | (Elective) | G(A) | 1 | 3 | 1 | 6 | Dwight |
| 6·662 | Elec. Mach. Dev. Prin............<br>*6·03* | (Elective) | G(A) | 2 | 3 | 1 | 6 | Dwight |
| 6·68 | Transmission-Line Trans..........<br>*6·04, M31* | (Elective) | G(A) | 2 | 3 | .. | 7 | Dahl |
| 6·69 | Sound in Elec. Com.<br>*M22* | (Elective) | G(A) | 2 | 2 | 3 | 5 | Fay |
| 6·70 | Elec. Eng. Lab.....<br>*6·00 (6·01)* | VI, VI-C | 3 | 1 | 2 | 4 | 5 | C. E. Tucker<br>Bennett |
| 6·71 | Elec. Eng. Lab.....<br>*6·70 (6·02)* | VI, VI-C | 3 | 2 | 2 | 3 | 5 | C.E.Tucker<br>Bennett |
| 6·72 | Elec. Eng. Lab.....<br>*6·71 (6·03)* | VI, VI-C | 4 | 1 | 1 | 3 | 4 | C. E. Tucker |
| 6·73 | Elec. Meas. Adv...<br>*6·71, 6·04* | (Elective) | G(A) | 1 or 2✦ | | | | Bennett |
| 6·74 | Elec. Eng. Lab.....<br>*6·03, 6·72* | (Elective) | G(A) | 1 or ✦<br>2 | | | | C. E. Tucker |
| 6·75 | Elec.Adv.Lab.Mach.<br>*(6·00)* | VI, VI-A<br>$III_4$ | 2<br>4 | 2<br>2 | 1<br>1 | 1<br>1 | 2<br>2 | Bennett |

✦Time specially arranged.

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 6·76 | Elec. Eng. Lab..... | VI-A(A) | 3 | S | 1 | 2 | 4 | C. E. Tucker |
| | *6·75 (6·01)* | VI-A(B) | 3 | **1** | 1 | 2 | 4 | |
| 6·77 | Elec. Eng. Lab..... | VI-A(A) | 3 | **2** | 1 | 2 | 2 | Bennett |
| | *(6·023) or 6·02* | VI-A(B) | 4 | S | 1 | 2 | 2 | |
| 6·78 | Elec. Eng. Lab..... | VI-A(A)$_{1,2}$ | 4 | **1** | 1 | 3 | 6 | C. E. Tucker |
| | *6·76, 6·032* | VI-A(B)$_{1,2}$ | 4 | **2** | 1 | 3 | 6 | |
| 6·781 | Elec. Eng. Lab..... | VI-A(A)$_3$ | 4 | **1** | 1 | 2 | 4 | C. E. Tucker |
| | *6·76, 6·032* | VI-A(B)$_3$ | 4 | **2** | 1 | 2 | 4 | |
| 6·80 | Elec. Eng. Lab..... | (Elective) | 4(B) | **1** or ✦ | | | | C. E. Tucker |
| | | | | **2** | | | | Bennett |
| 6·81 | Elec. Eng. Lab..... | XIV | 3 | **1** | 1 | 2 | 2 | C. E. Tucker |
| | *6·01* | | | | | | | Bennett |
| 6·82 | Elec. Eng. Lab..... | XIV | 3 | **2** | 1 | 2 | 2 | C. E. Tucker |
| | *6·81 (6·02)* | | | | | | | Bennett |
| 6·83 | Elec. Eng. Lab..... | XIV | 4 | **1** | 1 | 2 | 2 | C. E. Tucker |
| | *6·82 (6·09)* | | | | | | | |
| 6·85 | Elec. Eng. Lab..... | X, Mil. Eng. | 4 | **2** | 0 | 2 | 3 | C. E. Tucker |
| | *6·40* | III$_{1,2,3}$, IX-B, XVI | 4 | **1** | 0 | 2 | 3 | |
| 6·86 | Elec. Eng. Lab..... | XI | 3 | **2** | 0 | 1 | 2 | C. E. Tucker |
| | *6·40* | | | | | | | |
| 6·88 | Elec. Eng. Lab..... | A.O. | 4 | **1** | 1 | 3 | 6 | C. E. Tucker |
| | *6·42* | | | | | | | |
| 6·89 | Elec. Eng. Lab..... | I$_{1,2,3}$, II, XV$_{1,2}$, XVII | 3 | **2** | 0 | 2 | 2 | C. E. Tucker |
| | *6·40* | XIII, XIII-C | 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 | |
| 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 | |
| 6·941 | 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 | |

✦Time specially arranged.

# BIOLOGY AND PUBLIC HEALTH

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 7·01 | General Biology... | VII, XI | 2 | 1 | 2 | 3 | 2 | Turner |
| | | V, IX-A, XIIb | 3 | 1 | 2 | 3 | 2 | |
| 7·03 | Theoret. Biology... | VII$_{1,2}$ | 4(B) | 2 | 2 | .. | 3 | Blake |
| | *7·01, 7·10* | | | | | | | |
| 7·05 | Micros. of Fibres.. | (Elective) | 4(B) | 1 | 1 | 3 | 1 | Jennison |
| 7·06 | Botany........... | VII$_{1,2}$ | 2 | 2 | 2 | 4 | 4 | Jennison |
| | *(7·01)* | | | | | | | |
| 7·07 | Mycology......... | VII$_2$ | 3 | 1 | 1 | 2 | 2 | Proctor |
| | *7·06* | | | | | | | |
| 7·08 | Parasitology...... | VII$_1$ | 4 | 2 | 2 | .. | 4 | Bigelow |
| | *7·01* | | | | | | | |
| 7·09 | Parasitology, Adv.. | (Elective) | G(A) | 2 | 0 | 4 | 4 | Bigelow |
| | *7·08* | | | | | | | |
| 7·10 | Zoölogy.......... | VII$_{1,2}$ | 2 | 2 | 1 | 4 | 3 | Blake |
| | *7·01* | XIIb | 3 | 2 | 1 | 4 | 3 | |
| 7·11 | Anatomy & Histol. | VII$_2$ | 3 | 1 | 2 | 6 | 4 | Bigelow |
| | *7·01* | | | | | | | |
| 7·12 | Anatomy & Histol.. | VII$_1$ | 3 | 2 | 2 | 5 | 4 | Bigelow |
| | *7·11* | | | | | | | |
| 7·13 | Cytology......... | (Elective) | G(A) | 2 | 4 | .. | 4 | Bigelow |
| | *7·12* | | | | | | | |
| 7·14 | Hist. of Biology... | (Elective) | G(A) | 1 | 1 | .. | 4 | Bigelow |
| | *7·01* | | | | | | | |
| 7·15 | Essent. of Anatomy | VII$_2$ | 3 | 1 | 3 | .. | 3 | Blake |
| | *7·10* | | | | | | | |
| 7·18 | Tech.Asp.of Entom. | (Elective) | G(A) | 1 | 2 | .. | 3 | Blake |
| | *7·10* | | | | | | | |
| 7·20 | Physiology........ | VII$_{1,2}$ | 3 | 2 | 3 | 3 | 5 | Bunker |
| | *5·501, 7·11 or 7·15* | | | | | | | |
| 7·22 | Pers. Hyg. & Nut.. | VII$_1$ | 4(B) | 1 | 2 | .. | 2 | Bunker |
| 7·23 | App. Nutrition.... | VII (Elective) | 4, G | 2 | 1 | .. | 2 | Turner |
| 7·281 | Sanitary Biology... | XI | 3 | 1 | 3 | 4 | 3 | Blake |
| 7·29 | Bacteriology...... | XI | 3 | 2 | 1 | 4 | 2 | Jennison |
| | *7·281* | | | | | | | |
| 7·301 | Bacteriology...... | VII$_{1,2,3}$ | 3 | 1 | 2 | 4 | 4 | Horwood |
| | *7·01* | | | | | | | |
| 7·302 | Bacteriology...... | VII$_{1,2,3}$ | 3(B) | 2 | 2 | 4 | 3 | Horwood |
| | *7·301* | | | | | | | |
| 7·31 | Bacteriology ...... | Mil.Eng. | 4 | 1 | 2 | .. | 2 | Prescott |
| 7·321 | Bacteriology,Adv.. | (Elective) | G(A) | 1 | 3 | .. | 4 | Jennison |
| | *7·301, 7·80* | | | | | | | |
| 7·322 | Bacteriology,Adv.. | (Elective) | G(A) | 2 | 1 | 4 | 2 | Jennison |
| | *7·321* | | | | | | | |
| 7·33 | Plant Diseases.... | VII$_2$ | 3 | 2 | 1 | .. | 2 | Prescott |
| | *7·301* | | | | | | | |
| 7·34 | Limnological Field. | VII$_3$ | 3 | S | 0 | 5 | 0 | Bunker |
| | *7·01, 5·122* | | | | | | | |
| 7·35 | Planktonology..... | (Elective) | G(A) | 1 | 2 | .. | 3 | Blake |
| | *7·06, 7·10* | | | | | | | |
| 7·361 | Indust. Microbiol.. | VII$_{1,2}$ | 4(B) | 1 | 1 | 4 | 2 | Prescott |
| | *7·301* | | | | | | | Proctor |
| 7·362 | Indust. Microbiol.. | VII$_2$ | 4(B) | 2 | 1 | 3 | 4 | Proctor |
| | *7·361* | | | | | | | |
| 7·371 | Indust. Microbiol.. | (Elective) | G(A) | 1 | 1 | 4 | 4 | Prescott |
| | *7·361* | | | | | | | |
| 7·372 | Indust. Microbiol.. | (Elective) | G(A) | 2 | 1 | 3 | 4 | Prescott |
| 7·421 | Food Fishes....... | (Elective) | 3 | 1 | 2 | 6 | 5 | Bigelow |
| | *7·10* | | | | | | | |
| 7·422 | Food Fishes....... | (Elective) | 3 | 2 | 2 | 4 | 2 | Bigelow |
| | *7·421* | | | | | | | |
| 7·43 | Fish Culture...... | (Elective) | 3 | 2 | 1 | .. | 2 | Bigelow |
| | *7·10* | | | | | | | |
| 7·441 | Tech. of Fish. Prod. | (Elective) | 4(B) | 1 | 1 | 3 | 4 | Proctor |
| | *7·302, 7·422* | | | | | | | |
| 7·442 | Tech. of Fish Prod. | (Elective) | 4(B) | 2 | 1 | 4 | 4 | Proctor |
| | *7·441* | | | | | | | |
| 7·50 | Infection & Immun. | VII$_{1,2}$ | 3(B) | 1 | 3 | .. | 3 | |
| | *7·301* | | | | | | | |
| 7·52 | Industrial Hygiene. | VII | 4(B) | 2 | 3 | 1 | 4 | Turner |
| | *7·50* | | | | | | | |
| 7·53 | Air Examination... | II (Elective) | 4(B) | 1 | 1 | 3 | 1 | Jennison |
| 7·541 | Pub. Health Adm.. | VII$_{1,2}$ | 4(B) | 1 | 2 | .. | 3 | Turner |
| | *7·302* | | | | | | | |

✦ Time specially arranged.

