Massachusetts

Institute of Technology

THE COURSES OF STUDY

AND

SUBJECTS OF INSTRUCTION

MARCH, 1920

THE TECHNOLOGY PRESS

CAMBRIDGE

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A NOTE CONCERNING THE INSTITUTE PUBLICATIONS

The regular publications of the Massachusetts Institute of Technology are as follows:

GENERAL INFORMATION, a pamphlet sent to candidates for admission.

COURSES OF STUDY, a detailed account of the curriculum.

DIRECTORY OF OFFICERS AND STUDENTS, the personnel of the staff and the students.

PRESIDENT'S REPORT TO THE CORPORATION, including the Treasurer's Report.

THE SUMMER SCHOOL AND THE SUMMER CAMP.

GRADUATE STUDY AND RESEARCH.

This pamphlet, COURSES OF STUDY, gives the curriculum in detail, with descriptions of the subjects of study given by the various departments of the Institute. This pamphlet includes:

Schedules of the Professional Courses.

Descriptions of the subjects of instruction.

Tabulation of the subjects with

- Hours of exercise.
- Year and Term.
- Instructor in charge.
- Required preparation.

Alphabetical list of subjects.

For a general description of the Professional Courses, with a statement of their purposes, the intending student is referred to the pamphlet of General Information which should be consulted in connection with this publication.

FIRST YEAR

All Courses Except IV. OPTION 1

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Chemistry, 501, 502, 503	80 — 50	80 — 50	80 — 50
Draw. and D. G., D11, 12, 13 (I, XI, XVI, D11, 14, 15)	60 — 0	60 — 0	60 — 0
English and History, EH11, 12, 13	30 — 50	30 — 50	30 — 50
Mathematics, M11, 12, 13	30 — 60	30 — 60	30 — 60
Military Science, 21, 22, 23	30 — 0	30 — 0	30 — 0
Physical Training, 15	10 — 0	10 — 0	10 — 0
Physics, 800a, 801a, 801a	40 — 50	40 — 50	40 — 50
Hours of exercises and preparation:	490 = 280 + 210	490 = 280 + 210	490 = 280 + 210

FIRST YEAR

COURSE IV. OPTION 1

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Drawing and Descriptive Geom., D11, 16, 17	60 — 0	60 — 0	60 — 0
English and History, EH11, 12, 13	30 — 50	30 — 50	30 — 50
Freehand Drawing, D18, 19, 20	70 — 0	30 — 0	40 — 0
French, L63	20 — 40	20 — 40	20 — 40
Mathematics, M11, 12, 13	30 — 60	30 — 60	30 — 60
Military Science, 21, 22, 23	30 — 0	30 — 0	30 — 0
Perspective, 412	..	10 — 30	10 — 20
Physical Training, 15	10 — 0	10 — 0	10 — 0
Physics, 800a, 801a, 801c	40 — 50	40 — 50	30 — 60
Hours of exercises and preparation	490 = 290 + 200	490 = 260 + 230	490 = 260 + 230

Civil Engineering — COURSE I.

SECOND YEAR

First year, Page 4. Description of Subjects of Instruction, Pages 33-99

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
Astronomy, 112	.. ..	30 — 30	.. ..
Descriptive Geometry, D23	60 — 45	.. ..	.. ..
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Geodesy, 113	.. ..	.. ..	30 — 30
Map Reading and Topographical Draw. 119	.. ..	30 — 0	.. ..
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism, 202	30 — 45	.. ..	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 80 a, 80 a, 803a	40 — 50	40 — 50	40 — 50
Spherical Trigonometry, 111	10 — 20	.. ..	.. ..
Stereotomy, D28	.. ..	50 — 10	.. ..
Surveying and Plotting, 100	.. ..	20 — 40	30 — 30
Hours of exercises and preparation:	500 = 230 + 270	500 = 260 + 240	500 = 220 + 280

REQUIRED SUMMER COURSE

Surveying Camp

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221, 222a 222a	30 — 60	20 — 30	20 — 30
Electrical Engineering, Elements of, 641, 642	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory, 686	.. ..	20 — 30	.. ..
Geodesy, 113	30 — 30	.. ..	.. ..
Geology, 1230a, 1231a, 1 a	30 — 20	40 — 25	30 — 30
Materials, 143	.. ..	.. ..	20 — 40
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Railway Drafting, 123	60 — 0	60 — 0	.. ..
Railway and Highway Engineering, 121	30 — 55	30 — 30	.. ..
Roads and Pavements 130	.. ..	.. ..	20 — 20
Structures, 140	.. ..	.. ..	40 — 80
Testing Materials Laboratory, 230	.. ..	.. ..	20 — 10
General Study		30 — 30	30 — 30
Hours of exercises and preparation:	480 = 240 + 240	480 = 260 + 220	480 = 210 + 270

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Bridge Design, 153	50 — 0	60 — 0	70 — 0
Engineering and Hydraulic Lab., 264	.. ..	30 — 30	.. ..
Foundations, 148	10 — 15	.. ..	.. ..
Heat Engineering, 246, 247, 248	30 — 60	30 — 60	30 — 30
Hydraulic and Sanitary Design, 179 (1)	.. ..	.. ..	30 — 0
Hydraulic and Sanitary Eng., 175 (1)	30 — 45	30 — 50	30 — 60
Hydraulics, 162	40 — 80	.. ..	.. ..
Railway Design, 125 (2)	.. ..	40 — 0	40 — 0
Railway Engineering, 125 (2)	30 — 45	20 — 40	30 — 50
Sanitary Science and Public Health, 756 (1)	.. ..	.. ..	20 — 0
Structures, 149	40 — 80	30 — 60	50 — 100
Thesis (1)	.. ..	40 — 0	60 — 0
Thesis (2)	.. ..	20 — 0	80 — 0
General Study	.. ..	30 — 30	.. ..
Option (1)	480 = 200 + 280	480 = 250 + 230	480 = 290 + 190
Option (2)	480 = 200 + 280	480 = 260 + 220	480 = 300 + 180

Mechanical Engineering — COURSE II.

SECOND YEAR

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Forging, 280, 280	30 — 0	30 — 0	.. ..
Foundry, 282	.. ..	60 — 0	.. ..
Machine Drawing, 212	.. ..	.. ..	60 — 0
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanical Engineering Drawing, 210, 211	60 — 0	30 — 0	.. ..
Mechanism, 200, 201	30 — 60	30 — 60	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Pattern Making, 284	.. ..	.. ..	60 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Surveying, 102	30 — 0	.. ..	.. ..
Hours of exercises and preparation:	500 = 280 + 220	500 = 280 + 220	500 = 280 + 220

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221, 222, 223	30 — 60	30 — 60	30 — 50
Engineering Laboratory, 260, 260	.. ..	20 — 10	20 — 10
Heat Engineering { 240, 242, 244	30 — 60	30 — 60	20 — 40
Heat Engineering { 241, 243	20 — 20	20 — 20	.. ..
Hydraulics, 164	.. ..	.. ..	30 — 50
Machine Design, 270, 270	.. ..	30 — 0	30 — 0
Machine Tool Work, 288, 290	.. ..	40 — 0	40 — 0
Materials of Engineering, 230, 230	.. ..	20 — 20	20 — 20
Mechanism of Machines, 2[illegible]	30 — 40	.. ..	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Surveying, 102	30 — 0	.. ..	.. ..
Vise and Bench Work, 286	40 — 0	.. ..	.. ..
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 240 + 240	480 = 250 + 230	480 = 250 + 230

Mechanical Engineering — COURSE II. — *Continued*

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Dynamics of Machines, 225	30 — 40	.. ..	.. ..
Electrical Engineering, Elements of, 641, 642	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory, 685	.. ..	.. ..	30 — 40
Engineering Laboratory, 261, 262, 263	40 — 40	40 — 40	20 — 20
General Engineering Lectures, 276	.. ..	10 — 5	.. ..
Heat Engineering, 245	30 — 30	.. ..	.. ..
Hydraulic Engineering, 168	30 — 45	.. ..	.. ..
Industrial Plants, 277, 278	.. ..	60 — 60	60 — 0
Machine Design, 271, 272	60 — 0	60 — 0	.. ..
Machine Tool Work, 292	30 — 0	.. ..	.. ..
Mechanics of Engineering, 226, 226	.. ..	20 — 40	20 — 40
Power Plant Design, 258	.. ..	.. ..	60 — 0
Testing Materials Laboratory, 235, 235	20 — 10	20 — 10	.. ..
General Study	.. ..	.. ..	30 — 30
Thesis	.. ..	.. ..	90 — 0
Electives,* 275	.. ..	40 — 0	40 — 0
Hours of exercises and preparation:	480 = 270 + 210	480 = 280 + 200	480 = 350 + 130

*In the second and third terms of the fourth year an elective, or electives, must be taken by each student, these electives totalling at least 60 hours. The electives may be chosen from the list offered by the Department of Mechanical Engineering, or other subjects for which the student has the adequate preparation may be taken if approved by the Department.

ELECTIVES OFFERED BY MECHANICAL ENGINEERING DEPARTMENT

1. Automatic Machinery, 275a
2. Automotive Engineering, 275b
3. Engine Design, 275c
4. Fire Protection Engineering, 275d
5. Heat Transmission, 275e
6. Heat Treatment, 275f
7. Internal Combustion Engines, 275g
8. Locomotive Engineering, 275h
9. Refrigeration, 275i
10. Textile Engineering, 275j
11. Theory of Elasticity, 275k

Mining Engineering and Metallurgy — COURSE III.

