

M. I. T. ANNUAL CATALOGUES AND BULLETINS

1867/68 TO 1868/69

01 OF 01

THIRD
ANNUAL CATALOGUE

OF THE

OFFICERS AND STUDENTS,

AND

Programme of the Course of Instruction

OF THE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

1867-8.

BOSTON:

ALFRED MUDGE & SON, PRINTERS, 34 SCHOOL STREET.

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GOVERNMENT
OF THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY.
FOR THE YEAR 1867-8.

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Vice-Presidents.

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L JACOB BIGELOW.

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L SAMUEL KNEELAND.

Committee on Instruction.

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L H. WELD FULLER..... *Chairman of Committee on Household
Economy.*
L EDWARD S. PHILBRICK..... *Chairman of Committee on Tools and
Instruments.*

On the Part of the Commonwealth.

HIS EXCELLENCY, GOV. ALEXANDER H. BULLOCK.
HON. GEORGE T. BIGELOW, *Chief Justice of the Supreme Court.*
HON. JOSEPH WHITE, *Secretary of the Board of Education.*

OFFICERS OF INSTRUCTION.

President.

WILLIAM B. ROGERS, LL.D.

- ✓ JOHN D. RUNKLE, A.M. *Walker Professor of Mathematics and Analytic Mechanics.*
- ✓ WILLIAM B. ROGERS, LL.D. *Thayer Professor of Physics and Geology.*
- ✓ FRANK H. STORER, S.B. *Professor of General and Industrial Chemistry.*
- ✓ *CHARLES W. ELIOT, A.M. *Professor of Analytical Chemistry and Metallurgy.*
- ✓ CYRUS M. WARREN, S.B. *Professor of Organic Chemistry.*
- ✓ WILLIAM P. ATKINSON, A.M. *Professor of the English Language and Literature.*
- FERDINAND BÔCHER. *Professor of Modern Languages.*
- ✓ JOHN B. HENCK, A.M. *Hayward Professor of Civil and Topographical Engineering.*
- WILLIAM WATSON, Ph.D. *Professor of Descriptive Geometry and Mechanical Engineering.*
- WILLIAM R. WARE, S.B. *Professor of Architecture.*
- GEORGE A. OSBORNE, S.B. *Professor of Navigation and Nautical Astronomy.*
- *JAMES D. HAGUE. *Professor of Mining Engineering.*
- EDWARD C. PICKERING, S.B. *Assistant Professor of Physics.*
- ✓ SAMUEL KNEELAND, A.M. M.D. *Instructor in Zoology and Physiology.*
- E. C. F. KRAUSS. *Assistant Instructor in Modern Languages.*
- EDWARD L. STODDARD. *Assistant in the Chemical Laboratory.*
- ALBERT F. HALL. *Assistant in Mechanical and Plan Drawing.*

✓ WILLIAM P. ATKINSON. *Secretary and Librarian. Post-Office address, — "Massachusetts Institute of Technology, Boylston Street, Boston."*

* During the present year the instruction in Mining Engineering will be given by A. L. ROCKWELL, A. M., Professor of Mining Engineering in the Sheffield Scientific School of Yale College, and that in Metallurgy by OSCAR D. ALLEN, Ph. B.

LIST OF STUDENTS.

FIRST YEAR.

[The numbers affixed to the names in the list indicate that the students are not *regular* students, but are taking partial courses in the years corresponding to the numbers.]

	Home.	Present Residence.
Atkinson, Frank P. . . .	Cambridge . . .	Cambridge.
Baker, George	Marshfield . . .	63 Bedford Street.
Bateman, Charles H. . . .	Roxbury	Roxbury.
Beal, Foster E. L. . . .	Fitchburg	South Boston.
Bush, J. S. F. 1	Roxbury	Roxbury.
Butler, Maxwell E. 1 . . .	New York	24 Somerset Street.
Cabot, Lincoln	Hingham	Brookline.
Channing, Walter, Jr. 1 . .	Dorchester . . .	Dorchester.
Chapman, James R. . . .	Beverly	Beverly.
Childs, Frank C. . . .	E. Lexington . .	E. Lexington.
Clark, Augustus	Beverly	Beverly.
Clark, James W., Jr. . . .	Framingham . . .	Framingham.
Coolidge, Herbert,	Watertown	Mt. Auburn.
Cutler, Henry M. . . .	San José, Cal. . .	19 Brookline Street.
Danforth, Charles F. . . .	Chelsea	Chelsea.
Dorr, Dudley A. . . .	Lexington	Lexington.
Duncklee, Horace L. . . .	Cambridge	Cambridge.
Ellery, Benjamin F. . . .	Gloucester	16 Davis Street.
Emmons, Arthur B. . . .	Boston	8 Mt. Vernon Place.
Faunce, Elmer	Kingston	Kingston.
Fay, Harrie F. . . .	Chelsea	Chelsea.
Foote, Edward H. . . .	N. Somerville . . .	N. Somerville.
Forbes, Edmund C. . . .	Clinton	24 Somerset Street.
Foster, William	Brookline	Brookline.
Francis, Joseph S. . . .	Lowell	Lowell.
French, Daniel C. 1	Concord	Concord.
Gay, Frederic T. . . .	N. Chelmsford . . .	N. Chelmsford.
Gibbs, Joseph F. . . .	Waltham	Waltham.
Gowen, Charles S. . . .	Clinton	3 Crescent Place.
Hall, Frank R. . . .	Boston	63 Hancock Street.
Hancock, John, 1	Winchendon	16 Tyler Street.
Herrick, J. Amory	Chelsea	Chelsea.
Hosmer, Alfred W. . . .	Concord	Concord.