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 7·542 | Pub. Health Adm.. *7·302* | VII$_{1,2}$ | 4(B) | 2 | 2 | .. | 3 | Turner |
| 7·551 | Public Health Lab. Meth........... *7·301* | VII$_1$ | 4(B) | 1 | 2 | 4 | 2 | |
| 7·552 | Public Health Lab. Meth........... *7·301* | VII$_1$ | 4(B) | 2 | 1 | 2 | 1 | |
| 7·553 | Public Health Lab.. Meth........... (Not offered summer 1932) | (Elective) | | S | 1 | 3 | 1 | |
| 7·56 | Pub. Health Surv.. *7·57* | (Elective) | G(A) | 2 | 2 | .. | 3 | Horwood |
| 7·57 | Municipal San..... *7·301* | VII$_{1,2,3}$<br>Mil. Eng. | 3(B)<br>4 | 2<br>2 | 4<br>4 | ..<br>.. | 4<br>4 | Horwood |
| 7·58 | Vital Statistics.... *7·301, 7·50* | VII$_{1,2}$ | 4(B) | 1 | 2 | .. | 3 | Horwood |
| 7·59 | Sanitation........ *7·302, 7·57* | VII$_2$ | 4(B) | 1 | 6 | .. | 2 | Horwood |
| 7·601 | Health Education.. *7·01* | (Elective) | G(A) | 1 | 2 | .. | 4 | Turner |
| 7·602 | Health Education.. *7·601* | (Elective) | G(A) | 2 | 1 | 3 | 6 | Turner |
| 7·603 | Health Edu. Meth.. (Not offered summer 1932) | (Elective) | | S | 2 | 1 | 4 | Turner |
| 7·604 | School Health Adm. | (Elective) | G(A) | 2 | 1 | .. | 1 | Turner |
| 7·605 | Health Ed. Subj. Matter (Not offered summer 1932).......... | (Elective) | | S | 3 | .. | 4 | Proctor |
| 7·63 | Pub. Health Field.. *7·542* | (Elective) | G(A) | 2 | 2 | .. | 4 | Turner |
| 7·64 | Public Health Prob. *7·542* | (Elective) | G(A) | 2 | 2 | .. | 4 | Turner |
| 7·65 | Health Hazards in Spec. Indus..... *7·52* | (Elective) | G(A) | 2 | 1 | .. | 5 | Prescott<br>Turner |
| 7·66 | Epidemiology..... *7·302, 7·50* | (Elective) | G(A) | 1 | 2 | .. | 6 | Horwood |
| 7·68 | Pathology........ *7·12, 7·551, 7·552* | (Elective) | G(A) | 2 | 1 | 2 | 4 | |
| 7·701 | Tech. of Food Sup.. *(7·301)* | VII$_2$ | 3 | 1 | 2 | 2 | 2 | Proctor |
| 7·702 | Tech. of Food Sup.. *(7·302)* | VII$_2$ | 3 | 2 | 2 | 2 | 4 | Proctor |
| 7·711 | Tech. of Food Prod. *7·701, 7·702* | VII$_2$ | 4(B) | 1 | 2 | 2 | 4 | Prescott<br>Proctor |
| 7·712 | Tech. of Food Prod. *7·701, 7·702* | VII$_2$ | 4(B) | 2 | 2 | 3 | 4 | Prescott<br>Proctor |
| 7·80 | Biochemistry...... *5·41, 7·301* | VII$_{1,2}$ | 4(B) | 1 | 3 | 5 | 5 | Bunker<br>Tobie |
| 7·81 | Enzyme Chemistry. *7·80* | (Elective) | G(A) | 2 | 1 | 3 | 5 | Bunker<br>Tobie |
| 7·91 | Biological Colloq... | VII | 4 | 1 | 1 | .. | 1 | Prescott<br>and Staff |
| 7·92 | Biological Colloq... | VII | 4 | 2 | 1 | .. | 1 | Prescott<br>and Staff |
| 7·931 | Biological Seminar. | (Elective) | G(A) | 1 | 1 | .. | 3 | Prescott |
| 7·932 | Biological Seminar. | (Elective) | G(A) | 2 | 1 | .. | 3 | and Staff |

# 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 | Bennett |
| 8·01 | Physics (Mech.)... | All courses except IV | 1 | 1 | 4 | 2 | 5 | Frank |
| 8·012 | Physics (College Transfer) | | 1 | 1 | 4 | .. | 6 | Bennett |
| 8·02 | Phys. (Mech. and Heat).......... *8·01* | All courses except IV | 1 | 2 | 4 | 2 | 5 | Frank |
| 8·03 | Physics (Elec.).... *8·01, M12* | All courses except IV | 2 | 1 | 4 | 1 | 5 | Page |
| 8·034 | Physics (College Transfer) | | 2 | 2 | 4 | .. | 6 | Bennett |
| 8·04 | Physics (Elec. Optics, & Modern Phys.) *8·03* | All courses except IV | 2 | 2 | 4 | 2 | 4 | Page |
| 8·05 | Sound, Sp. & Aud. *8·04, M12* | VI-C | 4 | 2 | 3 | .. | 6 | Morse |
| 8·06 | Acoust., Ill. & Col. | IV-A | 3 | 1 | 1 | .. | 2 | Drisko |
| 8·07 | Precision of Meas.. *M22* | XIII-A | G | 1 | 1 | .. | 1 | Goodwin |
| | | $I_4$, XIV | 4 | 1 | 1 | .. | 1 | |
| | | XV | 3 | 1 | 1 | .. | 1 | |
| 8·10 | Heat Measurements *8·04* | (Elective) | 4 | 1 | 1 | 3 | 2 | Wilkes |
| 8·11 | Heat Measurements *8·04* | IX-A | 3 | 1 | 0 | 2 | 1 | Wilkes |
| 8·12 | Heat Measurements *8·04* | $III_3$, XIV | 3 | 1 | 1 | 2 | 1 | Wilkes |
| | | $III_4$ | 4 | 1 | 1 | 2 | 1 | |
| 8·13 | Heat Measurements *8·04* | (Elective) | 4 G(B) | 2 | 1 | 4 | 1 | Wilkes |
| 8·14 | Heat Measurements II............. *8·10, 8·11, 8·12 or 8·13* | (Elective) | G(A) | 1✦ | | | | Wilkes |
| 8·15 | Photography...... *8·04* | (Elective) | | 2 | 2 | .. | 1 | Hardy |
| 8·152 | Adv. Photography. *8·161* | (Elective) | | 2 | 0 | 3 | 2 | Hardy |
| 8·161 | Optics........... *8·04* | $I_4$, VIII | 3 | 1 | 3 | .. | 6 | Hardy |
| 8·162 | Optical Meas...... *(8·161)* | $I_4$, VIII | 3 | 1 | 0 | 3 | 2 | Hardy |
| 8·171 | Advanced Optics... *8·161* | (Elective) | 4(B) | 1 | 2 | .. | 3 | Hardy |
| 8·173 | Color Meas....... *8·161* | (Elective) | 4(B) | 2 | 0 | 3 | 2 | Hardy |
| 8·174 | Motion Picture Photography.... *8·161* | (Elective) | 4(B) | 1 | 1 | .. | 3 | Hardy |
| 8·181 | Optics, Seminar.... *8·161* | (Elective) | G(A) | 2 | 2 | .. | 2 | Hardy |
| 8·191 | Photomicrography & the Microscope.. *8·04* (Not offered 1932–33) | II(T.E.) | G(B) | 1 | 1 | 2 | 2 | Hardy |
| 8·193 | Geom. Optic, Adv.. *8·161* (Not offered 1932–33) | (Elective) | G(A) | 1 | 2 | .. | 4 | Hardy |
| 8·194 | Phys. Optics, Adv.. *8·161* (Not offered 1932–33) | (Elective) | G(A) | 2 | 2 | .. | 4 | Hardy |
| 8·201 | Elec. & Magnetism. *8·04, M22* | $I_4$, VIII, XIV | 3 | 2 | 3 | .. | 5 | Nottingham |
| 8·202 | Electronic Lab..... *8·04, M22* | $I_4$, VIII, XIV | 3 | 2 | 0 | 3 | 2 | Nottingham |
| 8·21 | El. of Electron. Phen........... *8·04, 8·201* | (Elective) | 4(B) | 1 | 2 | .. | 4 | Nottingham |
| 8·212 | Experimental Electronics...... *8·201* (*8·21*) or (*8·213*) | VIII(Elective) | 4(B) | 1 and 2 | 1 | 3 | 3 | Nottingham |
| 8·213 | Adv. Electronics... *M22, 8·04, 8·201, 8·512* (Not offered 1932–33) | (Elective) | G(A) | 1 | 3 | .. | 6 | Nottingham |
| 8·214 | Adv. Electronics... *8·213* (Not offered 1932–33) | (Elective) | G(A) | 2 | 3 | .. | 6 | Nottingham |

✦ Time specially arranged.