OPTION 1. Mining and Metallurgy

SECOND YEAR

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Fire Assaying, 331	.. ..	.. ..	80 — 20
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 9
Mineralogy and Petrology, 1201, 1202	80 — 10	80 — 10	.. ..
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Qualitative Analysis, 510	100 — 20	.. ..	.. ..
Quantitative Analysis, 512a, 512b	.. ..	110 — 10	100 — 10
Hours of exercises and preparation:	500 = 310 + 190	500 = 320 + 180	500 = 310 + 190

REQUIRED SUMMER COURSE

Surveying Camp

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220, 221, 222	30 — 60	30 — 60	30 — 60
Gas Analysis, 531	20 — 10	.. ..	.. ..
Geology, 1230	30 — 30	.. ..	.. ..
Geology, 1231	.. ..	30 — 30	.. ..
Geology, 1232	.. ..	.. ..	30 — 30
Heat Measurements, 812	.. ..	40 — 15	.. ..
Hydraulics, 104	.. ..	.. ..	30 — 40
Metallurgical Laboratory, 354, 355	90 — 10	80 — 15	.. ..
Metallurgy, 341, 342, 343a	40 — 40	30 — 30	20 — 15
Mining Engineering, 301, 302	.. ..	30 — 30	40 — 35
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Quantitative Analysis, 513	60 — 0	.. ..	.. ..
Testing Materials Laboratory, 236	.. ..	.. ..	20 — 10
General Study	.. ..	.. ..	30 — 30
Hours of exercises and preparation:	480 = 300 + 180	480 = 270 + 210	480 = 230 + 250

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrical Engineering, Elements of, 641, 642	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory, 685	.. ..	.. ..	30 — 40
Forging, 281	.. ..	.. ..	40 — 0
Geological Surveying, 1234	.. ..	.. ..	40 — 30
Geology, Economic, 1240	.. ..	50 — 50	.. ..
Geology, Field, 1233	40 — 20	.. ..	.. ..
Metallurgical Calculations, 359	20 — 20	.. ..	.. ..
Metallography, II 363	20 — 10	.. ..	.. ..
Mining Engineering, 303, 304	20 — 20	40 — 40	.. ..
Ore Dressing, 321	40 — 40	.. ..	.. ..
Ore Dressing Laboratory, 322	80 — 15	.. ..	.. ..
Power in Mining, 253	.. ..	40 — 40	.. ..
Thermochemistry and Ch. Equil, 568	.. ..	.. ..	30 — 60
Thesis	.. ..	85 — 0	120 — 30
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 280 + 200	480 = 275 + 205	480 = 290 + 190

Mining Engineering and Metallurgy — COURSE III.

OPTION 2. Metallurgy

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

SUMMER SCHOOL (FOLLOWING FIRST YEAR)

Machine Drawing, 214a	45 — 0
Mechanism, 202a	35 — 55

SECOND YEAR

Same as for Option 1

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220, 221, 222	30 — 60	30 — 60	30 — 60
Electrochemistry, 890	.. ..	30 — 30	.. ..
Forging, 281a	.. ..	.. ..	30 — 0
Gas Analysis, 331	20 — 10	.. ..	.. ..
Heat Measurements, 812	.. ..	40 — 15	.. ..
Hydraulics, 164	.. ..	.. ..	30 — 40
Metallurgical Laboratory, 354, 355	90 — 10	80 — 15	.. ..
Metallurgy, 344	.. ..	.. ..	40 — 40
Metallurgy, 341, 342a	40 — 40	30 — 30	.. ..
Metallurgy of Iron and Steel, 343	.. ..	.. ..	40 — 80
Mining Engineering, 305	.. ..	30 — 30	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Quantitative Analysis, 513	60 — 0	.. ..	.. ..
Testing Materials Laboratory, 236	.. ..	.. ..	20 — 10
*General Study	30 — 30	.. ..	.. ..
Hours of exercises and preparation:	480 = 300 + 180	480 = 270 + 210	480 = 220 + 260

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrical Engineering, Elem. of, 641, 642	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory, 685	.. ..	.. ..	30 — 40
Engineering Laboratory, 260c	.. ..	.. ..	20 — 10
Foundry, 283a	40 — 0	.. ..	.. ..
Heat Engineering, 240, 242	30 — 30	30 — 60	.. ..
Heat Engineering, 241, 243	20 — 20	20 — 20	.. ..
Metallurgical Calculations, 359	20 — 20	.. ..	.. ..
Metallography I, 361, 362	60 — 20	20 — 0	.. ..
Ore Dressing (Lecture and Laboratory) 323	45 — 10	.. ..	.. ..
Stationary Structures, 144	.. ..	.. ..	30 — 50
Technical Electrical Measurements, 689	.. ..	.. ..	15 — 15
Thermochemistry and Ch. Equil., 568	.. ..	.. ..	30 — 60
Thesis	.. ..	100 — 15	90 — 30
*General Study	30 — 30	30 — 30	30 — 30
*Professional Option	.. ..	40 — 40	.. ..
Hours of exercises and preparation:	480 = 275 + 205	480 = 270 + 210	480 = 245 + 235

* For Professional Option the choice lies between Economic Geology, 1240 (40 — 40) or Machine Tool Work, 288 (40 — 0) and Vise and Bench Work, 286 (40 — 0).

Economic Geology is recommended but to be admitted to it, the student must have taken Geology as a General Study in first term of either 3d or 4th year.

Mining Engineering and Metallurgy — COURSE III.

OPTION 3. Mining

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

SECOND YEAR

Same as for Options 1-2.

REQUIRED SUMMER COURSE

Surveying Camp

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220, 221, 222	30 — 60	30 — 60	30 — 60
Gas Analysis, 531	20 — 10	.. ..	.. ..
Geology, 1230	30 — 30	.. ..	.. ..
Geology, 1231	.. ..	30 — 30	.. ..
Geology, 1232	.. ..	.. ..	30 — 20
Metallurgy, 341, 342, 343a	40 — 40	30 — 30	20 — 20
Metallurgy Laboratory, 354	90 — 10	.. ..	.. ..
Mineralogy and Petrography, 1214	.. ..	60 — 30	30 — 20
Mining Engineering, 301, 302	.. ..	30 — 30	40 — 40
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Quantitative Analysis, 513	60 — 0	.. ..	.. ..
Stationary Structures, 144	.. ..	.. ..	30 — 50
Testing Materials Laboratory, 236	.. ..	.. ..	20 — 10
General Study	.. ..	30 — 30	.. ..
Hours of exercises and preparation:	480 = 300 + 180	480 = 240 + 240	480 = 230 + 250

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrical Engineering, Elements of, 641, 642	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory, 685	.. ..	30 — 40	.. ..
Geological Surveying, 1234	.. ..	.. ..	40 — 30
Geology, Applied Economic, 1242	.. ..	.. ..	20 — 20
Geology, Economic, 1240, 1241	.. ..	50 — 50	40 — 10
Geology, Field, 1233	40 — 20	.. ..	.. ..
Geology, Historical, 1250	40 — 30	.. ..	.. ..
Hydraulics, 164	.. ..	.. ..	30 — 40
Mining Engineering, 303, 304	20 — 20	40 — 40	.. ..
Ore Dressing, 321	40 — 40	.. ..	.. ..
Ore Dressing, Laboratory, 322	80 — 15	.. ..	.. ..
Power in Mining, 253	.. ..	40 — 40	.. ..
Thermochemistry and Cl.. Equil., 568	.. ..	.. ..	30 — 60
Thesis	.. ..	15 — 0	100 — 0
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 280 + 200	480 = 235 + 245	480 = 290 + 190

Architecture — COURSE IV. — Option 1

SECOND YEAR

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
Applied Perspective, 413, 413, 414	20 — 0	20 — 0	20 — 0
Architectural History, 441	10 — 20	10 — 20	10 — 20
Design, 471	100 — 0	100 — 0	140 — 0
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Freehand Drawing, D42	40 — 0	40 — 0	40 — 0
French, L71	20 — 30	20 — 30	.. ..
History of Ornament, 431	.. ..	.. ..	10 — 0
Mathematics, M21, 22	30 — 60	30 — 60	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Office Practice, 421, 421	.. ..	40 — 0	40 — 0
Shades and Shadows, 411	30 — 10	.. ..	.. ..
Water Color, 453	20 — 0	20 — 0	20 — 0
Hours of exercises and preparation:	500 = 330 + 170	500 = 340 + 160	500 = 370 + 130

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221a, 222c	30 — 60	15 — 30	.. ..
Applied Perspective, 415, 415, 415	20 — 0	20 — 0	20 — 0
Architectural History, 442	10 — 20	20 — 40	20 — 30
Building Construction, 480	20 — 10	.. ..	.. ..
Constructive Design, 481	.. ..	25 — 0	60 — 0
Design, 472	140 — 0	140 — 0	160 — 0
European Civilization and Art, 446	30 — 40	30 — 40	30 — 40
Freehand Drawing, D43	40 — 0	40 — 0	40 — 0
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Water Color, 453	.. ..	20 — 0	20 — 0
Hours of exercises and preparation:	480 = 320 + 160	480 = 340 + 140	480 = 380 + 100

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Business and Patent Law, Ec62	.. ..	.. ..	30 — 30
Constructive Design, 482	40 — 0	.. ..	.. ..
Design, 473	280 — 0	320 — 0	260 — 0
European Civilization and Art, 447	30 — 40	30 — 40	30 — 40
Life Class, D44	60 — 0	60 — 0	60 — 0
Philosophy of Architecture, 451	10 — 10	10 — 10	10 — 10
Professional Relations, 422	10 — 0	10 — 0	10 — 0
Hours of exercises and preparation:	480 = 430 + 50	480 = 430 + 50	480 = 400 + 80

Architecture — COURSE IV. — Option 2

SECOND YEAR

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
Architectural History, 441	10 — 20	10 — 20	10 — 20
Design, 471	100 — 0	100 — 0	140 — 0
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Freehand Drawing, D42	40 — 0	40 — 0	40 — 0
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Perspective, 412	.. ..	10 — 30	.. ..
Physics, 802a, 803a, 803a	40 — 50	40 — 50	.. ..
Shades and Shadows, 411	30 — 10	.. ..	.. ..
Hours of exercises and preparation:	500 = 310 + 190	500 = 290 + 210	500 = 310 + 190