	Home.	Present Residence.
Hunt, Theodore	Concord	Concord.
Johnson, Walter L. . . .	Holliston	Holliston.
Judkins, Charles A. . . .	Winchester	Winchester.
Levanseler, Frank E. . . .	Boston	19 Brookline Street.
Lincoln, George R. . . .	Phila., Penn. . . .	45 Essex Street.
Littlefield, Charles L. . . .	Brighton	Brighton.
Lothrop, William U. . . .	E. Boston	163 Webster Street.
Nicholson, Charles M. . . .	Boston	18 Louisburg Square.
Nottage, John	Nashua, N. H. . . .	90 Princeton Street.
Nourse, Henry M. . . .	Boston	Norfolk House.
Pike, William A. . . .	Dorchester	Dorchester.
Powers, Charles F. 1	Somerville	Somerville.
Pratt, George H. . . .	Salem	Salem.
Reed, John	Boston	1 Oak Place.
Rollins, Edward W. . . .	Concord, N. H. . . .	Winchester.
Sawyer, Joseph D. 1	Boston	31 Commonwealth Avenue.
Scott, Joseph R. . . .	West Roxbury	West Roxbury.
Smaller, Carlos J. . . .	Cuba	South Boston.
Smith, Herbert M. . . .	Grafton	120 Harrison Avenue.
Smith, Walter W. . . .	Dayton, O. . . .	6 Berkeley Street.
Sprague, Daniel F. . . .	Stoneham	Stoneham.
Stearns, William C. 1	Lexington	Lexington.
Stearns, William H. . . .	Malden	Malden.
Stone, Charles F. . . .	Waltham	Waltham.
Thatcher, Harry L. . . .	Middleboro'	114 Harrison Avenue.
Trowbridge, Almarin, Jr. . . .	Charlestown	Charlestown.
Warren, Charles B. . . .	Waltham	Waltham.
Weeks, Isaiah S. P. . . .	West Barnstable	1167 Washington Street.
Wheildon, Frederic W. . . .	Concord	Concord.
White, Joseph N. 1	Winchendon	16 Tyler Street.
Whittier, Randal	Boston	41 Beach Street.

SECOND YEAR.

Archer, Charles F. 2	Salem	Salem.
Avery, Charles E. 1, 2, 3	Boston	42 Chester Park.
Bannard, William N. . . .	Kingsboro', N.Y. . . .	Cambridgeport.
Bolton, Edward D. . . .	Somerville	Somerville.
Breck, Charles H. 1, 2	Brighton	Brighton.
Brewster, William W. . . .	Plymouth	20 Boylston Street.
Buckingham, Edward M. . . .	Boston	53 Worcester Street.

	Home.	Present Residence.
Cabot, Samuel, Jr.	Boston	11 Park Square.
Cary, S. Mathews	Houlton, Me. . .	54 Dover Street.
Cassell, Charles G.	East Liberty, Pa.	12 Berkeley Street.
Chester, Arthur	Westford, N. Y.	Newton Centre.
Clark, George L.	Boston	Charles Street.
Clark, Edward K.	Bangor, Me. . .	20 Hudson Street.
Clark, Walter	Tarrytown, N.Y.	Brookline.
Clarke, Eliot C., A. B. (<i>Harvard Univ.</i>) ²	West Roxbury .	West Roxbury.
Cross, Charles R.	Newburyport .	60 Pleasant Street.
Curtis, Russell H.	Jamaica Plain .	Jamaica Plain.
Dickinson, William C.	Cincinnati, O. .	Waltham.
Fisk, Robert F.	Cambridge . . .	Cambridge.
Forbes, J. Malcolm, ²	Milton	Milton.
Fuller, Frank L.	Grantville . . .	Grantville.
Gray, Samuel S.	Boston	1 Beacon Hill Place.
Hardy, George R.	Malden	Malden.
Hemenway, Charles T. ²	Waltham. . . .	Waltham.
Henry, William T.	Fall River . . .	8 Oak Street.
Herreshoff, Nathaniel G. ²	Bristol, R. I. . .	4 Boylston Place.
Hillard, Frank S. ²	Boston	27 Edinboro' Street.
Hillard, James L.	Boston	27 Edinboro' Street.
Hinman, Charles W.	W. Concord, Vt.	41 Anderson Street.
Lee, William W. ^{1, 2, 3}	Charlestown . .	Charlestown.
Little, John M. ^{1, 2, 3}	Boston	2 Commonwealth Avenue.
Loring, David, ^{1, 2}	Concord	2 Bowdoin Street.
Mason, Sampson D.	Concord	Concord.
Morse, Charles A. ^{1, 2, 3}	Leominster . . .	Charlestown.
Orvis, Christel	Jamaica Plain .	Jamaica Plain.
Osgood, Josiah A.	Chelsea	Chelsea.
Page, Frederic R.	Boston	67 Revere Street.
Pearson, Arthur H. ^{1, 2, 3}	Haverhill . . .	Haverhill.
Pearson, Frank P. ^{1, 2, 3}	Haverhill . . .	Haverhill.
Preble, Henry O. ²	Charlestown . .	Charlestown.
Prescott, Benj. T. Jr. ^{1, 2, 3}	Boston	Boston.
Pullen, Clarence E. ²	Foxcroft, Me. . .	63 Worcester Street.
Ritchie, Andrew M.	Brookline . . .	Brookline.
Sanford, Oliver N.	Hyde Park . . .	Dorchester.
Stevens, George H. ^{2, 3}	Chelsea	Chelsea.
Tillinghast, Theodore F.	New Bedford . .	8 Oak Street.
Towne, Truman B. ²	Boston	53 Leverett Street.
Turner, Edmund K.	Marblehead . .	Marblehead.

	Home.	Present Residence.
Veazie, Winchester, 2 . . .	Boston . . .	10 Franklin Square.
Weiss, Charles M.	Watertown . . .	Watertown.
Wells, Frank, 1, 2	Quincy, Ill. . . .	14 Orange Street.
Wells, Webster	New York	Roxbury.
Wheeler, D. Merrick, 2 . . .	Worcester	Worcester.
Whiting, Warren M.	Framingham . . .	136 Beacon Street.
Whittlesey, Walter	Chelsea	Chelsea.
Wilbur, Charles A.	Watertown	Watertown.
Willard, Daniel W.	Brookline	Brookline.
Willard, Harry S. 1, 2, 3 . . .	Ohio	20 Hudson Street.
Wrinkle, Lawrence F. J. . . .	Lee	Roxbury.
Wyman, George D. 1, 2, 3 . . .	Woburn	22 Harrison Avenue.

THIRD YEAR.