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 8·26 | Polar Molecules...<br>*8·311* (Not offered 1932–33) | (Elective) | 4(B) | 1 | 3 | 1 | 3 | Müller |
| 8·27 | X-Rays & Crystal Physics........<br>*8·04, M22* | (Elective) | 4(B) | 1 | 2 | 1 | 5 | Warren |
| 8·28 | X-Ray Diffraction.<br>*8·27* | (Elective) | G(A) | 2 | 2 | .. | 4 | Warren |
| 8·29 | LatticeTh. of the Solid State......<br>*8·27, 8·311*<br>(Not offered 1932–33) | (Elective) | G(A) | 2 | 2 | .. | 4 | Warren |
| 8·30 | Special Problems in Crystal Physics..<br>*8·27* | (Elective) | G(B) | 2 | ✦ | | | Warren |
| 8·311 | Atomic Structure..<br>*8·04* | VIII | 3 | 2 | 3 | .. | 5 | Harrison |
| 8·312 | Atomic Struct. Lab.<br>*8·04 (8·311)* | VIII | 3 | 2 | 0 | 3 | 2 | Harrison |
| 8·32 | Line Spectra......<br>*8·311* | (Elective) | 4(B) | 1 | 3 | .. | 6 | Harrison |
| 8·341 | Spectroscopy Seminary.......<br>*8·32* | (Elective) | G(A) | 1 | 1 | .. | 1 | Harrison |
| 8·342 | Spectroscopy Seminary.......<br>*8·32* | (Elective) | G(A) | 2 | 1 | .. | 1 | Harrison |
| 8·343 | Sp. Topics in Spect. Res............<br>*8·32* | (Elective) | G(A) | 1 or 2 | ✦ | | | Harrison |
| 8·35 | Excitation of Spectra........<br>*8·32, 8·36* | (Elective) | G(A) | 2 | 2 | 3 | 4 | Stockbarger |
| 8·36 | Radia. Meas.......<br>*8·04* | (Elective) | 4(B) | 1 | 2 | 3 | 4 | Stockbarger |
| 8·361 | Radiation Meas....<br>*8·36* | (Elective) | G(A) | 1 or 2 | 0 | 5 | 0 | Stockbarger |
| 8·45 | Int. to Phys. Sci... | VIII | 2 | 2 | 4 | .. | 6 | Müller |
| 8·461 | Int. to Theor. Phys.<br>*8·04, M22* | VIII, XVIII | 3(B) | 1 | 4 | .. | 8 | Slater |
| 8·462 | Int. to Theor. Phys.<br>*8·461* | VIII, XVIII | 3(B) | 2 | 4 | .. | 8 | Slater |
| 8·471 | Hist. Dev. of Phys. | VIII | 4(B) | 1 | 3 | .. | 6 | Allis |
| 8·472 | Rec. Dev. of Phys. | VIII | 4(B) | 2 | 3 | .. | 6 | Allis |
| 8·481 | Advanced Mechan.I<br>*8·462 or 8·471*<br>(Not offered 1932–33) | (Elective) | G(A) | 1 | 3 | .. | 6 | Stratton |
| 8·482 | Adv. Mechanics.II<br>*8·462 or 8·471*<br>(Not offered 1932–33) | (Elective) | G(A) | 2 | 3 | .. | 6 | |
| 8·49 | Elasticity and Fluid Dynamics.......<br>*8·462 or 8·471*<br>(Not offered 1932–33) | (Elective) | G(A) | 2 | 3 | .. | 6 | Stratton |
| 8·491 | Bound. Value Prob. in Th. Phys.....<br>*8·461, 8·462*<br>(Not offered 1932–33) | (Elective) | G(A) | 2 | 3 | 0 | 6 | Stratton |
| 8·50 | Heat & Thermo...<br>*8·02, M22* | VIII | 3 | 1 | 3 | .. | 4 | Sears |
| 8·512 | Statistical Mech....<br>*8·50* | (Elective) | G(A) | 2 | 3 | .. | 6 | Frank |
| 8·521 | Quantum Mech....<br>*8·311, 8·462 or 8·472, 8·481, or M652* | (Elective) | G(A) | 1 | 3 | .. | 6 | Morse |
| 8·522 | Theory of Spectra..<br>*8·521* | (Elective) | G(A) | 2 | 3 | .. | 6 | Morse |
| 8·53 | Special Topics in Quantum Theory<br>*8·521, 8·522* | (Elective) | G(A) | 1 | 3 | .. | 6 | |
| 8·541 | Electromag. Th....<br>*M77 or 8·462* | VI-C | 4(B) | 1 | 2 | .. | 2 | Stratton |
| 8·542 | Electromag. Wave Prop...........<br>*8·541* | VI-C | 4(B) | 2 | 2 | .. | 3 | Stratton |

✦Time specially arranged.

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 8·56 | Electromag. Wave Th. I.......... *8·491* | (Elective) | G(A) | 1 | 3 | .. | 6 | Vallarta |
| 8·57 | Electromag. Wave Theory II...... *8·56* | (Elective) | G(A) | 2 | 3 | .. | 6 | Vallarta |
| 8·58 | Th. of Relativity.. *8·462, M631* (Not offered 1932–33) | (Elective) | G(A) | 1 | 3 | .. | 6 | Vallarta |
| 8·591 | Theoretical Seminar........ | (Elective) | G(A) | 1 | 1 | .. | 1 | Morse |
| 8·592 | Theoretical Seminar........ | (Elective) | G(A) | 2 | 1 | .. | 1 | Morse |
| 8·61 | Ceramics......... *5·02, 8·04* | (Elective) | 4(B) | 2 | 2 | 2 | 5 | F. H. Norton |
| 8·62 | Optical Ceramics.. *12·211* | (Elective) | 4(B) | 2 | 0 | 3 | 1 | C.L. Norton, Jr. |
| 8·63 | Fund. Ceramic Proc. *5·62, 8·10 or 8·11* *8·61* | (Elective) | G(A) | 1 | 3 | 4 | 4 | F. H. Norton |
| 8·64 | Phys. Prop. Ceramic Pr............. *8·63* | (Elective) | G(A) | 2 | 2 | 3 | 4 | F. H. Norton |
| 8·801 | Electrochem. Prin.. *8·04, M22* | XIV<br>XIIa | 3<br>4 | 1<br>1 | 4<br>4 | ..<br>.. | 6<br>6 | Goodwin |
| 8·802 | Electrochem. Prin.. *8·801* | XIV<br>XIIa | 3<br>4 | 2<br>2 | 3<br>3 | ..<br>.. | 6<br>6 | Goodwin |
| 8·82 | Electrochemistry... *8·802* | XIV | 4(B) | 1 | 2 | .. | 4 | Goodwin |
| 8·83 | Electrochem., Adv.. *8·82* | (Elective) | G(A) | 1 | 2 | .. | 4 | Thompson |
| 8·851 | App. Electrochem.. *8·82* | XIV | 4(B) | 1 | 1 | .. | 1 | Thompson |
| 8·852 | App. Electrochem.. *8·851* | XIV | 4(B) | 2 | 2 | .. | 4 | Thompson |
| 8·86 | Electrochem. Lab.. *(8·82)* | XIV | 4(B) | 1 | 0 | 5 | 1 | Stockbarger |
| 8·871 | App. Electroch. Lab. *(8·851)* | XIV | 4(B) | 1 | 0 | 2 | 1 | Thompson |
| 8·872 | App. Electroch. Lab. *8·871* | XIV | 4(B) | 2 | 0 | 2 | 1 | Thompson |
| 8·89 | Electric Furnaces.. *8·04, 5·02* | (Elective) | 4(B) | 1 | 1 | 2 | 2 | Thompson |
| 8·90 | Electroch. Elem.... *8·04 and 5·02* | $III_3$ | 4 | 2 | 2 | 2 | 2 | Thompson |
| 8·93 | Electroch. Colloq. *8·82* | XIV | 4(B) | 2 | 1 | .. | 1 | Goodwin |
| 8·98 | Glass Blowing..... | (Elective) | 4 | 1 | 0 | 1 | 0 | Thompson |