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220b, 222b, 223b	50—100	40 — 80	30 — 60
Architectural History, 442	10 — 20	20 — 40	20 — 30
Building Construction, 480	20 — 10	.. ..	.. ..
Color and Acoustics, 806	10 — 10	.. ..	.. ..
Electric Wiring of Buildings, 638	10 — 20	.. ..	.. ..
European Civilization and Art, 443	30 — 40	30 — 40	30 — 40
Materials, 143	.. ..	.. ..	20 — 40
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Professional Relations, 422	10 — 0	10 — 0	10 — 0
Structural Design, 491	.. ..	100 — 0	80 — 0
Structural Drawing, 490	40 — 40	.. ..	.. ..
Structures, 141	.. ..	20 — 40	20 — 40
Hours of exercises and preparation:	480 = 210 + 270	480 = 250 + 230	480 = 240 + 240

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Business and Patent Law, Ec62	.. ..	.. ..	30 — 30
Engineering Laboratory, 260d	.. ..	.. ..	10 — 0
European Civilization and Art, 447	30 — 40	30 — 40	30 — 40
Foundations, 148	10 — 15	.. ..	.. ..
Hydraulics, 163	.. ..	20 — 40	.. ..
Mechanical Equipment of Buildings, including Steam and Heat and Ventilation, 257	.. ..	.. ..	40 — 40
Philosophy of Architecture, 451	10 — 10	10 — 10	10 — 10
Sanitary Science and Public Health, 756	.. ..	.. ..	20 — 0
Structural Design (including Concrete), 492	165 — 0	240 — 0	90 — 0
Structures, 151	40 — 80	30 — 60	20 — 40
Testing Materials Laboratory, 237	30 — 10	.. ..	.. ..
Testing Materials Laboratory (Concrete) 238	30 — 10	.. ..	.. ..
Thesis	.. ..	.. ..	70 — 0
Hours of exercises and preparation:	480 = 315 + 165	480 = 330 + 150	480 = 320 + 160

Chemistry— COURSE V

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99
(Summer following First Year. Qualitative Analysis, 210 — 30)

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
German, L21	30 — 50	30 — 50	30 — 50
Inorganic Chemistry I, 505	.. ..	.. ..	30 — 45
Mathematics, M21, 22	30 — 60	30 — 60	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Quantitative Analysis, 512a, 512b, 513	110 — 20	120 — 10	50 — 10
Options			
1. Mineralogy, 1203	.. ..	.. ..	70 — 15
2. General Biology and Bacteriology, 724	.. ..	.. ..	70 — 15
Hours of exercises and preparation:	500 = 270 + 230	500 = 280 + 220	500 = 280 + 220

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Chemical Principles I, 565, Lecture	10 — 10	10 — 10	10 — 10
Recitations	30 — 30	30 — 30	30 — 30
Laboratory	12 — 18	12 — 18	12 — 18
Inorganic Chemistry I, 505	30 — 45 *	.. ..	.. ..
Organic Chemistry I, 551	40 — 30	40 — 30	30 — 25
Organic Chemistry Laboratory, 556a	90 — 0	140 — 0	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Research Problem:			
Inorganic or Organic Chemistry, 590, 591	.. ..	10 — 15	160 — 20
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	465 = 272 + 193	465 = 302 + 163	465 = 302 + 163

* This will be replaced by Chemical Literature after 1920-21.

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Chemical Principles II, 567, Recitations	30 — 50	.. ..	.. ..
Laboratory	10 — 10	.. ..	.. ..
Chemistry of Colloids, 569	.. ..	20 — 20	.. ..
Gas Analysis, 531	20 — 10	.. ..	.. ..
History of Chemistry, 593	.. ..	.. ..	30 — 30
Industrial Chemistry, 575	40 — 40	30 — 30	.. ..
Metallography I, 541	.. ..	40 — 20	.. ..
Recent Developments in Chemistry, 594	.. ..	10 — 10	10 — 10
Research Problem, Physical Chemistry, 592	160 — 20	.. ..	.. ..
Special Methods and Instruments, 540	.. ..	.. ..	30 — 20
Thesis, 595	.. ..	100 — 20	200 — 20
Thesis Reports, 596	.. ..	10 — 10	10 — 10
General Study	.. ..	30 — 30	.. ..
Optional Subjects	90 — 0	100 — 0	110 — 0
Hours of exercises and preparation:	480 = 350 + 130	480 = 340 + 140	480 = 390 + 90

Students offering Elementary and Advanced French upon entrance will take German as shown in the Course Scheme.

Students offering Elementary and Advanced German upon entrance will take Elementary French in the second year in place of the German appearing in the Course Scheme. This course will include Technical French in the third period.

Students offering Elementary French and Elementary German will, in the second year take Technical French the first term, and the last two terms take Intermediate German.

Electrical Engineering — COURSE VI.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
Electrical Engineering, Principles of, 600	.. ..	.. ..	50 — 70
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Foundry, 283	30 — 0	.. ..	.. ..
Machine Drawing, 212	.. ..	60 — 0	.. ..
Machine Tool Work, 289	.. ..	60 — 0	.. ..
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanical Engineering Drawing, 210	60 — 0	.. ..	.. ..
Mechanism, 200, 201	30 — 60	30 — 60	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Vise and Bench Work, 287	30 — 0	.. ..	.. ..
Hours of exercises and preparation:	500 = 280 + 220	500 = 280 + 220	500 = 210 + 290

REQUIRED SUMMER COURSE

Surveying, 100a 60—15

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221, 222	30 — 60	30 — 50	.. ..
Electrical Engineering, Principles of, 601	40 — 60	.. ..	.. ..
Electrical Engineering, Principles of, 602	.. ..	40 — 60	.. ..
Electrical Engineering, Principles of, 603	.. ..	.. ..	40 — 60
Electrical Engineering Laboratory, 670	25 — 25	.. ..	.. ..
Electrical Engineering Laboratory, 671	.. ..	50 — 40	.. ..
Electrical Engineering Laboratory, 672	.. ..	.. ..	50 — 40
Heat Engineering, 250, 251, 252	30 — 60	30 — 60	30 — 60
Mathematics, M35	30 — 60	.. ..	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
General Study	.. ..	30 — 30	30 — 30
Options:			
Applied Mechanics (Kinetics), 224	.. ..	.. ..	30 — 50
Stationary Structures, 144			
Hours of exercises and preparation:	480 = 185 + 295	480 = 210 + 270	480 = 210 + 270

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrical Engineering, Principles of, 604	60 — 80	.. ..	.. ..
Electrical Engineering, Principles of, 605	.. ..	60 — 70	.. ..
Electrical Engineering, Principles of, 606	.. ..	.. ..	60 — 80
Electrical Engineering Laboratory, 673	70 — 50	.. ..	.. ..
Electrical Engineering Laboratory, 674	.. ..	70 — 50	.. ..
Engineering Laboratory, 260b	40 — 30	.. ..	.. ..
Hydraulics, 165	20 — 40	20 — 40	.. ..
Thesis	.. ..	20 — 0	190 — 0
General Study	.. ..	30 — 30	30 — 30
Professional Options	30 — 60	30 — 60	30 — 60
Hours of exercises and preparation:	480 = 220 + 260	480 = 230 + 250	480 = 310 + 170

Electrical Engineering—COURSE VI-A. (Co-operative Course)

Description of Subjects of Instruction, Pages 33-99

In preparation for this curriculum students must have successfully completed the first two years of the undergraduate Electrical Engineering course (Course VI) at the Institute, or the equivalent.

Note: In 1920 and thereafter the work will begin with the Summer Term at the shops.

GROUP A (FOR YEAR 1920-1921)

THIRD YEAR

	Summer Term July 6-Oct. 2	First Term Oct. 4-Dec. 31	Second Term Jan 3-Mar. 19	Third Term Apr. 4-July 2
AT WORKS				
Machine shop training room, assembling and inspecting	Daily			
Lectures on Manufacturing Methods				
Electrical Engineering, (Direct Current Machinery), 601	20—40			
English: effective writing and speaking, E31	20—40			
AT WORKS				
Winding, Insulating and Drafting		Daily		
Lectures on Manufacturing Methods				
Electrical Engineering, (Direct Current Machinery), 601		20—40		
English: effective writing and speaking, E31		20—40		
AT M. I. T.				
Applied Mechanics, 221			30—60	
Electrical Engineering (Alternating Currents), 602			20—40	
Electrical Engineering Laboratory, 675			60	
Heat Engineering, 250			30—60	
Mathematics, M35,			30—60	
Political Economy, Ec31			30—30	
Surveying 102a			30—0	
Vacation, March 20-April 13 inclusive.				
AT WORKS				
Drafting, Designing and Meter Testing	Daily			
Lectures on Manufacturing Methods				
Electrical Engineering (Alternating Current Machinery), 603				20—40
General Study				20—40

COURSE VI-A — *Continued*

GROUP B (FOR YEAR 1920-1921)

THIRD YEAR

	Summer Term July 6-Oct. 2	First Term Oct. 4-Dec. 22	Second Term Jan. 3-Apr. 2	Third Term Apr. 4-Jn. 18
AT WORKS				
Machine shop training room, assembling and inspecting	Daily	.. ..	.. ..	.. ..
Lectures on Manufacturing Methods		.. ..	.. ..	.. ..
Electrical Engineering (Direct Current Machinery), 601	20—40	.. ..	.. ..	.. ..
English: effective writing and speaking, E31	20—40	.. ..	.. ..	.. ..
AT M.I.T.				
Principles of Electrical Engineering, Direct Current Machinery and Alternating Currents, 601, 602	.. ..	20—40	.. ..	.. ..
Applied Mechanics, 221	.. ..	30—60	.. ..	.. ..
Political Economy, Ec31	.. ..	30—30	.. ..	.. ..
Heat Engineering, 250	.. ..	30—60	.. ..	.. ..
Mathematics, M35	.. ..	30—60	.. ..	.. ..
Electrical Engineering Laboratory, 675	.. ..	60	.. ..	.. ..
Surveying 102a	.. ..	30—0	.. ..	.. ..
Vacation, December 23-January 3 inclusive.				
AT WORKS				
Winding, Insulating and Drafting	Daily	.. ..	.. ..	.. ..
Lectures on Manufacturing Methods	.. ..	.. ..	.. ..	.. ..
Electrical Engineering (Alternating Currents), 602	.. ..	.. ..	20—40	.. ..
English: effective writing and speaking	.. ..	.. ..	20—40	.. ..
AT M.I.T.				
Principles of Electrical Engineering, Alternating Current Machinery, 603	.. ..	.. ..	.. ..	40—60
Electrical Engineering Laboratory, 676	.. ..	.. ..	.. ..	90
Applied Mechanics, 222	.. ..	.. ..	.. ..	30—50
Heat Engineering, 251	.. ..	.. ..	.. ..	30—60
Political Economy, Ec31	.. ..	.. ..	.. ..	30—30
General Study	.. ..	.. ..	.. ..	30—30
Vacation, June 19-July 4 inclusive.				