Baker, William H.	Fitchburg	Winchester.
Bowditch, William E.	Brookline	Brookline.
Bradford, Lawrence, 3	Boston	169 Charles Street.
Carson, Howard A.	N. Oxford	169 Charles Street.
Child, Samuel G.	Boston	1293 Washington Street.
Colburn, Walter W.	Somerville	Somerville.
Coolidge, Walter,	Brookline	Brookline.
Edmands, J. Rayner	Boston	57 West Cedar Street.
Ewell, Arthur F. 3	Boston	11 Dix Place.
Fillebrown, Charles B. 3 . . .	Winthrop, Me. . .	Boston.
Gelett, William	Kingston	Kingston.
Harman, Henry A. 2, 3	Williamstown . . .	47 Essex Street.
Merrill, Nathan F. 1, 3	Cambridgeport . .	Cambridgeport.
Merrill, Thomas W. 1, 3	Cambridgeport . .	Cambridgeport.
McManus, Edward T. 3	Boston	Boston.
Nichols, William R.	Roxbury	Roxbury.
Revere, Joseph, 2, 3	Boston	93 Beacon Street.
Saltmarsh, Ernest O.	Dorchester	Dorchester.
Taft, Ezra F., A. B. (<i>Amer-</i> <i>erst Coll.</i>), 3	Dedham	Dedham.
Tebbetts, Eugene L.	Lisbon, Me.	60 Pleasant Street.
Thorndike, George F.	Boston	29 Edinboro' Street.
True, Charles S.	Yarmouth, Me. . .	60 Pleasant Street.
Tryon, William	Boston	22 McLean Street.
Whitaker, Channing	Needham	1437 Washington Street.
Wiley, Walter T. 3	Boston	68 Mt. Vernon Street.

FOURTH YEAR.

	Home.	Present Residence.
Appleton, Ellery C.	Boston	17 Appleton St.
Bailey, Abraham	Charlestown	Charlestown.
Conant, N. Whitney	Louisville, Ky.	6 Temple Street.
Duncklee, John B., S. B. (<i>Har-</i> <i>vard Univ.</i>)	Brighton	Brighton.
Firth, Frank R.	Boston	5 Indiana Place.
Forbes, Eli	Clinton	24 Somerset St.
Gilman, Chas. C.	Chelsea	Chelsea.
Greene, Charles E., A. M., (<i>Har-</i> <i>vard Univ.</i>)	Cambridge	Cambridge.
Hall, Albert F.	Charlestown	Charlestown.
Hoyt, William E.	P'tsmouth, N.H.	5 Allston Place.
Jackson, William	Brighton	Brighton.
Kinsman, Benjamin W., A. B. (<i>Tufts College</i>) 4	Somerville	Somerville.
Richards, Robert H.	Boston	18 Boylston Pl.
Sears, Walter H.	Plymouth	100 Carver St.
Smith, Charles A.	Newburyport	Newburyport.
Stone, Joseph	Charlestown	Charlestown.
Tilden, Bryant P.	Boston	7 Somerset St.
Tolman, James P.	Roxbury	Roxbury.

SUMMARY.

1st year — Regular course	56
Partial “	8
2d year — Regular course	37
Partial “	23
3d year — Regular course	14
Partial “	11
4th year — Regular course	17
Partial “	1
Total — Regular	124
Partial	43
	<hr/> 167

SCHOOL
OF THE
INSTITUTE OF TECHNOLOGY.

The objects of the School of the Massachusetts Institute of Technology are:— To provide a full course of scientific studies and practical exercises for students seeking to qualify themselves for the professions of the Mechanical Engineer, Civil Engineer, Practical Chemist, Engineer of Mines, and Builder and Architect:— To furnish a general education, founded upon the Mathematical, Physical, and Natural Sciences, English and other Modern Languages, and Mental and Political Science:— To provide courses of Evening Instruction in the main branches of knowledge above referred to, for persons of either sex who are unable to devote themselves to study during the day, but who desire to avail themselves of systematic evening lessons or lectures.

REGULAR COURSE.

The regular course extends through four years. The studies and exercises of the first and second years, and certain general studies in the third and fourth years, are required of all regular students. At the beginning of the third year, each

regular student may select one of the following six courses, with a view of obtaining the corresponding degree or diploma:—

1. A COURSE IN MECHANICAL ENGINEERING.
2. “ “ “ CIVIL AND TOPOGRAPHICAL ENGINEERING.
3. “ “ “ PRACTICAL CHEMISTRY.
4. “ “ “ GEOLOGY AND MINING.
5. “ “ “ BUILDING AND ARCHITECTURE.
6. “ “ “ SCIENCE AND LITERATURE.

CONDITIONS OF ADMISSION.

To be admitted to the first year's course, the student must have attained the age of sixteen years, and must pass a satisfactory examination in arithmetic, algebra as far as equations of the second degree, plane geometry, English grammar, and geography. It is particularly important that applicants should write a rapid and legible hand, as the examinations and other exercises of the School will be in great part conducted in writing. In general, the training given at the best High Schools and Academies will be a suitable preparation for the studies of this School.

In order to enter the second year's course, the student must be at least seventeen years of age, and must pass a satisfactory examination upon the first year's studies, beside passing the admission examination; and a like rule will apply to the case of students seeking admission into the classes of the succeeding years.

Examinations for admission to the first year's course will be held on Monday, July 13, 1868, and on Monday, Sept. 28, 1868, beginning at 9, A. M., precisely. The candidates will assemble at the Institute's building, Boylston Street, Boston. The examination for advanced standing will take place on Tuesday, Sept. 29, beginning at 9, A. M. Under special circumstances, students may present themselves for admission at other times;

but it is strongly recommended to all persons desiring to join the School to enter at the time of the regular examinations.

To make the opportunities of instruction as widely accessible as possible, students will be allowed to enter special divisions of either of the courses,—as, for example, the classes of mathematics, of engineering, of chemistry, of physics, or of mining and metallurgy,—on giving satisfactory evidence that they are prepared to pursue such special studies with advantage.

FIRST YEAR.

MATHEMATICS.

1. *Algebra*.—Quadratic Equations; Imaginary Expressions; Ratio; Proportion; Progression; Permutations and Combinations; Binomial Theorem; Indeterminate Co-efficients; Theory of Logarithms, with Construction and Use of Tables.
2. *Solid Geometry*.—Plane and Solid Angles; The Prism and Pyramid; The Sphere, Cylinder and Cone; Spherical Angles and Polygons.
3. *Plane Trigonometry*.—Different Methods of Measuring Angles; Trigonometrical Ratios and Functions; Construction and Use of Trigonometrical Tables; Solution of Triangles.
4. *Applications* of Plane Trigonometry to Heights, Distances, Navigation, &c.