# 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 | Ryan |
| 10·15 | Thesis Reports.... *10·26* | X | 4 | 2 | 2 | .. | 2 | C. S. Robinson |
| 10·17 | Indust. Chemistry. *(5·41, 5·61)* | X | 3 | 1 | 3 | .. | 2 | Ryan |
| 10·18 | Indust. Chemistry. *10·17, (5·42, 5·62)* | X | 3 | 2 | 3 | .. | 4 | Lewis |
| 10·191 | Chem. Eng. Lit.... *L12, L52* | X (Elective) | 2 | 1 | 3 | .. | 5 | C. S. Robinson |
| 10·192 | Chem. Eng. Lit.... *10·191* | X (Elective) | 2 | 2 | 3 | .. | 5 | C. S. Robinson |
| 10·201 | Indust. Chemistry.. *5·41, 5·611* | $XV_2$ | 3 | 2 | 4 | .. | 4 | Lewis |
| 10·203 | Indust. Chemistry.. *(5·42), (5·62)* | V | 3 | 2 | 3 | .. | 4 | Lewis |
| 10·21 | Indust. Chemistry.. *10·18* | V, X, $XV_2$ | 4(B) | 1 | 2 | .. | 2 | Lewis |
| | | Chem. War. | G(B) | 1 | 2 | .. | 2 | Lewis |
| 10·25 | Indust. Stoichiom.. *5·42, 5·62* | Chem. War. | G(A) | 1 | 2 | .. | 4 | Weber |
| 10·26 | Indust. Chem. Lab.. *(10·21)* | X, $XV_2$ | 4(B) | 1 | 2 | 3 | 1 | Weber |
| 10·28 | Chemical Eng...... *5·61, 10·17* | X | 3 | 2 | 3 | .. | 6 | Lewis |
| | | Chem. War. | G | 1 | 3 | .. | 6 | |
| 10·29 | Chemical Eng...... *10·28* | X | 4 | 1 | 3 | .. | 6 | Lewis |
| | | Chem. War. | G | 2 | 3 | .. | 6 | |
| 10·30 | Eng. Equipment... *(10·32)* | X-B | 4 | 2 | 4 | .. | 3 | Ryan |
| 10·31 | Chemical Eng..... *10·18, 10·28* | X, $XV_2$ | 4(B) | 1 | 5 | .. | 4 | C. S. Robinson |
| | | Chem. War. | G(B) | 1 | 5 | .. | 4 | |
| 10·32 | Chemical Eng..... *10·31* | X, X-B, $XV_2$ | 4(B) | 2 | 5 | .. | 4 | C. S. Robinson |
| | | Chem. War. | G(B) | 2 | 5 | .. | 4 | |
| 10·38 | Chemical Eng..... | II(A.O.) | 4 | 1 | 5 | .. | 2 | C. S. Robinson |
| 10·41 | Distillation....... *10·32* | (Elective) | G(A) | 2 | 2 | .. | 6 | McAdams |
| 10·42 | Drying........... *10·32* | (Elective) | G(A) | 1 | 2 | .. | 4 | Sherwood |
| 10·43 | Evaporation...... *10·31* | (Elective) | G(A) | 1 | 2 | .. | 4 | C. S. Robinson |
| 10·46 | Absorption and Ext. *10·32* | (Elective) | G(A) | 2 | 2 | .. | 4 | Sherwood |
| 10·50 | Heat Transmission. *10·31* | (Elective) | G(A) | 2 | 2 | .. | 4 | McAdams |
| 10·52 | Chemical Eng. II... *10·32* | (Elective) | G(A) | 1 | 2 | .. | 4 | McAdams |
| 10·53 | Chem. Eng. Des... *10·81, 10·82, 10·83* | X-A | G(A) | 1 | 3 | .. | 6 | Sherwood |
| 10·54 | Economic Balance.. *(10·32)* | (Elective) | G(A) | 1 | 5 | .. | 7 | McAdams |
| 10·55 | Economic Balance. *10·32* | (Elective) | G(A) | 2 | 3 | .. | 6 | Sherwood |
| 10·62 | App. Chem. Therm. *5·62, 10·29* | (Elective) | G(A) | 2 | 3 | .. | 6 | Weber |
| 10·63 | App. Colloid Chem. *5·62* | (Elective) | G(A) | 2 | 3 | .. | 6 | Lewis |
| 10·65 | High Pres. Proc.... *(10·32)* | (Elective) | G(A) | 2 | 2 | .. | 4 | Marek |
| 10·68 | Mat. of Chem. Eng. *5·62* | (Elective) | G(A) | 1 | 2 | .. | 2 | Brugmann |
| 10·70 | Prin. of Combust... *Gen. Inorg. Chem.* | (Elective) | G(A) | 1 | 4 | .. | 6 | Mangelsdorf |
| 10·71 | Fuel Engineering... *10·70* | (Elective) | G(A) | 2 | 3 | .. | 6 | Mangelsdorf |
| 10·72 | Fuel Eng. Practice. *10·71, 10·78* | (Elective) | G(A) | 1 | 0 | 20 | 0 | Ryan |
| 10·73 | Fuel Eng. Design... *10·72* | (Elective) | G(A) | 1 | 3 | .. | 6 | Hottel |
| 10·74 | Furnace Design.... *10·31* | (Elective) | G(A) | 2 | 3 | .. | 6 | Hottel |
| 10·76 | Sem. in Rad. Heat Trans.......... *10·31* | (Elective) | G(A) | 2 | 2 | .. | 4 | Hottel |
| 10·78 | Fuel Eng. Lab..... *10·70* | (Elective) | G(B) | 2 | 0 | 4 | 2 | V. C. Smith |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 10·79 | Automotive Fuels.. *Gen. Inorg. Chem.* | (Elective) | G(B) | 1 | 3 | .. | 3 | Hottel |
| 10·81 | Sch. Ch. Eng. Prac. (Bangor Station). *10·32* | X-A | G(A) | 1, 2 | .. | 11* | .. | Ryan |
| 10·82 | Sch. Ch. Eng. Prac. (Boston Station). *10·31* | X-A | G(A) | 1, 2 | .. | 11* | .. | Ryan |
| 10·83 | Sch. Ch. Eng. Prac. (Buffalo Station). *10·31* | X-A | G(A) | 1, 2 | .. | 11* | .. | Ryan |
| 10·84 | Sch. Ch. Eng. Prac. (Bangor Station). *10·31* | X-B | 4 | 2 | .. | 11* | .. | Ryan |
| 10·85 | Sch. Ch. Eng. Prac. (Boston Station). *10·31* | X-B | 4 | 2 | .. | 11* | .. | Ryan |
| 10·86 | Sch. Ch. Eng. Prac. (Buffalo Station). *10·31* | X-B | 4 | 2 | .. | 11* | .. | Ryan |
| 10·90 | Exp. Research Problem *5·42, 5·62* | X(Elective) | G(A)✦ | | | | | Lewis |
| 10·911 | Research Conf..... *5·42, 5·62* | (Elective) | G(A) | 1 | 1 | .. | 1 | Lewis |
| 10·912 | Research Conf..... *10·911* | (Elective) | G(A) | 2 | 1 | .. | 1 | Lewis |
| 10·941 | Org. & Meth. of Ind. Research....... *5·42, 5·62* | (Elective)<br>Chem. War. | G(A)<br>G | 1<br>1 | 1<br>1 | ..<br>.. | 2<br>2 | Brugmann |
| 10·942 | Org. & Meth. of Ind. Research....... *10·941* | (Elective)<br>Chem. War. | G(A)<br>G | 2<br>2 | 1<br>1 | ..<br>.. | 2<br>2 | Brugmann |
| 10·991 | Sem. in Chem. Eng. *10·32* | (Elective) | G(A) | 1 | 2 | .. | 2 | Lewis |
| 10·992 | Sem. in Chem. Eng. *10·32* | (Elective) | G(A) | 2 | 2 | .. | 2 | McAdams |

✦ Time specially arranged.
* Field work 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....... | $III_{1,2,3}$, XII | 2 | 1 | 2 | 6 | 2 | Buerger |
| | *5·02* | IX-A | 3 | 1 | 2 | 6 | 2 | |
| 12·02 | Mineralogy....... *12·01* | XII | 2 | 2 | 1 | 4 | 1 | Buerger |
| 12·05 | Mineralogy, Adv... *12·15* | (Elective) | G(A) | 1 | 1 | 4 | 1 | Buerger |
| 12·15 | Petrography...... *12·02, 12·211* | XII | 3 | 2 | 1 | 7 | 2 | Buerger |
| 12·17 | Petrographic Res.. *12·15* | (Elective) | G(A) | 2 | 1 | 7 | 2 | Buerger |
| 12·211 | Optical Crystallog.. *8·02* | XII | 3(B) | 1 | 1 | 3 | 1 | Buerger |
| 12·212 | Optical Crystallog.. Adv........... *12·211* | (Elective) | G(A) | 2 | 1 | 2 | 1 | Buerger |
| 12·25 | Physical Crystallog. *8·04* | $III_4$ | 3(B) | 1 | 1 | 2 | 2 | Buerger |
| 12·30 | Geology.......... | $III_{1,2}$, XII | 2 | 2 | 3 | 1 | 2 | Morris |
| | *12·01* | IX-A | 3 | 2 | 3 | 1 | 2 | |
| 12·31 | Geology.......... | $III_{1,2}$, XII | 3 | 1 | 3 | 2 | 3 | Shimer |
| | *12·30* | IX-A | 4 | 1 | 3 | 2 | 3 | |
| 12·321 | Geology.......... | I | 3 | 1 | 2 | .. | 1 | Morris |
| | | XI | 4 | 1 | 2 | .. | 1 | |
| 12·322 | Geology.......... *12·321* | I | 3 | 2 | 1 | 2 | 3 | Morris |
| 12·33 | Field Geology..... *1·03, 12·01, 12·31* | $III_{1,2}$, XII | 4 | 1 | 0 | 3 | 2 | Morris |
| 12·351 | Geol. Survey., Adv. *12·33* | (Elective) | G(A) | 1 | 0 | 4 | 4 | Morris |
| 12·352 | Geol. Survey., Adv.. *12·351* | (Elective) | 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 or G60* | 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 | 4 | .. | 3 | Newhouse |
| 12·41 | Econ. Geol. Lab... *12·40* | XII | 4(B) | 1 | 0 | 6 | 2 | Newhouse |
| 12·42 | App. Econ. Geol... *12·40* | XII | 4(B) | 2 | 2 | .. | 1 | Newhouse |
| 12·431 | Ec. Geol. Lab., Adv. *12·41* | (Elective) | G(A) | 1 | 0 | 4 | 1 | Lindgren |
| 12·432 | Ec. Geol. Lab., Adv. *12·41* | (Elective) | G(A) | 2 | 0 | 4 | 1 | Lindgren |
| 12·433 | Ec. Geol. Sem., Adv. *12·40* | (Elective) | G(A) | 1 | 2 | .. | 2 | Lindgren |
| 12·434 | Ec. Geol. Sem., Adv. *12·40* | (Elective) | G(A) | 2 | 2 | .. | 2 | Lindgren |
| 12·44 | Ec. Geol. of Fuels.. *G60* | (Elective) | 4,G(B) | 2 | 1 | .. | 1 | Whitehead |
| 12·46 | Econ. Geol. of Non-Metallic Deposits *12·40* | XII | 4(B) | 1 | 2 | 1 | 3 | Newhouse |
| 12·47 | Microstruct. of Ores and Metals..... *5·12, 8·02* | $III_{1,2}$ | 4(B) | 1 | 0 | 3 | 0 | Newhouse |
| 12·48 | Eng. Geol. & Hyd.. *12·31* | XII | 4(B) | 1 | 3 | .. | 2 | Morris |
| 12·49 | Geol. of Materials. | IV-A | 2 | 2 | 2 | .. | 2 | Morris |
| | | XVII | 3 | 2 | 2 | .. | 2 | |
| 12·50 | Historical Geology. *12·31 or G60* | XII | 3 | 2 | 2 | 1 | 2 | Shimer |
| 12·511 | Paleontology...... *12·31 or G60* | 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* | (Elective) | G(A) | 1 | 1 | 3 | 3 | Shimer |
| 12·522 | Paleontology, Adv. *12·521* | (Elective) | G(A) | 2 | 1 | 3 | 3 | Shimer |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 12·53 | Index Fossils....... *12·511* | (Elective) | G(A) | **2** | 2 | 4 | 1 | Shimer |
| 12·54 | Micropaleontology. *12·512* | (Elective) | G(A) | **1** | 1 | 2 | 2 | Shimer |
| 12·55 | Organic Evol., Adv. *G64* | (Elective) | G(A) | **2** | 2 | .. | 3 | Shimer |
| 12·581 | Stratigraphy, Adv.. *12·50* | (Elective) | G(A) | **1** | 2 | .. | 4 | Shimer |
| 12·582 | Stratigraphy, Adv.. *12·15, 12·581* | (Elective) | G(A) | **2** | 2 | .. | 4 | Shimer |
| 12·60 | Struct. Geology.... *12·31* | XII | 4(B) | **1** | 2 | .. | 3 | Morris |
| 12·61 | Diastro. & Vulcan.. *12·15, 12·31* | XII | 4(B) | **2** | 2 | .. | 3 | Morris |
| 12·631 | Geol. Seminar, Adv. *12·31* | (Elective) | G(A) | **1** | 2 | .. | 5 | Shimer |
| 12·632 | Geol. Seminar, Adv. *12·31* | (Elective) | G(A) | **2** | 2 | .. | 5 | Lindgren and Staff |
| 12·64 | Geol. of N. America. *12·50* | (Elective) | G(A) | **1** | 2 | .. | 4 | Shimer |
| 12·65 | Geology of Europe. *12·64* | (Elective) | G(A) | **2** | 2 | .. | 4 | Shimer |
| 12·80 | Geol. Coal & Petrol. *12·31 or G60* | XII<br>$III_2$ | 4(B)<br>3 | **2**<br>**2** | 4<br>4 | ..<br>.. | 3<br>3 | Whitehead |
| 12·81 | Geol. of Petroleum. *12·80* | (Elective) | G(A) | **2** | 3 | .. | 2 | Whitehead |
| 12·851 | Theoret.Geophysics Adv. *8·461* | (Elective) | G(A) | **1** | 3 | .. | 4 | Slichter |
| 12·852 | Theoret.Geophysics, Adv. *8·461, 12·851* | (Elective) | G(A) | **2** | 3 | .. | 4 | Slichter |
| 12·86 | Seismology, Elem... *12·222* | $I_4$ | 4(B) | **1** | 2 | .. | 2 | Slichter |
| 12·87 | Intro. Geophysics Prospect....... *12·322* | $I_4$(b) | 4(B) | **2** | 2 | .. | 2 | Slichter |