COURSE VI-A—*Continued*

GROUP A (FOR YEAR 1920-1921)

FOURTH YEAR

	Summer Term July 6-Sept. 18 *	First Term Oct. 4-Jan. 1 **	Second Term Jan. 3-Mar. 19 ***	Third Term Apr. 4-July 2
AT M. I. T.				
Applied Mechanics, 222	30—50	.. ..	.. ..	.. ..
Electrical Engineering, Principles of (Var. and Alt. Currents), 602	40—60	.. ..	.. ..	.. ..
Electrical Engineering Laboratory, 676	90	.. ..	.. ..	.. ..
Heat Engineering, 251	30—60	.. ..	.. ..	.. ..
Political Economy, Ec31	30—30	.. ..	.. ..	.. ..
General Study	30—30	.. ..	.. ..	.. ..
*Vacation September 19—October 3 inclusive.				
AT WORKS				
Drafting, Designing and Meter Testing		Daily (44 hours per week)		
Lectures on Manufacturing Methods	.. ..		.. ..	.. ..
Electrical Engineering, Principles of (Alt. Cur.), 602	.. ..	20—40	.. ..	.. ..
General Study	.. ..	20—40	.. ..	.. ..
**Christmas recess December 24—26 inclusive.				
AT M. I. T.				
Electrical Engineering, Principles of (Alt. Cur. Mach.) 603	.. ..	.. ..	60—80	.. ..
Electrical Engineering Laboratory, 677	.. ..	.. ..	50	.. ..
Heat Engineering, 252	.. ..	.. ..	30—60	.. ..
Political Economy, Ec31	.. ..	..	30—30	.. ..
Stationary Structures, 144	.. ..	.. ..	30—50	.. ..
General Study	.. ..	.. ..	30—30	.. ..
***Vacation March 20—April 3 inclusive.				
AT WORKS				
Motor, Transformer and Turbine Testing				Daily (48 hours per week)
Lectures on Manufacturing Methods	.. ..	.. ..	.. ..	.. ..
Electrical Engineering, Principles of (Alt. Cur. Mach.), 604	.. ..	.. ..	.. ..	20—40
General Study	.. ..	.. ..	.. ..	20—40

COURSE VI-A — *Continued*

GROUP B (FOR YEAR 1920-1921)

FOURTH YEAR

	Summer Term July 6-Oct. 2	First Term Oct. 4-Dec. 18 †	Second Term Jan. 3-Apr. 2	Third Term Apr. 4-June 18 ‡
AT WORKS				
Winding, Insulating and Drafting	Daily (44 hours per week)			
Lectures on Manufacturing Methods.				
Electrical Engineering, Principles of (Alt.Cur. Mach.), 603	20—40			
English (effective speaking and writing)	20—40			
AT M. I. T.				
Electrical Engineering, Principles of (Alt. Cur. Mach.) 603		60—80		
Electrical Engineering Laboratory, 677		50		
Heat Engineering, 252		30—60		
Political Economy, Ec31		30—30		
Stationary Structures, 144		30—50		
General Study		30—30		

† Vacation December 19—January 2 inclusive.

AT WORKS				
Drafting, Designing and Meter Testing			Daily (18 hours per week)	
Lectures on Manufacturing Methods.				
Electrical Engineering (Alt. Cur. Mach.), 604			20—40	
General Study			20—40	
AT M. I. T.				
Electrical Engineering, Principles of (Alt. Cur. Mach.) 604				60—80
Electrical Engineering Laboratory, 678				50
Hydraulics, 165				40—80
Materials of Electrical Engineering, 231				20—20
Mechanical Engineering Laboratory, 260b				40—30
General Study				30—30

‡ Vacation, June 10—July 4 inclusive.

COURSE VI-A — *Continued*

FIFTH YEAR

GROUP A (FOR YEAR 1921-1922)

	Summer Term	First Term	Second Term	Third Term
AT M. I. T.	July 6-Sept. 17	Oct. 2-Dec. 31	Jan. 2-Mar. 18	Apr. 3-June 6
		*	**	***
Electrical Engineering, Principles of (High Volt. Trans of Power), 605	60—80	.. ..	.. ..	.. ..
Electrical Engineering Laboratory, 678	50	.. ..	.. ..	.. ..
Engineering Laboratory, 260b	40—30	.. ..	.. ..	.. ..
Hydraulics, 165	40—80	.. ..	.. ..	.. ..
Materials of Electrical Engineering, 231	20—20	.. ..	.. ..	.. ..
General Study	30—30	.. ..	.. ..	.. ..
* Vacation, September 18—October 1 inclusive.				
AT WORKS				
Engineering and Research Assignments at Lynn and Schenectady		Daily (44 hours per week)		
Lectures on Manufacturing Methods.				
Electrical Engineering, Advanced Course	.. ..	30—60	.. ..	.. ..
** Christmas recess December 24—December 31 inclusive.				
AT M. I. T.				
Electrical Engineering, Principles of, Adv. course	.. ..	.. ..	60—80	.. ..
Graduate Courses and Research	.. ..	.. ..	360	.. ..
*** Vacation, March 19—April 2 inclusive.				
AT M. I. T.				
General Study (Business Law and Organization)	.. ..	.. ..	.. ..	40—80
Seminar, Research and Thesis	.. ..	.. ..	.. ..	360
††				

GROUP B (FOR YEAR 1921-1922)

	Summer Term	First Term	Second Term	Third Term
AT WORKS	July 5-Oct. 1	Oct 2-Dec. 17	Jan. 2-Apr. 1	Apr. 3-June 6
		‡		
Motor, Transformer and Turbine Testing	Daily (48 hours per week)			
Lectures on Manufacturing Methods.				
Electrical Engineering, Prin. of (High Volt. Trans. of Power), 605	20—40	.. ..	.. ..	.. ..
General Study	20—40	.. ..	.. ..	.. ..
AT M. I. T.				
Electrical Engineering, Principles of, Advanced Course	.. ..	60—80	.. ..	.. ..
Graduate Courses and Research	.. ..	3 [illegible]	.. ..	.. ..
‡ Vacation, December 18—January 1.				
AT WORKS				
Engineering and Research Assignments at Lynn and Schenectady			Daily (44 hours per week)	
Lectures on Manufacturing Methods.				
Electrical Engineering, Advanced Course	.. ..	.. ..	30 — 60	.. ..
AT M. I. T.				
General Study (Business Law and Organization)	.. ..	.. ..	.. ..	40—80
Seminar, Research and Thesis	.. ..	.. ..	.. ..	360
††				

††The prescribed course is here completed with conferring of Masters' Degrees at Commencement Exercises of the Institute on June 9.

Opportunity for an additional (optional) summer term of Engineering and Research and Research Assignments at the Works will be open to those students who desire to elect it.

Biology and Public Health — COURSE VII.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Biology, General, 701	.. ..	.. ..	140 — 60
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
French or German	30 — 30	30 — 30	30 — 30
Mathematics, M21, 22	30 — 60	30 — 60	.. ..
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Qualitative Analysis, 510	130 — 20	.. ..	.. ..
Quantitative Analysis, 512a	.. ..	140 — 10	.. ..
Water Supplies and Air, 520	.. ..	.. ..	40 — 0
Hours of exercises and preparation:	500 = 290 + 210	500 = 300 + 200	500 = 310 + 190

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Anatomy and Histology, 710	80 — 40	70 — 30	70 — 40
Anthropology, 715	20 — 30	.. ..	.. ..
Bacteriology, 730	80 — 50	50 — 30	20 — 10
Chemistry of Food, 525	.. ..	50 — 10	.. ..
Organic Chemistry, 550	30 — 30	.. ..	.. ..
Organic Chemical Laboratory, 556b	.. ..	.. ..	100 — 0
Physiology, 720	.. ..	60 — 60	60 — 60
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 270 + 210	480 = 290 + 190	480 = 310 + 170

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Biochemistry, 527	30 — 50	.. ..	.. ..
Biological Colloquium, 780	10 — 10	10 — 10	10 — 10
Biology of Infectious Diseases, 750	.. ..	20 — 30	20 — 30
Biology, Theoretical, 703	20 — 20	20 — 20	20 — 30
Parasitology, 707	10 — 20	10 — 20	10 — 20
Personal Hygiene, 722	30 — 30	.. ..	.. ..
Public Health Laboratory Methods, 738	.. ..	60 — 20	60 — 20
Sanitary Science and Public Health, 756	.. ..	.. ..	20 — 0
Vital Statistics, 758	20 — 40	.. ..	.. ..
General Study	30 — 30	.. ..	.. ..
Hours of exercises and preparation:	150 + 200	120 + 100	140 + 110
Option 1. General Biology			
Genetics, 704	30 — 60	.. ..	.. ..
Paleontology, 1251a	20 — 20	40 — 20	40 — 20
Thermochemistry and Chemical Equilibrium, 568	.. ..	.. ..	30 — 60
	200 + 280	160 + 120	210 + 190
Thesis	.. ..	200	80
Hours of exercises and preparation:	480	480	480