MECHANICAL DRAWING AND DESCRIPTIVE GEOMETRY.

The use of mathematical instruments, and of water-colors and India ink, will be taught in connection with the instruction in Geometry and Trigonometry. The course will include the graphical construction of problems in these branches.

The study of Descriptive Geometry will be commenced, and will include the graphical solution of problems of position relative to the point, the right line, and the plane.

FREE-HAND DRAWING.

Instruction will be given in drawing with chalk upon the black-board, and with charcoal, crayons, the pencil, and pen and ink. The students will draw from models, casts and photographs, and from studies of landscape.

ELEMENTARY MECHANICS.

1. *Preliminary Ideas regarding Matter, Motion, and Forces.*—Uniform and Varied Right-Line Motions; Composition and Resolution of Forces applied to a point.
2. *Mechanics of Solids.*—Composition of Forces applied to different points in a Mass; Statical Moments; Parallel Forces; Couples; Centre of Gravity; The Pendulum; Curve-line Motion; Friction; Elasticity and Strength of Materials; Impact; Elements of Machinery; Virtual Velocities; Mechanical Work; Vis Viva.
3. *Mechanics of Liquids and Gases.*—Pressure and Equilibrium of Fluids; Centre of Pressure; Principle of Archimedes; Specific Gravities; Equilibrium of floating Bodies: Flow through Orifices, Tubes, etc.; Impulse and Resistance of Water; Weight and Compressibility of Air; Barometer; Flow of Air and Gases; Resistance; Hydraulic and Pneumatic Instruments and Machines; Capillarity, and Osmotic Forces.

CHEMISTRY.

The course of instruction in Chemistry consists:— 1st, Of a weekly exercise which combines an illustrated lecture by the professor, and a recitation by the students upon the lecture of the preceding week:— 2d, Of a weekly lesson in the laboratory, where every student is provided with a desk and the necessary apparatus, and will perform, under the supervision of the professors, such experiments as are useful to illustrate and enforce the laws of chemical action, the principles of chemical nomenclature, and the properties of those substances and the nature

of those processes which are of importance in common life, or in the useful arts.

In his laboratory-work, the student will use a text-book, in which all needed directions to secure safety and success in performing the experiments are minutely given. The course will include the description and study of all the important chemical elements; but only inorganic chemistry will be treated of during this year.

ENGLISH LANGUAGE AND LITERATURE.

The studies of the English department will embrace:—1st, Exercises in English Composition, arranged with special reference to the future wants of the students, and the cultivation of a habit of expressing their thoughts with clearness and precision:—2d, Lectures on the History and Structure of the English Language:—3d, The Critical Study of Standard English Writers.

A knowledge of the Latin language is not required for admission, and the course of instruction in English will not presuppose any acquaintance with Latin; but it is strongly recommended to young men who propose to enter this School to acquire, whenever possible, such a knowledge of Latin as will enable them to read easy Latin prose.

MODERN LANGUAGES.

In the study of the Modern Languages, the first aim will be to enable the student to *read* French and German, so that, in the latter years of the course, French and German as well as English text-books may be used in any department.

German alone is studied during the present year. Special attention is given to the German grammar.

SECOND YEAR.

MATHEMATICS.

1. *Spherical Trigonometry*.— Deduction of the Formulæ; Napier's Circular Parts and Analogies; Bowditch's Rules; Gauss's Equations; Solution of Right and Oblique Triangles.
2. *Plain Coordinate Geometry*.— Elementary Principles and Definitions; The Point; Equations and Properties of the Straight Line, Circle, Parabola, Ellipse, and Hyperbola.
3. *Analytic Geometry of Three Dimensions*.— The Point; Equations of the Straight Line and Plane, and of Surfaces of the Second Degree, with their Classification and Properties.
4. *Differential and Integral Calculus*.— General Principles and Notation; Derivatives and Integrals of the Simple Functions.

DESCRIPTIVE ASTRONOMY.

Form of the Earth; Diurnal Revolution; Parallax; Refraction and Twilight; Earth's Annual Motion; Seasons; Sun; Ecliptic; Spherical Coordinates and Figure of the Earth's Orbit; Time; Astronomical Instruments; Universal Gravitation; Kepler's Laws; Precession and Nutation; Moon's Orbit and Phases; Tides; Eclipses; Planets; Comets and Nebulæ; Constellations.

SURVEYING.

Surveying by Measurement of Lines alone; Compass Surveying; Trigonometrical Surveying; Levelling; Topographical Surveying; Plane Table Surveying; Theory and Adjustments of Instruments; Field-practice in the preceding branches; Office-practice in Plotting Surveys, Computing Areas, etc., and in Drawing Plans.

MECHANICAL DRAWING AND DESCRIPTIVE GEOMETRY.

In Mechanical Drawing, the course of the previous year will be continued, with application to Orthographical, Isometric and Spherical Projection, and to Shades and Shadows.

The study of Descriptive Geometry will be continued so as to include problems of position relative to such surfaces as occur in the Arts, and will be illustrated by a set of models.

FREE-HAND DRAWING.

The exercises of the previous year will be continued, with the use of water-colors and distemper.

EXPERIMENTAL PHYSICS.

1. *Phenomena and Laws of Sound.*—Of Waves in general; Propagation, Reflection and Refraction of Sound; Musical Sounds, Laws of Vibrations of Columns of Air, Rods, Cords, Bells; Musical Instruments; Speech and Hearing.
2. *Phenomena and Laws of Heat.*—Expansion; Specific Heat, Fusion, Boiling, Evaporation; Tension of Vapors; Hygrometers; Steam Gauges; Communication, Reflection, and Refraction of Heat; Luminous and Obscure Rays; Sources and Mechanical Equivalent of Heat; the Steam Engine; etc.
3. *Phenomena and Laws of Light.*—Intensity; Photometers; Reflection; Refraction; Dispersion; the Spectrum; Achromatic Combinations; the Spectroscope; the Eye and Vision; Optical Instruments; Diffraction; Law of Interference; Doctrine of Undulations; Double Refraction, and Polarization.

CHEMISTRY.

A systematic course of instruction will be given in Qualitative Analysis, by laboratory practice and oral and written examinations. Every student will work in the laboratory twice a week, during the greater part of the year.