# 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 | XIII | 3(B) | 1 | 2 | .. | 2 | Jack |
| | *M12, 8·01* | XIII-A | 4 | 1 | 2 | | 2 | |
| 13·011 | Naval Architecture. *8·01* | XIII-C | 3 | 1 | 2 | .. | 2 | Owen |
| 13·02 | Naval Architecture. | XIII | 3(B) | 2 | 2 | .. | 2 | Jack |
| | *13·01* | XIII-A | 4 | 2 | 2 | .. | 2 | |
| 13·021 | Naval Architecture. *13·011* | XIII-C | 3 | 2 | 2 | .. | 2 | Chapman |
| 13·03 | Naval Architecture. | XIII | 4(B) | 1 | 3 | .. | 3 | Jack |
| | *13·02* | XIII-A | G | 1 | 3 | .. | 3 | |
| 13·11 | Th. of Warship Des. | XIII-A | 4 | 1 | 4 | .. | 6 | Keith<br>Rossell |
| 13·12 | Th. of Warship Des. | XIII-A | 4 | 2 | 4 | .. | 4 | Hovgaard |
| 13·13 | Th. of Warship Des. | XIII-A | G | 1 | 6 | .. | 9 | Hovgaard<br>Keith |
| 13·14 | Th. of Warship Des. | XIII-A | G | 2 | 5 | .. | 6 | Hovgaard<br>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 | 8 | 0 | Hovgaard |
| 13·24 | Warship Design ... | XIII-A | G | 2 | 0 | 10 | 0 | Hovgaard |
| 13·31 | Ship Construction.. | XIII | 2 | 1 | 2 | .. | 2 | Owen |
| 13·32 | Ship Construction.. | XIII, XIII-C | 2 | 2 | 2 | .. | 2 | Jack |
| 13·33 | Ship Construction.. *13·32* | XIII, XIII-C | 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 | 4(B) | 2 | 2 | .. | 1 | Jack |
| 13·39 | Shipyard Practice.. | XIII-A | 4 | 2 | 2 | .. | 2 | Jack<br>Keith |
| 13·41 | Ship Drawing..... | XIII | 2 | 2 | 0 | 5 | 0 | Owen |
| 13·42 | Ship Design....... *13·41* | XIII | 3 | 1 | 0 | 3 | 0 | Owen |
| 13·43 | Ship Design....... *13·42* | XIII | 3 | 2 | 0 | 6 | 0 | Owen |
| 13·45 | Ship Design....... *13·43* | XIII | 4(B) | 1 | 0 | 6 | 0 | Owen |
| 13·46 | Ship Design....... *13·45* | XIII | 4(B) | 2 | 0 | 3 | 0 | Owen |
| 13·47 | Ship Design....... *13·021, 13·51* | XIII-C | 4 | 1 | 0 | 6 | 0 | Owen |
| 13·48 | Model Making.... | XIII-A | 4 | 2 | 0 | 2 | 0 | Owen |
| 13·50 | Marine Engineering | XIII, XIII-C | 2 | 1 | 2 | .. | 1 | Jack |
| 13·51 | Marine Engineering *2·40* | XIII, XIII-C | 3 | 2 | 2 | .. | 3 | Burtner |
| 13·54 | Marine Engineering *2·221, 2·40, 13·51* | XIII | 4(B) | 1 | 2 | .. | 3 | Burtner |
| 13·56 | Marine Engineering *13·51, 13·72* | XIII-C | 4 | 1 | 2 | .. | 3 | Chapman |
| 13·58 | Marine Engineering | XIII-A | 4 | 1 | 3 | .. | 4 | Chapman |
| 13·61 | Marine Eng. Design *2·20, 2·40, 13·51* | XIII | 4(B) | 1 | 0 | 5 | 0 | Burtner |
| 13·62 | Marine Eng. Design *13·61* | XIII | 4(B) | 2 | 1 | 4 | 0 | Burtner |
| 13·64 | Marine Eng. Design *13·58* | XIII-A | 4 | 2 | 0 | 4 | 0 | Chapman |
| 13·66 | Marine Eng. Design *2·42, 13·51* | XIII-C | 4 | 2 | 0 | 2 | 0 | Burtner |
| 13·70 | Steam Turbines.... *2·42, 13·51* | XIII, XIII-A | 4(B) | 2 | 2 | .. | 3 | Burtner |
| 13·72 | Marine Diesel Eng. | XIII | 4 | 2 | 2 | .. | 2 | Chapman |
| | *2·40* | XIII-C | 3 | 2 | 2 | .. | 2 | |
| 13·81 | Ship Operation.... *13·021, 13·51, 13·83* | XIII-C | 4(B) | 1 | 2 | .. | 3 | Chapman |
| 13·82 | Ship Operation.... *13·81* | XIII-C | 4(B) | 2 | 3 | .. | 4 | Chapman |
| 13·83 | Terminal Facilities. | XIII-C | 3 | 1 | 3 | .. | 3 | 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.<br>*2·20, 8·04, M43, 16·52* | XVI | 3 | 2 | 3 | .. | 3 | Ober |
| 16·01 | Aerodyn. Airplane Des.<br>*M44, 16·00* | XVI | 4(B) | 1 | 4 | .. | 4 | Koppen |
| 16·02 | Aircraft Structures.<br>*1·401* | XVI | 4(B) | 1 | 2 | .. | 2 | Newell |
| 16·05 | Airplane Structures.<br>*16·02* | XVI (Elective) | 4(B) | 2 | 3 | .. | 3 | Newell |
| 16·06 | Airplane St., Adv..<br>*16·03, 16·12* | (Elective) | G(A) | 1 | 3 | .. | 6 | Newell |
| 16·08 | Airplane Des. Prob.<br>*16·01, 16·11* | XVI (Elective) | 4(B) | 2 | 2 | 4 | 6 | Koppen |
| 16·11 | Airplane Des. Prac.<br>*16·00, 16·01* | XVI | 4(B) | 1 | 0 | 4 | 0 | Koppen |
| 16·12 | Airplane Des. Prac.<br>*16·11, (16·11)* | XVI | 4(B) | 2 | 0 | 4 | 0 | Newell |
| 16·14 | Airplane Des. Prac., Adv............<br>*(16·08)* | (Elective) | G(A) | 2 | 0 | 6 | 0 | Koppen |
| 16·21 | Airship Theory....<br>*M44, 16·00* | (Elective) | G(A) | 1 | 2 | .. | 3 | R. H. Smith |
| 16·22 | Airship Struct.....<br>*M22, 16·72* | (Elective) | G(A) | 2 | 2 | .. | 4 | R. H. Smith |
| 16·26 | Adv. Aeronautical Problems......<br>*16·01 or 16·06 or 16·21 or 16·63 or 16·83* | XVI (Elective) | G(A) | 1 or 2 | ✦ | | | C. F. Taylor or R. H. Smith |
| 16·30 | Aircraft Propell. Des............<br>*16·01* | (Elective) | G(A) | 2 | 2 | 2 | 4 | Ober |
| 16·35 | Aircraft Instrum...<br>*8·04* | (Elective) | G(A) | 1 | 3 | .. | 3 | Draper |
| 16·44 | Com.Oper. of Aircr.<br>*16·01 or 16·76,* Ec32 | $I_2c$ | 4(B) | 2 | 3 | .. | 6 | Sayre |
| 16·52 | Airplane Shopwork. | XVI | 3 | S | 0 | 8 | 2 | Markham |
| 16·53 | Aircraft Prod. Meth. | XVI | 3 | S | 0 | 7 | 2 | Markham |
| 16·55 | Airplane Design...<br>*16·01* | XVI | 4(B) | 2 | 3 | 4 | 2 | Koppen |
| 16·62 | Aeronautical Lab..<br>*16·01 or (16·01)* | XVI | 4(B) | 1 | 2 | 2 | 3 | Ober |
| 16·63 | Aero.Lab.& Res. Methods........<br>*16·62* | XVI (Elective) | 4(B) | 2 | 2 | 2 | 2 | Ober |
| 16·69 | Aeronaut. Seminar.<br>*16·55* | (Elective) | G(A) | 2 | 2 | .. | 2 | R. H. Smith |
| 16·73 | Adv. Wing Theory.<br>*M44* | (Elective) | G(A) | 1 | 3 | .. | 6 | R. H. Smith |
| 16·74 | Adv. Wing Theory.<br>*16·73* | (Elective) | G(A) | 2 | 3 | .. | 6 | R. H. Smith |
| 16·76 | Aeronautics.......<br>*M21, 2·20* | II (Elective)<br>$I_2c$<br>XIII-A | 4(B)<br>4(B)<br>G | 2<br>1<br>1 | 3<br>3<br>3 | ..<br>..<br>.. | 1<br>1<br>2 | Markham<br>Ober |
| 16·78 | Aeronautics.......<br>*16·76* | XIII-A | G(B) | 2 | 3 | .. | 5 | Ober |
| 16·83 | Airplane Engines ..<br>*2·611, 10·79, 16·01* | XVI (Elective) | 4(B) | 2 | 3 | 3 | 6 | C. F. Taylor |
| 16·85 | Airp.Eng.Des.Prac.<br>*2·12, 2·42, 2·251* | (Elective) | G(B) | 1 | 2 | 6 | 0 | E. S. Taylor |
| 16·86 | Airplane Eng. Des. Prac...........<br>*16·85, (16·83)* | (Elective) | G(B) | 2 | 2 | 6 | 0 | E. S. Taylor |
| 16·90 | Meteorology, Int ..<br>*8·04* | XVI (Elective) | 4(B) | 2 | 2 | .. | 2 | Willett |
| 16·911 | Synoptic Meteor...<br>*8·04, L12 (16·90) (16·921)* | (Elective)<br>VIII (Elective) | G(B)<br>4 | 1<br>1 | 2<br>2 | ..<br>.. | 2<br>2 | Willett |
| 16·912 | Synoptic. Meteorol.<br>*16·911, (16·922)* | (Elective)<br>VIII (Elective | G(B)<br>4 | 2<br>2 | 2<br>2 | ..<br>.. | 2<br>2 | Willett |
| 16·921 | Meteorol. Lab.....<br>*16·90 (16·911)* | (Elective)<br>VIII (Elective) | G(B)<br>4 | 1<br>1 | 0<br>10 | 10<br>0 | 0<br>0 | Willett |

✦Time specially arranged.