Biology and Public Health — COURSE VII.—*Continued*

Option 2. Industrial Biology

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Industrial Hygiene and Sanitation, 753	.. ..	30 — 30	.. ..
Industrial Microbiology, 736	60 — 20	80 — 30	80 — 20
Optical Meth. in Chem. Analysis, 529	30 — 20	.. ..	.. ..
	240 + 240	230 + 160	220 + 130
Thesis	.. ..	90	130
Hours of exercises and preparation:	480	480	480

Option 3. Public Health

Industrial Hygiene and Sanitation, 753	.. ..	30 — 30	.. ..
Industrial Microbiology, 736	60 — 20	.. ..	.. ..
Municipal Sanitation, 764	20 — 30	20 — 30	.. ..
Problems and Practice in Public Health, 754	.. ..	30 — 30	30 — 30
	230 + 250	200 + 190	170 + 140
Thesis	.. ..	90	170
Hours of exercises and preparation:	480	480	480

Physics — COURSE VIII.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism, 202	30 — 60	.. ..	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physical Instruments, 809	.. ..	.. ..	40 — 20
Physical Literature, 810	.. ..	20 — 40	20 — 40
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Qualitative Analysis, 510	100 — 20	.. ..	.. ..
Quantitative Analysis, 512a	.. ..	140 — 10	.. ..
Hours of exercises and preparation:	500 = 260 + 240	500 = 290 + 210	500 = 220 + 280

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221a	30 — 60	.. ..	.. ..
Electrical Engineering, Elem. of, 640	30 — 45	.. ..	.. ..
Electrical Engineering Laboratory, 685	.. ..	30 — 40	.. ..
Electricity, 820	.. ..	50 — 50	50 — 40
Heat Measurements, 811	.. ..	.. ..	50 — 40
Optics and Laboratory, 817, 818	.. ..	40 — 60	60 — 30
Photography, 816	60 — 30	.. ..	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Technical Electrical Measurements, 690	30 — 45	.. ..	.. ..
Theoretical Physics, 823	30 — 60	30 — 60	30 — 60
General Study	.. ..	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 210 + 270	480 = 210 + 270	480 = 250 + 230

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electric Furnaces, 889	.. ..	40 — 20	.. ..
Electrochemistry, Principles of, 880, 880, 881	40 — 70	30 — 60	20 — 40
Mathematics M36, 38, 39	30 — 60	30 — 60	30 — 60
Metallography I, 541	.. ..	.. ..	40 — 20
Organic Chemistry, 550	30 — 30	.. ..	.. ..
General Study	30 — 30	.. ..	30 — 30
	130 + 190	100 + 140	120 + 150
Thesis	.. 30	.. 110	.. 120
Elective*	.. 90	.. 90	.. 90
Option 1. Microscopic Analysis, 1221	20 — 20	20 — 20	.. ..
Option 2. Theory of Probability M26	20 — 20	20 — 20	.. ..
Hours of exercises and preparation:	480	480	480

*German or French, Heat Engineering, Aeronautics, Chemical Engineering, Industrial Chemistry, Organic Chemistry Laboratory, Advanced Mathematics, Theoretical Physics, Experimental Physics, etc.

General Science — COURSE IX-A.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Biology, General, and Bacteriology, 729	.. ..	.. ..	70 — 60
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Language	30 — 50	30 — 50	30 — 50
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Qualitative Analysis, 510	110 — 20	.. ..	.. ..
Quantitative Analysis, 512a	.. ..	120 — 10	.. ..
Hours of exercises and preparation:	500 = 270 + 230	500 = 280 + 220	500 = 230 + 270

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Anatomy and Histology, 710	70 — 40	.. ..	.. ..
Geology, 1230	30 — 30	.. ..	.. ..
Geology, 1231	.. ..	30 — 30	.. ..
Geology, 1232	.. ..	.. ..	30 — 20
Mineralogy, 1201, 1202	60 — 10	40 — 20	.. ..
Organic Chemistry, 550	30 — 30	.. ..	.. ..
Organic Chemistry Laboratory, 556	.. ..	60 — 0	.. ..
Organic Evolution, 1254	.. ..	.. ..	30 — 30
Physical Instruments, 809	.. ..	.. ..	40 — 20
Physiology, 720	.. ..	60 — 60	50 — 50
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Thermochemistry and Ch. Equil., 508	.. ..	.. ..	30 — 60
General Study	30 — 30	30 — 30	30 — 30
Elective	30 — 30	30 — 30	.. ..
Hours of exercises and preparation:	480 = 280 + 200	480 = 280 + 200	480 = 240 + 240

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Elective and Thesis	330	330	330
Theoretical Physics, 823	30 — 60	30 — 60	30 — 60
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480	480	480

General Engineering—COURSE IX-B.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
Astronomy, 112	.. ..	30 — 30	.. ..
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Foundry, 283a	40 — 0	.. ..	.. ..
Machine Drawing, 212	.. ..	60 — 0	.. ..
Map Reading and Topographical Drawing 119	.. ..	30 — 0	.. ..
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanical Engineering Drawing, 210	60 — 0	.. ..	.. ..
Mechanism, 202	30 — 50	.. ..	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Spherical Trigonometry, 111	10 — 20	.. ..	.. ..
Surveying and Plotting, 100	.. ..	20 — 40	30 — 30
Vise, Bench and Machine Tool Work, 295b	.. ..	.. ..	60 — 0
Hours of exercises and preparation:	500 = 270 + 230	500 = 270 + 230	500 = 250 + 250

Optional Summer School in Surveying, Mechanical, Electrical or Chemical Subjects.

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221, 222	30 — 60	30 — 60	.. ..
Electrical Engineering, Elements of, 641, 642	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory, 685	.. ..	.. ..	30 — 40
Heat Engineering { 240, 242	30 — 60	30 — 60	.. ..
Heat Engineering { 241, 243	20 — 20	20 — 20	.. ..
Hydraulics, 164	.. ..	.. ..	30 — 50
Materials of Engineering, 230	.. ..	20 — 20	20 — 20
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Structures, 140	.. ..	.. ..	40 — 80
General Study	30 — 30	.. ..	.. ..
Options	65	85	110
Hours of exercises and preparation:	480 = 235 + 245	480 = 245 + 235	480 = 260 + 220

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Aeronautics, 825	30 — 60	30 — 60	30 — 60
Engineering Laboratory, 260	40 — 20	.. ..	.. ..
Heat Measurements	40 — 20	.. ..	.. ..
Mathematical Laboratory, M54	.. ..	20 — 40	20 — 40
Testing Materials Laboratory, 235, 235	20 — 10	20 — 10	.. ..
Professional Options and Thesis	180	240	270
General Study	30 — 30	30 — 30	30 — 0
Hours of exercises and preparation:	480 = 340 + 140	480 = 340 + 140	480 = 350 + 130

The Committee in charge of the Course may allow some substitution of suitable subjects for those above listed.

Chemical Engineering — COURSE X.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99
Summer School following First Year. Qualitative Analysis, 510 210—30

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
German, L21	30 — 50	30 — 50	30 — 50
Mathematics, M21, 22	30 — 60	30 — 60	.. ..
Mechanism, 203, 203	.. ..	20 — 25	20 — 25
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Problems of the Chemical Engineer, 586	10 — 0	.. ..	.. ..
Quantitative Analysis, 512a, 512b, 513	100 — 20	75 — 10	75 — 10
Hours of exercises and preparation:	500 = 270 + 230	500 = 255 + 215	500 = 255 + 245

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221, 222	30 — 60	30 — 60	.. ..
Chemical Principles I, 565 . . . Lecture	10 — 10	10 — 10	10 — 10
Laboratory	12 — 18	12 — 18	12 — 18
Recitation	30 — 30	30 — 30	30 — 30
Electrical Engineering, Elements of, 640	.. ..	.. ..	30 — 40
German, L31	30 — 30	.. ..	.. ..
Heat Engineering, { 240, 242	.. ..	30 — 60	30 — 60
{ 241a	.. ..	.. ..	20 — 20
Machine Drawing, 214	.. ..	.. ..	60 — 0
Organic Chemistry I, 551	40 — 30	40 — 30	30 — 20
Organic Chemistry Laboratory, 556a	90 — 0	60 — 0	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 272 + 208	480 = 242 + 238	480 = 252 + 228

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mathematics M41	30 — 60	.. ..	.. ..
Chemical Engineering, I, 576	40 — 55	40 — 60	40 — 60
Chemical Principles II, 567	30 — 45	.. ..	.. ..
Electrical Engineering Laboratory, 685	30 — 40	.. ..	.. ..
Engineering Laboratory, 260, 261b	40 — 20	20 — 10	.. ..
Experimental Problems in Ind. Chem., 587	.. ..	100 — 35	.. ..
Foundry, 283	30 — 0	.. ..	.. ..
Industrial Chemistry, 575	30 — 30	30 — 30	.. ..
Inorganic Chemistry, 505	.. ..	.. ..	30 — 45
Machine Tool Work, 297	.. ..	.. ..	30 — 0
Testing Materials Laboratory, 236	.. ..	20 — 10	.. ..
Thesis Report and Memoirs, 596	.. ..	.. ..	30 — 10
Thesis	.. ..	35 — 0	175 — 0
Vise, Bench and Machine Tool Work, 295	.. ..	30 — 0	.. ..
General Studies	.. ..	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 230 + 250	480 = 305 + 175	480 = 335 + 145

Students offering Elementary and Advanced French upon entrance will take German as shown in the Course Scheme.