The object of this instruction will be to enable the student to detect and prove the presence of any chemical element, whether in a simple or compounded condition. He will be taught to detect and isolate the more common bases and acids, and he will be continually exercised in the application of his acquired knowledge to the analysis of substances whose composition is unknown to him. Towards the close of the year, a course of lectures will be given on the Elements of Organic Chemistry.

ENGLISH.

The course for this year will embrace the study of General and Comparative Grammar (in connection with the instruction of the Professor of Modern Languages), the further study of the History and Structure of the English Language, the reading of English standard writers, and continued practice in Composition.

MODERN LANGUAGES.

French will be begun the second year, and taught upon the same principles as German during the first year.

The study of German will be continued. An advanced class will be formed, composed of students of the second, third, and fourth years. The students of this class will have an opportunity to acquire some knowledge of the literature of the language; and, so far as practicable in such a course, they will be instructed in conversational forms.

THIRD YEAR.

I. — COURSE IN MECHANICAL ENGINEERING.

1. Differential and Integral Calculus; Analytic Mechanics.
2. Applied Mechanics; comprehending —
Strength of Materials used in construction; Estimation of the Resistances of Friction and Rigidity; Pure and Applied Cinematics; Dynamics of Solids, and the Application to the Theory of Machines; Hydrostatics and Hydrodynamics; Thermodynamics; Estimation of the Useful Effect of Machines; Principles of Mechanism.
3. Descriptive Geometry applied to Masonry, Carpentry, and Machinery.
4. Drawing of Machinery.
5. Physics continued.
6. Logic, Rhetoric, and the History of English Literature.

7. Extended study of French and German, for the first of which Spanish may be substituted.

II. — COURSE IN CIVIL AND TOPOGRAPHICAL ENGINEERING.

1. Differential and Integral Calculus ; Analytic Mechanics ; Applied Mechanics.
2. Spherical Astronomy ; Higher Geodesy ; Determination of Latitude and Longitude.
3. Survey, Location, and Construction of Roads, Railways, and Canals.
4. Measurement and Computation of Earth-work and Masonry.
5. Hydrographical Surveying ; Tide Gauges ; Soundings ; River and Harbor Improvements.
6. Field-Practice.
7. Drawing of Plans, Profiles, Elevations, Sections, etc.
8. Descriptive Geometry, applied to Masonry and Carpentry.
9. Physics continued.
10. Logic, Rhetoric, and the History of English Literature.
11. Extended study of French and German, for the first of which Spanish may be substituted.

III. — COURSE IN PRACTICAL CHEMISTRY.

1. Chemical Analysis, Quantitative,—embracing the Analysis and Commercial Testing of Ores, Metals, Alloys, and Mineral Materials ; Soda-ash, Bleaching-salt, Saltpetre, Paints, Drugs, and Manures ; Drinking and Mineral Waters.
2. Lectures on Industrial Chemistry ; on the Manufacture of Glass, Pottery, Soda-ash, Acids, Soap, Gas, etc. ; on the Arts of Dyeing, Calico-Printing, Tanning, Brewing, Distilling, etc.
3. Descriptive and Determinative Mineralogy.
4. Lectures on Structural and Systematic Geology.
5. Drawing,—of Apparatus, and of Machinery and Plans for Chemical, Dyeing, and Print works.
6. Physics continued.
7. Logic, Rhetoric, and the History of English Literature.
8. Extended study of French and German, for the first of which Spanish may be substituted.

IV.—COURSE IN MINING ENGINEERING.

1. Differential and Integral Calculus ; Analytic Mechanics ; Applied Mechanics.
2. Spherical Astronomy and Higher Geodesy.
3. Field-practice in Engineering ; Construction of Roads and Railways ; Measurement of Earth-work and Masonry.
4. Descriptive and Determinative Mineralogy ; Use of the Blow-pipe ; Assaying in the Wet and Dry Ways.
5. Metallurgy.—Metallurgical Processes, Constructions and Implements ; Furnaces, Crucibles, Blowing Machines, Fuesis, and Fluxes.
6. Structural and Systematic Geology ; Successive formations with their leading fossils ; Details of the Geology of North America.
7. Drawing.—Geological Sections and Maps ; Coloring of Maps and Sections ; Drawing of Furnaces, Refineries, and Metallurgical Apparatus.
8. Physics continued.
9. Logic, Rhetoric, and the History of English Literature.
10. Extended study of French and German, for the first of which Spanish may be substituted.

V.—COURSE IN BUILDING, AND ARCHITECTURE.

1. Differential and Integral Calculus ; Analytic Mechanics ; Applied Mechanics.
2. Descriptive Geometry applied to Masonry and Carpentry.
3. Drawing of Projects in Architectural Design and Construction.
4. Physics continued.
5. Logic, Rhetoric, and the History of English Literature.
6. Extended study of French and German, for the first of which Spanish may be substituted.

VI.—COURSE IN SCIENCE AND LITERATURE.

1. Differential and Integral Calculus ; Analytic Mechanics.
2. Descriptive Geometry : Applications.
3. Physics continued.—Magnetism ; Electricity ; Meteorology.
4. Quantitative Chemical Analysis.
5. Structural and Systematic Geology.

6. Logic, Rhetoric, and the History of English Literature.
7. Extended study of French and German, for the first of which Spanish may be substituted.
8. Drawing — subjects chosen with reference to the special aptitudes and aims of the student.

Of the subjects 1, 2, 4, the student may omit one, and he may substitute for either of the remaining two some specialty of one of the Professional Courses.

FOURTH YEAR.

I. — COURSE IN MECHANICAL ENGINEERING.

1. Construction of Machines and Study of Motors.
 - Calculation of the Strength and Proportions of the Parts of a Machine.
 - Hand Machinery ; as Cranes, Derricks, Pumps, Turn-tables, etc.
 - The Hydraulic Motors ; Water-wheels, including Turbines ; Water-Pressure Engines.
 - Power and Strength of Boilers.
 - Steam Engines, — Stationary, Locomotive, Marine ; Air and Gas Engines.
 - Construction and Arrangement of Machinery in Mills for Grinding, for Textile Manufactures, etc.
2. Lectures on Combustion and Fuel ; and on Warming, Ventilating, and Lighting.
3. Lectures on the Chemistry and Geology of the Materials used in Construction.
4. Descriptive Geometry applied to Masonry, Carpentry, and Machinery.
5. Drawing of Machines, Working Plans and Projects of Machinery, Mills, etc.
6. Lectures on History, Political Economy, and the Science of Government.
7. Lectures on Mental and Moral Philosophy.
8. Instruction in Zoölogy, Physiology, and Botany.
9. Extended study of French and German, for the first of which Italian may be substituted.