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 16·922 | Meteorol. Lab. . . . . *16·921, (16·912)* | (Elective) | G(B) | **2** | 0 | 8 | 0 | Willett |
| | | VIII (Elective) | 4 | **2** | 0 | 8 | 0 | |
| 16·931 | Dyn. Meteorology. *16·912, 16·922, 8·461, 8·462, 8·50, (M36)* | (Elective) | G(A) | **1** | 5 | .. | 10 | Rossby |
| 16·932 | Dyn. Meteorology. *16·931* | (Elective) | G(A) | **2** | 5 | .. | 10 | Rossby |
| 16·941 | Meteorol. Seminar. *(16·931)* | (Elective) | G(A) | **1** | 2 | .. | 4 | Rossby |
| 16·942 | Meteorol. Seminar. *16·941, (16·932)* | (Elective) | G(A) | **2** | 2 | .. | 4 | Rossby |
| 16·95 | Meteorol. Instru. . . *(16·90)* | (Elective) | 4,G(B) | **2** | 0 | 4 | 0 | Lange |

## BUILDING CONSTRUCTION

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| 17·20 | Hist.of Construction | XVII | 2 | 2 | 3 | .. | 0 | McSweeney |
| 17·21 | Building Const.... *D12* | XVII | 2 | 1 | 5 | .. | 1 | R. F. Tucker |
| 17·22 | Building Const.... *17·21* | XVII | 2 | 2 | 5 | .. | 1 | R. F. Tucker |
| 17·31 | Building Const.... *17·22* | XVII | 3 | 1 | 5 | .. | 1 | R. F. Tucker |
| 17·41 | Building Const.... *17·32* | XVII | 4 | 1 | 5 | 10 | 0 | Voss |
| 17·42 | Building Const.... *17·41* | XVII | 4 | 2 | 6 | 8 | 0 | R. F. Tucker |
| 17·46 | Building Const.... | $III_{1,2}$ | 4 | 2 | 4 | 4 | 0 | R. F. Tucker |
| 17·50 | Job Management.. | IV-A, XVII | 4 | 2 | 1 | 0 | 1 | R. F. Tucker |
| 17·51 | Structural Analysis. *2·15* | XVII | 3 | 1 | 2 | 2 | 2 | Voss |
| 17·52 | Structural Analysis. *17·51* | XVII | 3 | 2 | 5 | .. | 2 | Voss |
| 17·65 | Quant. Surv. & Est. | XVII | 3 | S | 0 | 11 | 0 | McSweeney |
| 17·73 | Materials......... | XVII | 2 | 2 | 2 | .. | 1 | Peskin |
| 17·74 | Materials......... | XVII | 3 | 2 | 2 | .. | 2 | Peskin |

# DRAWING

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| D11 | Draw. & Desc. Geom..... *M2, M3* | All courses except IV | 1 | 1 | 0 | 6 | 1 | W.H.Lawrence |
| D12 | Draw. & Desc. Geom..... *D11* | All courses except IV | 1 | 2 | 0 | 6 | 1 | W.H.Lawrence |
| D13 | Desc. Geom....... (College Class) *M3* | | 1 | 1 | 3 | .. | 4 | Watts |
| D23 | Desc. Geometry... (College Class) *M3* | | 1 | 1 | 3 | .. | 4 | Watts |

# BUSINESS AND ENGINEERING ADMINISTRATION AND ECONOMICS

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| Ec21 | Political Economy.. *E12* | VI, VI-C, VI-A, XIII-C, XV | 2 | **1** | 3 | .. | 5 | Doten |
| | | XVII | 3 | **1** | 3 | .. | 5 | |
| Ec31 | Political Economy.. *E12* | I, II, III, IV, IV-A V, VI, VI-C, VII, VIII, IX-A, IX-B, X, XI, XII, XIII, XIV, XVIII, | 3 | **1** | 3 | .. | 3 | Dewey |
| | | XVI | 4 | **1** | 3 | .. | 3 | D. S. Tucker |
| Ec32 | Political Economy. *Ec31* | I, II, III, IV, IV-A, V, VI, VI-C, VI-A(A), VII, VIII, IX-A, IX-B, X, XI, XII, XIII, XIV, XVIII | 3 | **2** | 3 | .. | 3 | Dewey D. S. Tucker |
| | | VI-A (B) | 3 | **1** | 3 | .. | 3 | |
| | | I-A, XVI | 4 | **1** | 3 | .. | 3 | |
| Ec33 | Current Economic Problems.... *Ec32, Ec37* | (Elective) | 4,G(B) | **2** | 2 | .. | 4 | Dept. Staff |
| Ec35 | Political Economy. *E12* | XIII-A | 4 | **1** | 3 | .. | 5 | Freeman |
| Ec37 | Banking.......... *Ec21, Ec65* | XIII-C, XV | 2 | **2** | 3 | .. | 4 | Dewey |
| Ec45 | Indust. Relations.. | I-A | 4(B) | **1** | 2 | .. | 2 | Doten |
| Ec46 | Indust. Relations.. *Ec21 or Ec31* | XIII-C, XV | 4(B) | **2** | 3 | .. | 5 | Doten |
| Ec471 | Personnel Manage. *Ec21 or Ec31, E46* | (Elective) | G(A) | **1** | 3 | .. | 5 | Doten |
| Ec472 | Personnel Manage. *Ec471* | (Elective) | G(A) | **2** | 3 | .. | 5 | Doten |
| Ec48 | Meas. of Human Ap. *Ec46, Ec65* | (Elective) | 4,G(B) | **2** | 2 | .. | 4 | O'Connor |
| Ec50 | Accounting....... | I, | 3 | **1** | 4 | .. | 2 | Porter |
| | Not open to 1st yr. | III, XVII | 3 | **2** | 4 | .. | 2 | Fiske |
| | | XIII-C, XV | 2 | **2** | 4 | .. | 2 | |
| | | XIII | 4 | **2** | 4 | .. | 2 | |
| Ec51 | Industrial Account. *Ec50* | XIII-C, XV | 4(B) | **1** | 4 | .. | 4 | Porter Fiske |
| Ec521 | Anal. of Bus. State. *Ec51, Ec57* | (Elective) | G(A) | **1** | 3 | .. | 5 | Fiske |
| Ec522 | Control through Bus. Records........ *Ec51, Ec72* | (Elective) | G(A) | **2** | 3 | .. | 5 | Fiske |
| Ec53 | Building Finance... *Ec21 or E32* | XVII | 4(B) | **1** | 3 | .. | 6 | D. S. Tucker |
| Ec56 | Corporations...... *Ec21, Ec50* | XIII-C, XV | 3 | **1** | 3 | .. | 6 | Armstrong |
| Ec57 | Corp. Fin. & Invest. *Ec56* | XIII-C, XV | 3 | **2** | 3 | .. | 6 | Armstrong |
| Ec581 | Fin. Adm. of Indust. *Ec32, Ec50* | (Elective) | G(A) | **1** | 3 | .. | 5 | Armstrong |
| Ec582 | Fin. Adm. of Indust. *Ec581 or Ec57* | (Elective) | G(A) | **2** | 3 | .. | 5 | Freeman |
| Ec591 | Pub.Util.Org.& Fin. *Ec21 or Ec31* | (Elective) | G(A) | **1** | 2 | .. | 4 | Armstrong |
| Ec592 | Pub.Util.Reg.&Rates *Ec591* | (Elective) | G(A) | **2** | 2 | .. | 4 | Armstrong |
| Ec61 | Business Law...... *Ec37, Ec57* | XIII-A, XIII-C, XV | 4(B) | **1** | 3 | .. | 3 | Schaefer |
| Ec62 | Business Law...... *Ec61* | XIII-C, XV | 4(B) | **2** | 3 | .. | 3 | Schaefer |
| Ec63 | Bus. Law & Org.... *Ec31* | I-A, VI-A | G(B) | **2** | 3 | .. | 5 | Schaefer |
| Ec64 | Business Law..... | (Elective) | | S | 3 | .. | 3 | Schaefer |
| Ec65 | Statistics......... *E12* | XV | 2 | **1** | 2 | .. | 2 | Dewey |
| | | XIII-C | 3,4 | **1** | 2 | .. | 2 | |
| Ec661 | Statistical Methods. *Ec65, M21* | (Elective) | G(A) | **1** | 2 | .. | 6 | MacKinnon |
| Ec662 | Statistical Methods. *Ec65, M21* | (Elective) | G(A) | **2** | 2 | .. | 6 | MacKinnon |
| Ec681 | Business Cycles.... *Ec37, Ec57, Ec65* | (Elective) | G(A) | **1** | 3 | .. | 5 | Ingraham |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| Ec682 | Business Cycles.... *Ec681* | (Elective) | G(A) | **2** | 3 | .. | 5 | Ingraham |
| Ec70 | Business Manage... *Ec56* | XV | 3 | **2** | 4 | .. | 4 | Fernstrom |
| Ec71 | Business Manage... *Ec70* | XV | 4(B) | **1** | 4 | .. | 6 | Schell |
| Ec72 | Business Manage... *Ec71* | XV | 4(B) | **2** | 4 | .. | 6 | Schell |
| Ec751 | Manufact. Anal.... *Ec72* | (Elective) | G(A) | **1** | 3 | .. | 5 | Schell |
| Ec761 | Industrial Mark... *Ec72 or equiv.* | (Elective) | G(A) | **1** | 3 | .. | 5 | Elder |
| Ec762 | Retail Marketing.. *Ec761* | (Elective) | G(A) | **2** | 3 | .. | 5 | Elder |
| Ec781 | Stand. Meas. in Indust. Man.... *Ec72, Ec51* | (Elective) | G(A) | **1** | 3 | .. | 5 | Raymond |
| Ec782 | Stand. Meas. in Indust. Man.... *Ec781* | (Elective) | G(A) | **2** | 3 | .. | 5 | Raymond |
| Ec80 | Ocean Ship. Adm... *Ec31* | XIII-C | 3 | **2** | 2 | .. | 4 | Fernstrom |
| Ec90 | Investment Analy.. *Ec57 or (Ec581)* | (Elective) | G(A) | **1** | 2 | .. | 6 | Tucker |
| Ec91 | Investment Analy.. *Ec90* | (Elective) | G(A) | **2** | 2 | .. | 6 | Tucker |
| Ec95 | Indust. Traf. Man. *Ec70* | (Elective) | G(A) | **1** | 3 | .. | 5 | Fernstrom |
| Ec98 | Ind. Res. Methods. *Ec70, Ec50* | XV | 4 | **1** | 1 | .. | 1 | Raymond |
| Ec99 | Ind. Problems..... *Ec51, Ec57, Ec61, Ec71* | XV1c | 4(B) | **2** | 2 | .. | 4 | Schell |