Students offering Elementary and Advanced German upon entrance will take Elementary French in the second year in place of the German appearing in the Course Scheme. This course will include Technical French in the third period.

Students offering Elementary French and Elementary German will, in the second year, take Technical French the first term, and the last two terms take Intermediate German.

Students desiring to enter X-A must indicate their intention not later than the end of the first term of the fourth year. If accepted, these students will omit Experimental Problems in Industrial Chemistry during the last two terms of the fourth year, and instead may take as optional subjects any professional courses offered during those two terms for which they have the necessary preparation.

Sanitary Engineering—COURSE XI.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
Descriptive Geometry, D21	.. ..	50 — 0	.. ..
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Map Reading and Topographical Drawing 119	.. ..	30 — 0	.. ..
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism, 202	30 — 45	.. ..	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Qualitative Analysis, 510	120 — 15	.. ..	.. ..
Quantitative Analysis, 512a, 512a	.. ..	50 — 20	50 — 10
Surveying and Plotting, 100	.. ..	20 — 40	30 — 30
Hours of exercises and preparation:	500 = 280 + 220	500 = 280 + 220	500 = 240 + 260

REQUIRED SUMMER COURSE

Surveying Camp

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221, 222a, 222a	30 — 60	20 — 30	20 — 30
Bacteriology, Elements of, 731	.. ..	50 — 10	.. ..
Biology, Elements of, 702	20 — 10	.. ..	.. ..
Geology, 1230a, 1231a, 1232a	30 — 20	40 — 25	30 — 30
Industrial Water Analysis, 521	.. ..	30 — 0	.. ..
Materials, 143	.. ..	.. ..	20 — 40
Organic Chemical Laboratory, 556b	.. ..	.. ..	60 — 0
Organic Chemistry, 550	30 — 30	.. ..	.. ..
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Railway Drafting, 123	70 — 0	50 — 0	.. ..
Railway and Highway Engineering, 121	20 — 40	20 — 25	.. ..
Roads and Pavements, 130	.. ..	.. ..	20 — 20
Structures, 141	.. ..	20 — 40	20 — 40
Testing Materials Laboratory, 230	.. ..	.. ..	20 — 10
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 260 + 220	480 = 290 + 190	480 = 250 + 230

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Bacteriology of Water and Sewage, 732	.. ..	30 — 10	.. ..
Engineering and Hydraulic Laboratory, 264	.. ..	30 — 30	.. ..
Heat Engineering, 246, 247, 248	30 — 60	30 — 60	30 — 30
Hydraulic and Sanitary Design, 180	.. ..	20 — 0	60 — 0
Hydraulics, 162	40 — 80	.. ..	.. ..
Microscopy of Drinking Waters, 706	.. ..	.. ..	20 — 20
Sanitary Science and Public Health, 756	.. ..	.. ..	20 — 10
Sanitary Engineering, 177	20 — 40	20 — 40	40 — 80
Structural Design, 151	.. ..	40 — 0	20 — 0
Structures, 150	40 — 80	30 — 60	20 — 40
Vital Statistics, 758	20 — 20	.. ..	.. ..
Water Supply and Wastes Disposal, 522	30 — 20	.. ..	.. ..
Thesis	.. ..	20 — 0	100 — 0
General Study	.. ..	30 — 30	.. ..
Hours of exercises and preparation:	480 = 180 + 300	480 = 250 + 230	480 = 310 + 170

Geology and Geological Engineering — COURSE XII.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Fire Assaying, 331a	.. ..	.. ..	50 — 10
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Mineralogy, 1201, 1202	80 — 10	80 — 10	.. ..
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Qualitative Analysis, 510	100 — 20	.. ..	.. ..
Quantitative Analysis, 512a, 512b	.. ..	110 — 10	120 — 20
Hours of exercises and preparation:	500 = 310 + 190	500 = 320 + 180	490 = 300 + 190

REQUIRED SUMMER COURSE

Surveying Camp

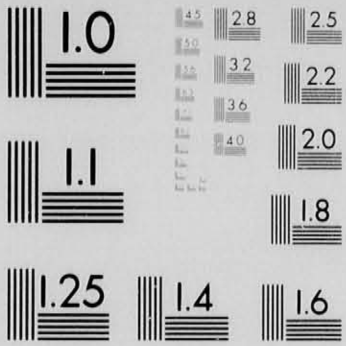
THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Geology, 1230, 1231, 1232	30 — 30	30 — 30	30 — 30
Language	30 — 50	30 — 50	30 — 50
Paleontology, 1251	30 — 40	30 — 40	.. ..
Petrography, 1215	40 — 20	40 — 20	60 — 40
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
General Study	30 — 30	30 — 30	30 — 30
*Professional Options	90 — 0	90 — 0	120 — ..
Hours of exercises and preparation:	480 = 280 + 200	480 = 280 + 200	480 = 300 + 180

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Economic Geology, 1242	.. ..	.. ..	20 — 20
Economic Geology, 1240, 1241	.. ..	50 — 40	60 — 30
Geological Seminar, 1262	30 — 60	30 — 60	.. ..
Geological Surveying, 1231a	.. — ..	.. — ..	80 — 30
Geology, Field, 1233	40 — 20	.. ..	.. ..
Index Fossils, 1253	60 — 30	.. ..	.. ..
Thesis and Professional Option	240	240	240
General Option	.. ..	30 — 30	.. ..
Hours of exercises and preparation:	480 = 370 + 110	480 = 350 + 130	480 = 400 + 80

*Professional Options may be chosen in Metallurgy, Mining, Physiography, Paleontology, Advanced Mineralogy, or Petrology, Geology of Coal and Petroleum, etc.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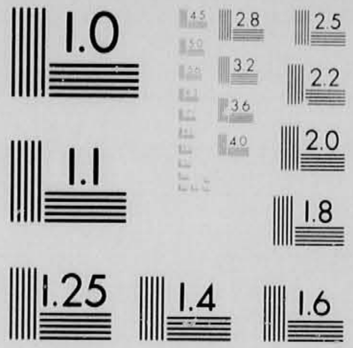
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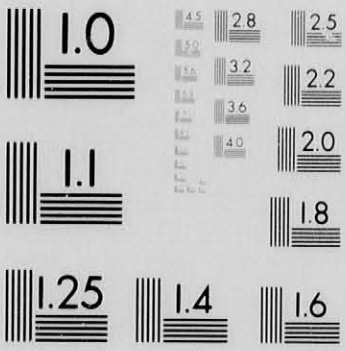
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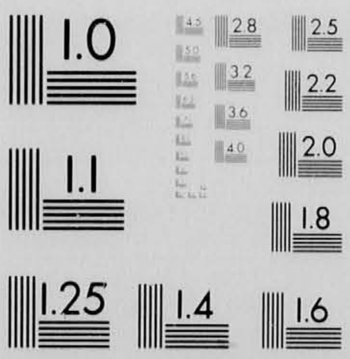
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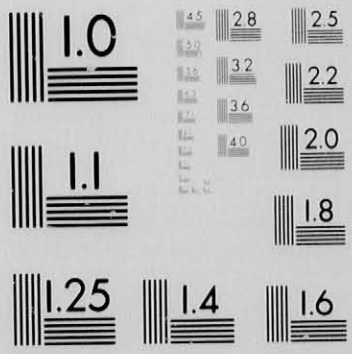
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Naval Architecture—COURSE XIII.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220	.. ..	.. ..	30 — 60
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Forging, 280	.. ..	60 — 0	.. ..
Foundry, 282	60 — 0	.. ..	.. ..
Machine Drawing, 212	.. ..	60 — 0	.. ..
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanical Engineering Drawing, 210	60 — 0	.. ..	.. ..
Mechanism, 200, 201	30 — 60	30 — 60	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Ship Construction, 1331	.. ..	.. ..	20 — 20
Ship Drawing, 1341	.. ..	.. ..	60 — 0
Surveying Instruments, 101	.. ..	.. ..	20 — 0
Hours of exercises and preparation:	500 = 280 + 220	500 = 280 + 220	500 = 260 + 240

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221, 222, 223a	30 — 60	30 — 60	30 — 60
Engineering Laboratory, 260	.. ..	.. ..	40 — 20
Heating Engineering { 240, 242	30 — 60	30 — 60	.. ..
Heating Engineering { 241a	20 — 20	.. ..	.. ..
Machine Tool Work, 288, 290	.. ..	40 — 0	40 — 0
Naval Architecture, 1301	20 — 30	20 — 40	20 — 40
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Ship Construction, 1332	.. ..	10 — 10	20 — 20
Ship Drawing, 1342	50 — 0	60 — 0	70 — 0
Vise and Bench Work, 286	40 — 0	.. ..	.. ..
General Study	30 — 30	30 — 30	30 — 30
Hours of exercises and preparation:	480 = 250 + 230	480 = 250 + 230	480 = 280 + 200

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Chemistry, 534a	20 — 20	.. ..	.. ..
Electrical Engin., Elem. of, 640	.. ..	.. ..	30 — 60
Engineering Laboratory, 261a, 261a	20 — 20	20 — 20	.. ..
Hydraulics, 163	.. ..	20 — 40	.. ..
Machine Tool Work, 292	30 — 0	.. ..	.. ..
Marine Engineering, 1351	.. ..	20 — 40	20 — 30
Marine Engine Design, 1352	.. ..	60 — 0	50 — 0
Materials of Engineering, 230	.. ..	20 — 20	20 — 20
Naval Architecture, 1302	20 — 40	30 — 60	.. ..
Ship Construction, 1333	20 — 20	20 — 20	20 — 20
Ship Drawing, 1343	75 — 0	90 — 0	60 — 0
Shipyard Org. and Management, 1315	.. ..	.. ..	20 — 20
Steam Turbines, 1360	30 — 60	.. ..	.. ..
Testing Materials Laboratory, 237	30 — 15	.. ..	.. ..
Thesis	.. ..	.. ..	110 — 0
General Study	30 — 30	.. ..	.. ..
Hours of exercises and preparation:	480 = 275 + 205	480 = 280 + 200	480 = 330 + 150

Electrochemical Engineering — COURSE XIV.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99
Summer School following First Year
Qualitative Analysis, 510, 190—30. Mechanism, 202a 35—55

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Electrical Engineering, Principles of, 600	.. ..	.. ..	50 — 60
English and History, EH21, EH22, EH2	30 — 50	30 — 50	30 — 50
Language†	30 — 50	30 — 50	30 — 50
Machine Tool Work, 291, 291a	.. ..	20 — 0	20 — 0
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Quantitative Analysis, 512a, 512b	90 — 20	90 — 20	.. ..
Vise and Bench Work, 287a	20 — 0	.. ..	.. ..
Hours of exercises and preparation:	500 = 270 + 230	500 = 270 + 230	500 = 230 + 270

†Students offering Elementary and Intermediate French upon entrance will take German. Students offering Elementary and Intermediate German upon entrance will take French. Students offering Elementary French and Elementary German upon entrance will take Technical French the first term, and Intermediate German the second and third terms.