II. — COURSE IN CIVIL AND TOPOGRAPHICAL ENGINEERING.

1. Structures of Wood ; Framing ; Trusses, Girders, and Arches ; Roofs and Bridges.
2. Structures of Stone ; Foundations ; Retaining Walls ; Arches ; Bridges.
3. Structures of Iron ; Foundations ; Beams, Girders, and Columns ; Roofs and Bridges.
4. Supply and Distribution of Water ; Distribution of Gas ; Drainage.
5. Geology and Chemistry of the Materials used in Construction.
6. Descriptive Geometry applied to Masonry and Carpentry.
7. Field-practice.
8. The Drawing of Plans, Profiles, Elevations, Sections, etc.
9. Lectures on History, Political Economy, and the Science of Government.
10. Lectures on Mental and Moral Philosophy.
11. Instruction in Zoölogy, Physiology, and Botany.
12. Extended study of French and German, for the first of which Italian may be substituted.

III. — COURSE IN PRACTICAL CHEMISTRY.

1. Quantitative Analysis continued ; Organic Analysis.
2. Preparation of Chemical Products, and Special Researches.
3. Lectures on Combustion and Fuel.
4. Lectures on Warming, Ventilating, and Lighting.
5. Drawing as in Third Year.
6. Lectures on History, Political Economy, and the Science of Government.
7. Lectures on Mental and Moral Philosophy.
8. Instruction in Zoölogy, Physiology, and Botany.
9. Extended study of French and German, for the first of which Italian may be substituted.

IV. — COURSE IN MINING ENGINEERING.

1. Construction of Machines.
2. Structures of Wood, Stone, and Iron ; Trusses, Arches, Girders, Roofs, and Bridges.

3. Quantitative Chemical Analysis.
4. Lectures on Combustion and Fuel.
5. Lectures on Warming, Ventilating and Lighting.
6. Geology of Coal, Iron, Copper, Lead, Zinc, Salt, Plaster, Silver, Gold, etc., with particular reference to North American localities.
7. Lectures on Mining.
 - Prospecting, Breaking Ground, Boring, Blasting, Tubing, Sinking Shafts, Driving Tunnels, Ventilating and Lighting.
 - The different Methods of working Mines.
 - Mining Machinery and Motors, — Engines, Horses, Pumps, Wagons, Drums, Ropes, etc., for conveying and raising the Material.
 - The Dressing and Concentration of Minerals, — Crushers, Stamps, Washers, Amalgamators, etc.
 - Quarrying and Open Mining.
 - Details of Mining in this country; with History and Statistics of Mining generally.
8. Drawing, — Geological Maps and Sections; Coloring of Maps and Sections; Plans and Sections of Mines, Quarries, and other open Workings; Mining Machinery and Implements; Plans of Ventilation.
9. Lectures on History, Political Economy, and the Science of Government.
10. Lectures on Mental and Moral Philosophy.
11. Instruction in Zoölogy, Physiology, and Botany.
12. Extended study of French and German, for the first of which Italian may be substituted.

V. — COURSE IN BUILDING AND ARCHITECTURE.

This course will be practical as well as theoretical, and will embrace the thorough study of composition and design, and of the history of the art. It will consist chiefly of a series of projects in construction and design, to be worked out by the student. These will be illustrated by lectures upon the theory and practice of the art, pertinent to the subjects in hand.

Although the regular courses of the three earlier years of the school, embracing Mathematics, Chemistry, Physics, Drawing,

and the scientific study of construction and materials, form the best preparation for the fourth year's course in Building and Architecture, yet other students will be admitted to it as special pupils; and it is hoped that practising draughtsmen, whose opportunities of study are limited, will avail themselves of those here offered. It will be the object of the course to furnish the instruction and discipline that cannot be obtained elsewhere, rather than to cover the whole ground of architectural study, Much of the ordinary detail of work must necessarily be left for students to acquire in architects' offices.

The following courses will be required of the regular students in this department:—

1. Study of Structures of Stone, Wood and Iron; Trusses, Arches, Girders, Roofs, and Bridges.
2. Lectures on Warming, Ventilating, and Lighting.
3. Lectures on the Geology and Chemistry of the Materials used in Construction.
4. Lectures on History, Political Economy, and the Science of Government.
5. Lectures on Mental and Moral Philosophy.
6. Instruction in Zoölogy, Physiology, and Botany.
7. Extended study of French and German, for the first of which Italian may be substituted.

VI.— COURSE OF SCIENCE AND LITERATURE.

1. Applications of the Calculus.
2. Outlines of Zoölogy, Physiology, and Botany.
3. Geology, continued; including Palæontology.
4. Quantitative Chemical Analysis; Organic Chemistry.
5. Lectures on Combustion and Fuel; on Warming, Ventilation, and Lighting.
6. Lectures on Mental and Moral Philosophy.
7. Lectures on History, Political Economy, and the Science of Government.
8. Extended study of French and German, for the first of which Italian may be substituted.
9. Drawing as in Third Year.

Of the subjects 1, 3, 4, the student may omit one, and he may substitute for either of the remaining two some specialty of one of the Professional Courses.

MILITARY TACTICS.

The regular students of the School will be taught the use of small-arms, and the simpler parts of tactics; and, for this purpose, will be organized into one or more companies, to meet on stated days for military instruction and exercise.

METHODS AND APPARATUS OF INSTRUCTION.

1. *Lectures and Familiar Expositions.* As a general rule, each lecture will be preceded by an examination on the previous one, in which the teacher will have an opportunity of re-enforcing the instruction already given, as well as of testing the progress of individual students. Text-books will be used in connection with the lectures.

2. *Written Examinations.* Beside the daily oral examinations already referred to as accompanying the lectures, written examinations will be held at stated periods, at which each class will be examined in the subjects appointed for study during the interval just elapsed.