# 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 | Copithorne |
| E11 | English........... | All courses | 1 | 1 | 2 | 0 | 4 | Pearson |
| E12 | English........... *E11* | All courses | 1 | 2 | 2 | 0 | 4 | Pearson |
| E15 | English Comp..... | (Elective) | | 1 or 2 | 2 | .. | 2 | Copithorne |
| E21 | English & History.. | All courses | 2 | 1 | 3 | .. | 5 | A. T. Robinson |
| E22 | English & History.. | All courses | 2 | 2 | 3 | .. | 5 | Rogers |
| E33 | Report Writing.... E22 | XIII-C, XV | 3 | 1 | 2 | .. | 2 | Crosby |
| | | $I_3$, IV-A | 3 | 2 | 2 | .. | 2 | |
| E41 | Problem Analysis.. | IV | 3 | 1 | 2 | .. | 2 | D. M. Fuller |
| E42 | Problems Analysis.. | IV | 3 | 2 | 2 | .. | 2 | W. A. Crosby |
| E44 | Committee Work.. | VI-A (A) | 3 | 1 | 2 | .. | 4 | D. M. Fuller |
| | | VI-A(B) | 4 | 1 | 2 | .. | 4 | |
| E45 | Business English... | I-A, VI-A(A) | 4 | S | 1 | .. | 3 | A.T.Robinson |
| | | VI-A(B) | 3 | S | 1 | .. | 3 | |
| E46 | Mod. Forms of Lit.. | VI-A(A) | 4 | 2 | 2 | .. | 4 | Watson |
| | | VI-A(B) | 3 | 2 | 2 | .. | 4 | |

# GENERAL STUDIES — G1–G99

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| G1 | History of Science.. | | 3, 4 | 1 | 2 | .. | 2 | Woodbury |
| G2 | History of Science.. *M12, 8'02* | | 3, 4 | 2 | 2 | .. | 2 | Woodbury |
| G3 | Int. Law & Amer... Foreign Policy... | | 3, 4 | 1 | 2 | .. | 2 | Vestal |
| G5 | Psychology....... | | 3, 4 | 1 | 2 | .. | 2 | Whittemore |
| G6 | Psychology of Social Adjustment..... | | 3, 4 | 2 | 2 | .. | 2 | Whittemore |
| | | | 3, 4 | 2 | 2 | .. | 2 | |
| G10 | Dev. of Trans..... | I-A.(Reg.) | G(B) | 2 | 2 | .. | 2 | C. B. Breed |
| G25 | Invest. Finance.... *Ec31* | | 3, 4 | 2 | 2 | .. | 2 | D. S. Tucker |
| G31 | Humanics........ | | 3, 4 | 1 | 2 | .. | 2 | Magoun |
| G32 | Humanics........ | | 3, 4 | 2 | 2 | .. | 2 | Magoun |
| G41 | Contemp. Eng. Lit. | | 3, 4 | 1 | 2 | .. | 2 | Rogers |
| G42 | Contemp. Eur. Lit. (Not offered in 1932–33) | | 3, 4 | 1 | 2 | .. | 2 | Rogers |
| G43 | American Literature (Not offered in 1932–33) | | 3, 4 | 2 | 2 | .. | 2 | Eaton |
| G44 | Philosophic Dramas of Literature.... (Not offered in 1932–33) | | 3, 4 | 2 | 2 | .. | 2 | Rogers |
| G45 | The Bible as Literature.......... | | 3, 4 | 2 | 2 | .. | 2 | Rogers |
| G46 | Public Speaking... | | 3, 4 | 1 | 2 | .. | 2 | Copithorne |
| G47 | Committee Reports | | 3, 4 | 1, 2 | 2 | .. | 2 | Bartlett |
| G48 | Appreciation of Music.......... | | 3, 4 | 2 | 2 | .. | 2 | Roberts |
| G50 | Fine Arts in Modern Life........... | | 3, 4 | 2 | 2 | .. | 2 | H. L. Seaver |
| G51 | Biography in Science | VI,VI-C,VI-A(B)(Req.) | 4 | 2 | 3 | .. | 5 | Pearson |
| | | VI-A(A)(Req.) | 4 | 1 | 3 | .. | 5 | |
| G54 | Science & Civilization............ | X(Req.) | 2 | 2 | 2 | .. | 2 | Woodbury |
| | | | 3, 4 | 2 | 2 | .. | 2 | |
| G55 | French Rev. and Napoleon....... (Not offered in 1932–33) | | 3, 4 | 1 | 2 | .. | 2 | Crosby |
| G56 | Beethoven and Wagner (Not offered in 1932–33) | | 3, 4 | 2 | 2 | .. | 2 | Roberts |
| G591 | Prob. of Modern Philosophy (Not offered in 1932–33) | | 3, 4 | 1 | 2 | .. | 2 | A. T. Robinson |
| G592 | Prob. of Modern Philosophy........ | | 3, 4 | 2 | 2 | .. | 2 | A. T. Robinson |
| G60 | Geology.......... | (Not open to students in I, $III_{1,2}$ IX-A, XI, XVII) | 3, 4 | 1 | 2 | .. | 2 | Shimer |
| | | V (Req.) | 2 | 1 | 2 | .. | 2 | |
| G62 | Mineral Resources in Rel. to Civ. | | 3, 4 | 1 | 2 | .. | 2 | Morris, Newhouse |
| G63 | Economic Geography | | 3, 4 | 2 | 2 | 0 | 2 | Prescott |
| G64 | Organic Evolution. | | 3, 4 | 2 | 2 | .. | 2 | Shimer |
| | | IX-A, XII (Req.) | 3 | 2 | 2 | .. | 2 | |
| G66 | Desc. Astronomy.. | (Not open to I) | 3, 4 | 2 | 2 | .. | 2 | Goodwin |
| | *8'04* | IX-A (Req.) | 4 | 2 | 2 | .. | 2 | |
| G71 | Prin. of Biology & Heredity....... | | 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.......... *L62 or equiv.* | | 3, 4 | 1 | 2 | .. | 2 | Pillionnel |
| G822 | French.......... *L62 or equiv.* | | 3, 4 | 2 | 2 | .. | 2 | Pillionnel |
| G831 | French.......... *L62 or equiv.* | | 3, 4 | 1 | 2 | .. | 2 | Langley |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| G832 | French........... *L62 or equiv.* | | 3, 4 | **2** | 2 | .. | 2 | Langley |
| G921 | German.......... *L22 or equiv.* | | 3, 4 | **1** | 2 | .. | 2 | Kurrelmeyer |
| G922 | German.......... *L22 or equiv.* | | 3, 4 | **2** | 2 | .. | 2 | Kurrelmeyer |
| G931 | German.......... *L22 or equiv.* | | 3, 4 | **1** | 2 | .. | 2 | Currier |
| G932 | German.......... *L22 or equiv.* | | 3, 4 | **2** | 2 | .. | 2 | Currier |
| G98 | Military History & Policy of U. S. | | 3, 4 | **2** | 2 | .. | 2 | Vestal |

## 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** (1st 10w.) | 0 | 1 | 0 | McCarthy |
| PT2 | Physical Training.. | All courses | 1 | **2** (1st 10w.) | 0 | 1 | 0 | McCarthy |

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## 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 | |
| M3 | Solid Geom. (Ent.). | | | S | 2 | .. | 5 | |
| M4 | Trigonometry (Ent.) | | | S | 2 | .. | 5 | |
| M11 | Calculus.......... *M1, M3, M4* | All courses | 1 | 1 | 3 | .. | 6 | R. D. Douglass |
| M12 | Calculus.......... *M11* | All courses | 1 | 2 | 3 | .. | 6 | Rutledge |
| M21 | Calculus.......... *M12* | All courses except IV | 2 | 1 | 3 | .. | 6 | Struik |
| M22 | Diff. Equations.... *M21* | All except III$_1$, $_2$, IV VII$_1$, $_2$, X, XIII-C, XV$_2$ | 2 | 2 | 3 | .. | 6 | Phillips |
| M23 | Higher Algebra & Geometry....... *M12* | XVIII | 2 | 1 | 3 | .. | 6 | Franklin |
| M24 | Higher Algebra & Geometry....... *M12* | XVIII | 2 | 2 | 3 | .. | 6 | Franklin |
| M26 | Least Squares..... *M22* | I$_4$, XVIII | 4(B) | 1 | 2 | .. | 2 | R. D. Douglass |
| M31 | Dif. Equ. of Elec... | VI, VI-C, VI-A(B) | 3 | 1 | 2 | .. | 4 | Franklin |
| | *M22* | VI-A(A) | 3 | 2 | 2 | .. | 4 | |
| M36 | Calculus, Adv..... *M22* | (Elective) | G(A) | 1 | 3 | .. | 6 | Phillips |
| M37 | Calculus, Adv..... *M36* | (Elective) | (GA) | 2 | 3 | .. | 6 | Phillips |
| M38 | Calculus, Adv..... *M22* | XIII-A | 4 | 2 | 3 | .. | 6 | Woods |
| M41 | Diff. Equations.... | X, | 4 | 1 | 3 | .. | 6 | Hitchcock |
| | *M21* | Chem. War. | G | 1 | 3 | .. | 6 | |
| M43 | Theoret. Aeronaut. | (Elective) | 4(B) | 1 | 4 | 2 | 4 | Rauscher |
| | *M22* | XVI | 3 | 1 | 4 | 2 | 4 | |
| M44 | Theoret. Aeronaut. | (Elective) | 4(B) | 2 | 4 | 2 | 4 | Rauscher |
| | *M43* | XVI | 3 | 2 | 4 | 2 | 4 | |
| M451 | Fourier's Series & Int. Equa....... | (Elective) | G(A) | 1 | 3 | .. | 9 | Wiener |
| M452 | Fourier's Series & Int. Equa....... | (Elective) | G(A) | 2 | 3 | .. | 9 | Wiener |
| M54 | Mathematical Lab. *M22* | XVIII | 4(B) | 2 | 3 | .. | 9 | R. D. Douglass |
| M551 | Funct. of Real Vari. *M22* | (Elective) | G(A) | 1 | 3 | .. | 9 | Phillips |
| M552 | Funct. of Real Vari. *M22* | (Elective) | G(A) | 2 | 3 | .. | 9 | Phillips |
| M561 | Funct.of Comp.Vari. *M22* | (Elective) | G(A) | 1 | 3 | .. | 9 | Rutledge |
| M562 | Funct.of Comp.Vari. *M561* | (Elective) | G(A) | 2 | 3 | .. | 9 | Rutledge |
| M571 | Diff. Equations.... *M22* (Not offered in 1932–33) | (Elective) | G(A) | 1 | 3 | .. | 9 | J. Douglas |
| M572 | Diff. Equations.... *M571* (Not offered 1932–33) | (Elective) | G(A) | 2 | 3 | .. | 9 | J. Douglas |
| M581 | Continuous Groups. *M22* | (Elective) | G(A) | 1 | 3 | .. | 9 | Zeldin |
| M582 | Continuous Groups. *M581* | (Elective) | G(A) | 2 | 3 | .. | 9 | Zeldin |
| M62 | Modern Algebra.... *M22* | (Elective) | G(A) | 2 | 3 | .. | 9 | Rice |
| M631 | Diff. Geometry.... *M22* | (Elective) | G(A) | 1 | 3 | .. | 9 | Struik |
| M632 | Diff. Geometry.... *M631* | (Elective) | G(A) | 2 | 3 | .. | 9 | Struik |
| M641 | Adv.Dif.Geometry. *M632* (Not offered in 1932–33) | (Elective) | G(A) | 1 | 3 | .. | 9 | Struik |
| M642 | Adv. Dif. Geometry *M641* (Not offered 1932–33) | (Elective) | G(A) | 2 | 3 | .. | 9 | Struik |
| M651 | Anal. Mechanics... *M22* | (Elective) | G(A) | 1 | 3 | .. | 9 | Franklin |
| M652 | Anal. Mechanics... *M651* | (Elective) | G(A) | 2 | 3 | .. | 9 | Franklin |
| M661 | Algeb. of Quan. Th. *M62* | (Elective) | G(A) | 1 | 3 | .. | 9 | Hitchcock |