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220, 221a	30 — 60	30 — 60	.. ..
Electrochemistry, Principles of, 880	40 — 70	30 — 60	30 — 60
Electrical Eng., Prin. of, 601, 602, 603a	40 — 60	40 — 60	40 — 60
Electrical Eng. Lab., 681, 682, 683	30 — 30	20 — 20	35 — 25
Heat Engineering, 243, 241	.. ..	20 — 20	20 — 20
Heat Measurements	.. ..	.. ..	30 — 10
Organic Chemistry, 550	30 — 30	.. ..	.. ..
Organic Chemistry Laboratory, 556b	.. ..	.. ..	60 — 0
Political Economy, Ec31	30 — 30	30 — 30	30 — 30
Testing Materials Laboratory, 236	.. ..	.. ..	20 — 10
General Study	.. ..	30 — 30	.. ..
Hours of exercises and preparation:	480 = 200 + 280	480 = 200 + 280	480 = 265 + 215

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Electrochemical Laboratory, 887	.. ..	70 — 0	.. ..
Applied Electrochemistry, 885	.. ..	30 — 60	10 — 50
Colloquium, 893	.. ..	10 — 10	10 — 10
Electrical Engineering, Principles of, 604a	50 — 70	.. ..	.. ..
Electrical Engineering Laboratory, 684	35 — 25	.. ..	.. ..
Electrochemical Laboratory, 886	70 — 0	.. ..	.. ..
Electrochemistry II, 882	30 — 60	.. ..	.. ..
Industrial Chemistry, 575	30 — 30	30 — 30	.. ..
Metallography I, 541	.. ..	.. ..	40 — 20
Thesis *	.. ..	60 — 0	180 — 0
Optional Studies**	80	180	160
Hours of exercises and preparation:	480	480	480

* Time subject to adjustment with optional studies with approval of Department.
** Time varies as to exercises and preparation.

Optional Studies:			
Assaying and Metallurgical Laboratory, 332	60 — 20	.. ..	.. ..
Chemical Engineering I, 576	30 — 30	30 — 60	30 — 60
Electrical Engineering (Professional Options in Electrical Engineering)	.. ..	30 — 60	30 — 60
Industrial Chemistry Laboratory	80 — ..	.. ..	.. ..
General Study (must be taken during one term)	30 — 30	30 — 30	30 — 30

Engineering Administration — COURSE XV.

First Year, Page 4. Description of Subjects of Instruction, Pages 33-99

OPTION 1. Civil Engineering

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting, Ec50	40 — 50	.. ..	.. ..
Applied Mechanics, 220	.. ..	.. ..	30 — 60
Astronomy, 112	.. ..	30 — 30	.. ..
Descriptive Geometry, D21	45 — 0	.. ..	.. ..
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism, 202	30 — 45	.. ..	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Political Economy, Ec22	.. ..	30 — 30	30 — 30
Spherical Trigonometry, 111	.. ..	10 — 20	.. ..
Surveying and Plotting, 100	.. ..	20 — 40	30 — 30
Hours of exercises and preparation:	500 = 245 + 255	500 = 220 + 280	500 = 220 + 280

REQUIRED SUMMER COURSE

Surveying Camp

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221, 222a., 222a	30 — 60	20 — 30	20 — 30
Banking, Ec37	30 — 50	.. ..	.. ..
Electrical Engineering, Elem. of, 640	30 — 40	.. ..	.. ..
Electrical Engineering Laboratory, 686	.. ..	.. ..	20 — 30
English, E32	.. ..	30 — 60	.. ..
Heat Engineering, 246, 247, 248	30 — 60	30 — 60	30 — 30
Industrial Organization, Ec56	30 — 60	30 — 60	.. ..
Industrial Relations, Ec46	.. ..	.. ..	30 — 45
Materials, 143	.. ..	.. ..	20 — 40
Railway and Highway Engineering, 121	20 — 40	20 — 30	.. ..
Report Writing, E33	.. ..	30 — 30	.. ..
Securities and Investments, Ec38	.. ..	.. ..	30 — 40
Statistics, Ec35	.. ..	40 — 10	.. ..
Structures, 140	.. ..	.. ..	40 — 75
Hours of exercises and preparation:	480 = 170 + 310	480 = 200 + 280	480 = 190 + 290

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Business Law, Ec60	20 — 40	20 — 40	20 — 40
Business Management, Ec58	30 — 60	30 — 60	40 — 80
Cost Accounting, Ec51	.. ..	40 — 70	.. ..
Engineering and Hydraulic Lab., 264	.. ..	30 — 30	.. ..
Foundations, 148	10 — 15	.. ..	.. ..
Hydraulic Engineering, 169	.. ..	.. ..	30 — 60
Hydraulics, 162	40 — 70	.. ..	.. ..
Railway Engineering, 125	30 — 45	.. ..	.. ..
Sanitary Science and Public Health, 756	.. ..	.. ..	20 — 0
Structural Design, 154	.. ..	40 — 0	20 — 0
Structures, 150	40 — 80	30 — 60	20 — 40
Testing Materials Laboratory, 230	.. ..	20 — 10	.. ..
Thesis	.. ..	.. ..	110
Hours of exercises and preparation:	480 = 170 + 310	480 = 210 + 270	480 = 260 + 220

Engineering Administration — COURSE XV.

OPTION 2. Mechanical and Electrical Engineering

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting, Ec50	.. ..	.. ..	40 — 50
Applied Mechanics, 220	.. ..	.. ..	30 — 60
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
Machine Drawing, 212, 213	.. ..	60 — 0	30 — 0
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanical Engineering Drawing, 210	60 — 0	.. ..	.. ..
Mechanism, 200, 201	30 — 60	30 — 60	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Political Economy, Ec22	30 — 30	30 — 30	.. ..
Hours of exercises and preparation:	500 = 250 + 250	500 = 250 + 250	500 = 230 + 270

REQUIRED SUMMER COURSES

Foundry, Vise, Bench and Machine Tool Work, 296	75 — 0
Surveying, 100a	60 — 15

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 221, 222, 223	30 — 60	30 — 60	30 — 50
Banking, Ec37	30 — 50	.. ..	.. ..
Electrical Engineering, Elements of, 641	.. ..	.. ..	30 — 45
Engineering Laboratory, 260, 260	.. ..	20 — 10	20 — 10
English, E32	.. ..	30 — 60	.. ..
Heat Engineering 240, 242	30 — 60	30 — 60	.. ..
Heat Engineering 241, 243	20 — 20	20 — 20	.. ..
Hydraulics, 164	.. ..	.. ..	30 — 50
Industrial Organization, Ec56	30 — 60	30 — 60	.. ..
Industrial Relations, Ec46	.. ..	.. ..	30 — 50
Machine Tool Work, 237	30 — 0	.. ..	.. ..
Materials of Engineering, 230	.. ..	.. ..	20 — 40
Report Writing, E33	30 — 30	.. ..	.. ..
Securities and Investments, Ec38	.. ..	.. ..	30 — 40
Statistics, Ec65	.. ..	40 — 10	.. ..
Hours of exercises and preparation:	480 = 200 + 280	480 = 200 + 280	475 = 190 + 285

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Business Law, E-60	20 — 40	20 — 40	20 — 40
Business Management, Ec58	30 — 60	30 — 60	40 — 80
Central Stations, 623a	.. ..	.. ..	30 — 60
Cost Accounting, Ec51	.. ..	40 — 70	.. ..
Electrical Engineering, Elements of, 641, 642	30 — 45	30 — 45	.. ..
Electrical Engineering Laboratory, 685	.. ..	.. ..	30 — 40
Engineering Laboratory, 261, 262a	40 — 40	20 — 10	.. ..
Engineering Electives	.. ..	40 — 0	.. ..
General Engineering Lectures, 276	.. ..	10 — 5	.. ..
Hydraulic Engineering, 169	30 — 45	.. ..	.. ..
Machine Design, 270, 271	60 — 10	60 — 0	.. ..
Testing Materials Laboratory, 236	20 — 10	.. ..	.. ..
Thesis	.. ..	.. ..	140
Hours of exercises and preparation:	480 = 230 + 250	480 = 250 + 230	480 = 260 + 220

Engineering Administration — COURSE XV.