3. *Laboratory Work in Chemical Analysis, Metallurgy, and Industrial Chemistry.* In the chemical laboratories, provision is made for the thorough and comprehensive study of qualitative and quantitative analysis, embracing organic as well as inorganic substances, and for special instruction in whatever relates to practical mineralogy, the chemical valuation of ores, and the various operations for the separation and refining of metals. In these laboratories, students of industrial chemistry will also have an opportunity of becoming practically familiar with the materials, implements, and processes of the more important chemical

arts and manufactures. A high value is set upon the educational effect of laboratory practice, in the belief that such practice trains the senses to observe with accuracy, and the judgment to rely with confidence on the proof of actual experiment.

4. A *Laboratory for Physical Manipulations*, in which the student may be exercised in a variety of mechanical and physical processes and experiments, will be established at an early day.

5. *Designing and Drawing of Machines and Works of Engineering and Architecture*.

6. *Practical Exercises in Surveying, Levelling, Geodesy, and Nautical Astronomy*.

7. *Excursions for the Inspection and Study of Machines, Processes of Manufacture, Buildings, Works of Engineering, Geological Sections, Quarries, and Mines*. In aid of the practical studies of the School, and as a means of initiating students into the actual details of the professions for which they are preparing, they will be required from time to time, in the progress of the course, assisted by one or more of their teachers, to make visits of inspection to machine-shops, engines, mills, furnaces, and chemical works, and to important buildings and engineering constructions which are within convenient reach.

With a like view, and under the same direction, they will be expected to spend such parts of vacations as may be assigned, in excursions for observation and practice.

EXAMINATIONS OF THE REGULAR COURSE.

Near the close of the months of January and May, general examinations will be held,—that of January embracing the subjects studied during the first half-year, that of May covering the studies of the whole year. Each examination on a distinct subject will be marked on a scale of 100, and the marks of each student will be reported to his parent or guardian. These returns are intended to enable the parent or guardian to judge of his son's or ward's proficiency in each department of instruc-

tion. No student who fails to pass the annual examination will be permitted to enter upon the studies of the following year without passing a new examination.

GRADUATING EXAMINATIONS.

The examinations for degrees will be held in the month of May, and will be partly oral and partly in writing. In both the questions will range over the entire series of studies on which the student is required to be prepared.

As part of these examinations, the candidates will be called upon to exhibit the drawings and projects prepared by them for the occasion, and to perform such laboratory manipulations and exercises as the Faculty may assign.

At the same time, the theses of the candidates will be presented for examination; and, where expedient, their authors will be called upon to explain or defend them.

DIPLOMAS AND CERTIFICATES.

As the diploma or certificate is intended to be, not only a reward to the student for his diligence and attainments, but an assurance to the public of his knowledge and skill in the particular department of science to which it relates, it will be conferred on such students only as give proof by their examinations and other exercises that they possess the prescribed qualifications; but all persons who fulfil this requirement shall be entitled to the testimonials of the Institute, without regard to the length of time they may have spent in the School.

The degrees or diplomas corresponding to the leading divisions of the School, will be as follows:

1. A DEGREE IN MECHANICAL ENGINEERING.
2. " " " CIVIL AND TOPOGRAPHICAL ENGINEERING.
3. " " " PRACTICAL CHEMISTRY.
4. " " " GEOLOGY AND MINING ENGINEERING.
5. " " " BUILDING AND ARCHITECTURE.
6. " " " SCIENCE AND LITERATURE.

To be entitled to either of these degrees, the student must pass a satisfactory examination on the whole course of studies and exercises prescribed in his department, including the elementary and general, no less than the advanced and special subjects. He must, moreover, prepare a dissertation on some subject included in the course of study, or submit an original report upon some machine or work of engineering, or some mine or mineral survey or scientific investigation, which shall be approved by the Faculty. He will be required, also, to have sufficient familiarity with French and German to be able to read without difficulty works in these languages, relating to science and the arts.

Beside the degrees or diplomas covering the complete courses of study above referred to, there will be given certificates of attainment in special subjects to such students as on examination are found to have attained the required proficiency in them.

REGULATIONS OF THE SCHOOL.

SCHOOL-YEAR.

The School-year begins on the first Monday in October, and ends on the Saturday preceding the first Monday in June. On Christmas and New Year's Day and all legal holidays, the exercises of the School will be suspended.

BOND OR DEPOSIT.

Every student, whether regular or special, is required, on entering the School, either to give a bond for two hundred dollars to pay all charges accruing under the Regulations of the School; or to deposit, if he prefer so to do, the sum of two hundred dollars with the Secretary of the Institute, to be accounted for at the end of the School-year, or whenever the depositor leaves the School, in case he leaves it before the end of the year. This deposit must be renewed at the beginning of each year. The

bond must be executed by two bondsmen, satisfactory to the Secretary of the Institute, one of them being a citizen of Massachusetts; and must be filed within ten days after the date at which the student joined the School.

FEEES.

The fees for regular students are: for the first year's course, \$125; for the second, third and fourth, \$150 each, — payable by students who have given bonds, one-half at the beginning, and one-half at the middle (first Monday in February) of the School-year. For one-half, or any less fraction of the School-year, two-thirds of the above fees are charged. The fees for special students vary according to the length and number of the courses chosen, and cannot be specified, except for such special courses as may be annually advertised.

ATTENDANCE.

Regular students are expected to attend all the exercises of the class to which they belong. Special students are expected to attend all the exercises of the course or courses of study which they have chosen. A weekly return of absences and tardiness will be made by the Secretary of the Faculty to the parent or guardian of every student not of age. Tardiness consists in entering a lecture-room, drawing-room, or laboratory, more than five minutes after the hour designated for the beginning of the exercise. All regular students are expected to devote themselves to the work of the School between the hours of 9, A. M., and 5, P. M., except during the interval for dinner, from 1½, P. M., to 3, P. M., and the afternoon of Saturday.

STUDY-ROOM.

If not occupied in the lecture-rooms, the laboratory, or the drawing-rooms, students may resort to the study-room. In this room, which is intended exclusively as a place for study, perfect order and quiet will be preserved.

DISCIPLINE.