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| M662 | Algeb. of Quan. Th. *M661* | (Elective) | G(A) | 2 | 3 | .. | 9 | Hitchcock |
| M671 | Potential Theory... *M22* | (Elective) | G(A) | 1 | 3 | .. | 9 | Hopf |
| M672 | Potential Theory... | (Elective) | G(A) | 2 | 3 | .. | 9 | Hopf |
| M681 | Calc. of Var....... *M22* | (Elective) | G(A) | 1 | 2 | .. | 6 | J. Douglas |
| M682 | Calc. of Var....... *M681* | (Elective) | G(A) | 1 | 2 | .. | 6 | J. Douglas |
| M70 | Hist.(Math.)Science *M12* (Not offered in 1932–33) | (Elective) | 4(B) | 1 | 2 | .. | 4 | |
| M76 | Th. of Probability.. *M21* | (Elective) | G(A) | 2 | 3 | .. | 9 | Struik |
| M77 | Vector Analysis.... *M22* | VI-C | 3(B) | 2 | 3 | .. | 5 | Phillips |
| | | VI-A(A)₂ | 4(B) | 1 | 3 | .. | 5 | |
| | | VI-A(B)₂ | 4(B) | 2 | 3 | .. | 5 | |
| M781 | Geometry, Adv.... *M22* (Not offered in 1932–33) | (Elective) | G(A) | 1 | 3 | .. | 9 | Woods |
| M782 | Geometry, Adv.... *M781* (Not offered in 1932–33) | (Elective) | G(A) | 2 | 3 | .. | 9 | Woods |
| M791 | Th. & App. Elast... | (Elective) | G(A) | 1 | 2 | .. | 6 | Hovgaard |
| M792 | Th. & App. Elast... | (Elective) | G(A) | 2 | 2 | .. | 6 | Hovgaard |
| M851 | Mod. Mech. Th.... (Not offered in 1932–33) | (Elective) | G(A) | 1 | 3 | .. | 6 | Wiener Struik |
| M852 | Mod. Mech. Th.... (Not offered 1932–33) | (Elective) | G(A) | 2 | 3 | .. | 6 | Wiener Struik |
| M90 | Math. Reading.... | (Elective) | 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** | 0 | 3 | 0 | Arthur |
| MS12 | Military Science... | All courses | 1 | **2** | 0 | 3 | 0 | Arthur |
| MS21 | Military Science... | All courses | 2 | **1** | 3 | .. | 0 | Adcock |
| MS221 | Coast Artillery.... | All courses | 2 | **2** | 3 | .. | 0 | Ottosen |
| MS222 | Engineer Corps.... | I, II, III, IV, IV-A, VI, VI-A, VII, IX-B, XI, XII, XIII-C, XV$_1$, XVI, XVII | 2 | **2** | 3 | .. | 0 | Harwood |
| MS223 | Signal Corps...... | VI, VI-A, VI-C, VIII, IX-B, XIV, XV$_1$b | 2 | **2** | 3 | .. | 0 | Bicher |
| MS224 | Ordnance Dept.... | II, III$_{3,4}$, VI-A, IX-A, X, XIII, XIV, XVIII, XV | 2 | **2** | 3 | .. | 0 | Gatchell |
| MS225 | Air Corps........ | XVI only | 2 | **2** | 3 | .. | 0 | Knight |
| MS226 | Chem. War. Ser... | V, X, XIV, XV$_2$ | 2 | **2** | 3 | .. | 0 | Johnstone |
| MS31 | Military Science, Adv. | All courses | 3 | **1** | 0 | 1 | 0 | Gatchell |
| MS311 | Coast Art., Adv.... *A basic course* | All courses | 3 | **1** | 2 | 1 | 2 | Atkinson |
| MS312 | Eng. Corps, Adv... *A basic course* | I, II, III, IV, IV-A, VI, VI-A, VII, IX-B, XI, XII, XIII-C, XV$_1$, XVI, XVII | 3 | **1** | 3 | .. | 3 | Adcock |
| MS313 | Signal Corps, Adv.. *A basic course* | VI, VI-A, VI-C, VIII, IX-B, XIV, XV$_1$b | 3 | **1** | 3 | .. | 3 | Bicher |
| MS314 | Ord. Dept., Adv... *A basic course* | II, III$_{3,4}$, VI-A, IX-A X, XIII, XIV, XV, XVIII | 3 | **1** | 1 | .. | 1 | Gatchell |
| M[illegible] | Chem. War. Ser.... *A basic course* | V, X, XIV, XV$_2$ | 3 | **1** | 2 | .. | 2 | Johnstone |
| MS32 | Military Science, Adv. | All courses | 3 | **1 & 2** | 0 | 1 | 0 | Arthur |
| MS321 | Coast Art., Adv.... *A basic course* | All courses | 3 | **2** | 2 | 1 | 2 | Atkinson |
| MS322 | Eng. Corps, Adv... *A basic course* | I, II, III, IV, IV-A, VI, VI-A, VII, IX-B, XI, XII, XIII-C, XV$_1$, XVI, XVII | 3 | **2** | 3 | .. | 3 | Adcock |
| MS323 | Signal Corps, Adv.. | VI, VI-A, VI-C, VIII, IX-B, XIV, XV$_1$b | 3 | **2** | 3 | .. | 3 | Bicher |
| MS324 | Ord. Dept., Adv... *A basic course* | II, III$_{3,4}$, VI-A, IX-A, X, XIII, XIV, XV, XVIII | 3 | **2** | 1 | .. | 1 | Gatchell |
| MS325 | Air Corps, Adv.... *A basic course* | XVI only | 3 | **2** | 3 | .. | 3 | Knight |
| MS326 | Chem. Warfare Service, Adv.... *A basic course* | V, X, XIV, XV$_2$ | 3 | **2** | 1 | .. | 1 | Johnstone |
| MS41 | Military Science, Adv. *(MS31)* | All courses | 4 | **1 & 2** | 0 | 1 | 0 | Gatchell |
| MS411 | Coast Art., Adv... *(MS311)* | All courses | 4 | **1** | 1 | 1 | 1 | Ottosen |
| MS415 | Air Corps, Adv.... | XVI only | 4 | **1** | 3 | .. | 3 | Knight |
| MS42 | Military Science, Adv. *(MS31)*, *(MS32)* | All courses | 4 | **2** | 0 | 1 | 0 | Arthur |
| MS421 | Coast Art., Adv.... *(MS321)* | All courses | 4 | **2** | 1 | 1 | 1 | Ottosen |

## MODERN LANGUAGES — L1–L99

| No. | Subject with Prerequisites | Taken by | Yr. | Tm. | Rec. Lec. | Lab. Draw. | Prep. | Instructor in Charge |
|---|---|---|---|---|---|---|---|---|
| L11 | German, Elem..... | (Elective) | | **1** | 3 | .. | 5 | Currier |
| L12 | German, Elem..... *L11* | (Elective) | | **2** | 3 | .. | 5 | Currier |
| L13 | German, Elem..... | XIII-A | 4 | **1** | 4 | .. | 8 | Currier |
| L21 | German, Int...... *L12, or Elem. Ent. German* | (Elective) | | **1** | 3 | .. | 5 | Kurrelmeyer |
| L22 | German, Int...... *L21* | (Elective) | | **2** | 3 | .. | 5 | Kurrelmeyer |
| L23 | German Int....... *L12 or Elem. Ent. German* | XVI (Elective) | | **1** | 2 | .. | 4 | Kurrelmeyer |
| L24 | German, Int...... *L23* | XVI (Elective) | | **2** | 2 | .. | 4 | Kurrelmeyer |
| L31 | German, Adv...... *L22, or Int. Ent. German* | (Elective) | | **1** | 3 | .. | 5 | Kurrelmeyer |
| L32 | German, Adv...... *L31* | (Elective) | | **2** | 3 | .. | 5 | Kurrelmeyer |
| L51 | French, Elem...... | (Elective) | | **1** | 3 | .. | 5 | Pillionnel |
| L52 | French, Elem...... *L51* | (Elective) | | **2** | 3 | .. | 5 | Pillionnel |
| L61 | French, Int....... *L52 or Elem. Ent. French* | (Elective) | | **1** | 3 | .. | 5 | Koch |
| L62 | French, Int....... *L61* | (Elective) | | **2** | 3 | .. | 5 | Koch |
| L63 | French, Adv...... *L62 or Int. Ent. French* | 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 | Pillionnel |
| L72 | French........... *L71* | XVI (Elective) | 3 | **2** | 2 | .. | 4 | Pillionnel |
| L81 | Spanish, Elem..... | (Elective) | | **1** | 3 | .. | 5 | Langley |
| L82 | Spanish, Elem..... *L81* | (Elective) | | **2** | 3 | .. | 5 | Langley |
| L91 | Italian, Elem...... (Not offered 1932–33) | (Elective) | | **1** | 3 | .. | 5 | Langley |
| L92 | Italian, Elem...... *L91* (Not offered 1932–33) | (Elective) | | **2** | 3 | .. | 5 | Langley |

# ALPHABETICAL LIST OF SUBJECTS

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(With reference to pages containing description)

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