While within the limits of the Institute, students are expected to behave with decorum, to obey the regulations of the School, and to pay a due respect to its officers. They are specially required to avoid all running, loud talking, or other noise in the entries of the building. Every student will be held responsible for the furniture which he uses, and the cost of repairing any damage thereto will be charged to him. In case of injury to the 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 will be assessed equally upon all the students of the School. Conduct inconsistent with the good order of the School, if repeated after admonition, will be followed by the dismissal of the offender.

AFTERNOON AND EVENING COURSES OF INSTRUCTION.

THIS department of the School is intended for the benefit of persons of either sex who are prevented from availing themselves of scientific instruction during the day, but are desirous of pursuing such studies in a systematic way, by the aid of afternoon or evening lessons and lectures. It will embrace a number of distinct courses, more or less varied from year to year by the omission or interchange of particular subjects, but including in their entire scope instruction in mathematics, physics, chemistry, geology, natural history, the English and other modern languages and literature, navigation and nautical astronomy, architecture, and engineering.

The programme of subjects, and the extent of the several courses, will be made known early in October of each year.

As it is the object of this branch of the School to provide substantial teaching, rather than merely popular illustration of the subjects, it is expected that all persons attending these courses will come with a serious purpose of improvement, and that they will cheerfully comply with such rules in regard to attendance and to order in the class or lecture-room as may be prescribed.

Except in the case of courses in which provision may be made for gratuitous instruction, a fee will be required, payable in advance.

THE TRUSTEE OF THE LOWELL INSTITUTE has established, under the supervision of the Institute of Technology, courses of instruction to be open to students of either sex, free of charge.

During the year 1865-66, six courses of instruction were given, as follows:

1. Eighteen Lectures on Mathematics, by Prof. Runkle.
2. Eighteen Lectures on Descriptive Geometry, by Prof. Watson.
3. Eighteen Lectures on the Chemistry of the Non-metallic Elements, by Prof. Storer.
4. Eighteen Lectures on the Metals, by Prof. Eliot.
5. Eighteen Lectures on the English Language and its Literature, by Prof. Atkinson.
6. Eighteen French Readings, by Prof. Bôcher.

The courses of instruction for the year 1866-67 were as follows:—

1. A course of thirty practical lessons in Chemical Manipulation, by Professors Storer and Eliot.
2. Eighteen lessons in Mathematics, by Prof. Runkle.
3. Eighteen lessons in Navigation and Nautical Astronomy, by Prof. Osborne.
4. Eighteen lessons in French, by Prof. Bôcher.
5. Ten lessons in Grammar, Rhetoric, and Composition, by Prof. Atkinson.

6. Ten lessons in Anatomy and Physiology, by Dr. Samuel Kneeland.

The courses for 1867-8 are as follows :

1. A course of eighteen lessons in Geometry and Trigonometry, by Prof. Osborne, on Tuesdays and Fridays, at 7½ P. M., beginning Nov. 12.
2. A course of eighteen lessons in the Calculus, by Prof. Runkle, on Tuesdays and Fridays, at 7½ P. M., beginning Jan. 17, 1868.
3. An elementary course of eighteen lessons in German, by Instructor Krauss, on Wednesdays and Saturdays, at 7½ P. M., beginning Nov. 13.
4. Two courses in Chemical Manipulation, by Prof. Storer, on Wednesday and Saturday afternoons, at 3 P. M., the first beginning on a day to be announced on the cards of successful applicants. The second will be a repetition of the first, with a new class, and will begin after the close of the first.
5. A course of ten lessons in Natural History, by Dr. Samuel Kneeland, Secretary of the Institute, on Tuesdays and Fridays, at 7½ P. M., beginning Jan. 14, 1868.
6. A course of ten lessons on Language and General Grammar, by Prof. Atkinson, on Tuesdays and Fridays, at 7½, P. M., beginning Feb. 18, 1868.

The conditions of attendance on these gratuitous courses are as follows :

1. Candidates must have attained the age of eighteen years.
2. Their applications must be made in writing, addressed to the Secretary of the Faculty, specifying the course or courses they desire to attend ; mentioning their present or prospective occupations ; and, where the course is of a nature demanding preparation, stating the extent of their preliminary training.
3. The number of students in each class is necessarily limited ; but the selection will be made under the direction of the Faculty.
4. It is expected that all persons attending these courses will cheerfully comply with the regulations prescribed for the class or lecture-room.

1867--8. First Half.

	9—10	10—11	11—12	12—1	3—4	4—5
MONDAY.	1 Year. I Mathematics. 2 " Mech. Drawing. 3 " Stereotomy. 4 " Engineering.	II Mathematics. Calculus. Mining Physics. I Mathematics Mech. Engineering.	I German. Desc. Geometry. Metallurgy I German. Mathematics. English. German.	II German. Physics. Applied Chem. Chemistry. English. Physics. Physics.	I Chemical Surveying. Spanish. Blowpipe Italian. Mech. Chemical Engineering. Engineering.	Chemical Manipulation. Blowpipe and Mineralogy. Italian. Drawing. Analysis.
TUESDAY.	1 Year. English. 2 " French. 3 " Calculus. 4 " Mining.	II Mathematics I Mathematics Mech. Engineering.	II Mathematics. English. German.	Chemistry. English. Physics. Physics.	Mech. Chemical Engineering. Engineering.	Drawing. Analysis.
WEDSDAY.	1 Year. I Mathematics. 2 " German. 3 " Engineering. 4 " Engineering.	II Mathematics Plan French. French.	I German. Drawing.	II German. Mechanism. Mechanism.	Mechanical Surveying. Blowpipe and Mineralogy. Spanish. Italian.	Drawing. Drawing. and Mineralogy. Italian.
THURSDAY.	1 Year. I Mathematics. 2 " Mech. Drawing. 3 " Mining. 4 " Mining.	II Mathematics Geology.	Desc. Geometry. Spherical Astron.	Physics. Applied Chem. Spherical Astron.	Mechanical Chemical Engineering. Engineering.	Drawing. Analysis.
FRIDAY.	1 Year. English. 2 " French. 3 " Calculus. 4 " Mining.	Physics. I Mathematics Mech. Engineering.	I German. II Mathematics. English. (U.S. Const.) German.	II German. English. Physics. Physics.	II Chemical Plan Drawing. Engineering. Engineering.	Manipulation.
SATURDAY.	1 Year. I Mathematics. 2 " German. 3 " German. 4 " English. (Pol. Econ.)	II Mathematics French French	Military Drill.			