OPTION 3. Chemical Engineering

Summer following First Year. Qualitative Analysis, 510, 210—30

SECOND YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Accounting, Ec50	40 — 50	.. ..	.. ..
English and History, EH21, EH22, EH23	30 — 50	30 — 50	30 — 50
German, L21	30 — 30	30 — 30	30 — 30
Mathematics, M21, 22, 23	30 — 60	30 — 60	30 — 60
Mechanism, 202b	30 — 30	.. ..	.. ..
Military Science, 31, 32, 33	30 — 0	30 — 0	30 — 0
Physics, 802a, 803a, 803a	40 — 50	40 — 50	40 — 50
Political Economy, Ec22	.. ..	30 — 30	30 — 30
Quantitative Analysis, 512a, 512b	.. ..	80 — 10	80 — 10
Hours of exercises and preparation:	500 = 230 + 270	500 = 270 + 230	500 = 270 + 230

THIRD YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Applied Mechanics, 220, 221a	30 — 60	30 — 60	.. ..
Banking, Ec37	30 — 50	.. ..	.. ..
Electrical Engineering, Elements of, 6.0	.. ..	.. ..	30 — 60
English, E32	.. ..	30 — 60	.. ..
Heat Engineering, { 240, 242	.. ..	30 — 60	30 — 60
Heat Engineering, { 241a	.. ..	.. ..	20 — 20
Industrial Organization, Ec56	30 — 60	30 — 60	.. ..
Industrial Relations, Ec46	.. ..	.. ..	30 — 50
Machine Drawing, 214	.. ..	60 — 0	.. ..
Organic Chemistry Laboratory, 556b	.. ..	.. ..	110 — 0
Organic Chemistry, 550	30 — 30	.. ..	.. ..
Report Writing, E33	30 — 30	.. ..	.. ..
Securities and Investments, Ec38	.. ..	.. ..	30 — 40
Statistics, Ec65	.. ..	40 — 20	.. ..
Thermochemistry and Ch. Equil., 568	30 — 70	.. ..	.. ..
Hours of exercises and preparation:	480 = 180 + 300	470 = 220 + 260	480 = 250 + 230

FOURTH YEAR

	First Term 10 Weeks	Second Term 10 Weeks	Third Term 10 Weeks
Business Law, Ec60	20 — 40	20 — 40	20 — 40
Business Management, Ec58	30 — 60	30 — 60	40 — 80
Chemical Engineering, I, 576a	30 — 30	30 — 30	.. ..
Cost Accounting, Ec51	.. ..	40 — 70	.. ..
Economics of Chemical Industries, 588	.. ..	.. ..	30 — 45
Electrical Engineering Laboratory, 685	30 — 40	.. ..	.. ..
Engineering Laboratory, 260a	.. ..	.. ..	60 — 30
Exp. Problems in Industrial Chemistry, 587	110 — 20	.. ..	.. ..
Industrial Chemistry, 575	40 — 30	30 — 30	.. ..
Testing Materials Laboratory, 236	.. ..	20 — 10	.. ..
Thesis	.. ..	30	135
Vise, Bench, Machine Tool Work, 205a	.. ..	40 — 0	.. ..
Hours of exercises and preparation:	480 = 260 + 220	480 = 240 + 240	480 = 285 + 195

DESCRIPTION OF COURSES

DEPARTMENT OF PHYSICAL TRAINING

The gymnasium of the Institute is located on the third floor of the Walker Memorial Building fronting on the Esplanade, east of the educational buildings. This gymnasium affords ample accommodation for the training of classes in gymnastics and indoor games.

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 Athletic Field gives an opportunity for track-team contests and inter-class games. This field is provided with a quarter-mile running track, straight-away 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.

15. Physical Training. Four lectures on the relation of exercise to health and on personal hygiene are given to the first-year class at the beginning of the school year, and all first-year men take a physical examination during the first month from which anthropometric charts are plotted. The class is then divided into four sections for gymnastic exercise, each section having one hour a week of work for thirty weeks under the direction of the instructor. All students not specifically excused, a majority of whose work is in the first year, are required to take these lectures and exercises.

DEPARTMENT OF MILITARY SCIENCE AND TACTICS

In conformity with the requirements of the Acts of Congress* of July 22, 1862, and August 30, 1890, and Section 1225 of the Revised Statutes of the United States, as amended by Acts of Congress, approved November 3, 1893, and the Acts of the General Court of Massachusetts in furtherance thereof, the Institute provides instruction in Military Science and Tactics. In addition to the above, and under the provisions of an Act of Congress of June 3, 1916, and subsequent acts amendatory thereto, units of the Reserve Officers' Training Corps have been established.

Male students who take a majority of their studies in the first and second year, or either of these years, are required to satisfactorily complete the military requirements. Aliens, graduates of approved institutions and

*For the endowment, support and maintenance of at least one college whose leading object shall be, without excluding other scientific and classical studies, including military science, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the Legislature of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life. An officer of the regular army with the rank of professor has the work in charge. On the graduation of every class he is required by statute to obtain from the President and report to the Adjutant General of the Army the names of such students belonging to the class as have shown special aptitude for military service and to furnish a copy of this report to the Adjutant General of the State.

students found physically unfit when examined by a Medical Officer are exempt from this requirement. Special consideration may be extended to students who have had prolonged military service. Students desiring relief from any part of the military requirement should consult the Professor of Military Science and Tactics immediately upon registration. Excuses in writing will be issued to such students as are found to be entitled to exemption; no student will be considered relieved from the military requirement without written authority.

The great demand for technically trained officers in the more scientific branches of the Army was most evident during the recent war. The majority of the courses at the Institute, and the excellent facilities available in connection therewith, afford the student an admirable preparation for the scientific duties of an officer of a technical arm of the service. Accordingly, the military training prescribed at Technology is designed to impart the specialized knowledge most essential to so supplement the general technical education of the student as to render his services of the maximum value to the country in time of war as an officer of Coast Artillery, Engineers, Ordnance or Signal Corps.

Having satisfactorily completed the two-year compulsory course in military training, the student may elect either of the following options:

1. He may discontinue all further military work: or

2. He may volunteer to pursue the Advanced Course of the Reserve Officers' Training Corps. This binds him to attend one six-week camp during the period allotted to summer vacation between his junior and senior years. During the third and fourth academic years, he is required to attend certain additional military instruction. In recognition of his service, the Federal Government allows him commutation of subsistence (amounting at present to 40 cents per day) during his junior and senior years, including the vacation period which intervenes between them; transports him to and from the summer camp, and during the period while he is on duty thereat, feeds and clothes him, provides him with all books and equipment, and supplies quarters and medical attendance. Upon graduation from the Institute he is eligible to receive a Reserve commission in the United States Army, but continues in civil life, subject to call as an officer in time of war.

Under present conditions, students who elect to pursue the Advanced Course receive not only their complete support for one six-week period, but in addition are paid over $240 in cash. This is, in effect, a military scholarship, open to all students who are citizens of the United States, physically sound, have made a satisfactory record in their compulsory military training, and display such physical, mental and moral qualifications as, in the judgment of the Professor of Military Science, render them suitable candidates for a commission. The right is reserved to discharge from the Advanced Course any student who is guilty of misconduct, or whose work in any department of the Institute falls below standard, or who is found in any way unfit or unsuitable for the commission for which he is a candidate.

21. Freshman Military Science. (Required in all courses.) This course considers the organization of the Army, and the relation of the Reserve Officers' Training Corps thereto; the study of military customs, courtesy, discipline, uniforms and insignia, the construction and use of the arms and equipment of the soldier, the elements of infantry drill, and the principles of personal hygiene, first aid and sanitation.

22. Freshman Military Science. (Required in all courses.) This course embraces the principles of small arms firing, gallery practice, minor tactics, leadership, the transportation and supply of troops, liaison and systems of communication.

23. Freshman Military Science. (Required in all courses.) This course considers the following subjects: map problems, sanitation, mess management and care of troops, field engineering, military law, international law, and the rules of land warfare. This term's work, at the option of the Government, may consist of practical infantry training.

24. Advanced Coast Artillery (a). (Optional). This course extends throughout the junior year, and is required only of students who elect to pursue the Advanced Course for this arm. The amount of time required depends upon the course in which the student is registered. Students desiring information regarding this course should consult the Professor of Military Science and Tactics.

25. Advanced Coast Artillery (b). (Optional.) Except that this course is given in the senior year, the remarks under course 24 above apply to this course.

26. Advanced Engineer (a). (Optional.) See note under course 24, above.

27. Advanced Engineer (b). (Optional.) See note under courses 24 and 25 above.

28. Advanced Ordnance (a). (Optional.) See note under course 24, above.

29. Advanced Ordnance (b). (Optional.) See note under courses 24 and 25 above.

31. Sophomore Military Science. (Required in all courses.) This course includes study of the military policy and history of the United States, the relation of munition production to military needs, the functions and characteristics of the several arms of the service, and the study of general tactics.

32. Sophomore Military Science. (Required in all courses.) This course deals especially with the duties of engineers in combat service, including the construction of various types of field fortifications and such related duties as military mapping, etc.

33. Sophomore Military Science. (Required in all courses.) This course includes the principles of artillery gunnery, the study of trajectories, the methods employed in direct and indirect fire, at fixed and moving targets, the use of range tables, the construction and use of artillery pieces, carriages, ammunition, and instruments, and the effects of artillery fire.

DEPARTMENT OF CIVIL AND SANITARY ENGINEERING

The instruction in Civil and Sanitary Engineering is given by means of lectures and recitations, and by practice in the field, the drafting-room and the laboratory. The strictly professional work begins in the second year and includes a thorough classroom course in surveying, followed by field practice in the use of surveying instruments and by drafting-room work consisting of computations and the preparation and interpretation of maps and profiles. This work is preliminary to an extensive summer course in which thorough training is given in surveying and in railroad field work. Students in civil engineering also take astronomy, geodesy and stereotomy during this year, while the sanitary engineers have extended courses in qualitative and quantitative analysis; students in both courses also begin applied mechanics during this year.

In the third year the chief professional subjects for the civil engineers are railway and highway engineering and the theory of structures; students in both courses also complete during this year their formal instruction in applied mechanics and in materials. The sanitary engineers continue chemistry and begin subjects of biology and bacteriology, while the civil engineers are given a course of considerable length in electrical engineering.

In the fourth year the work is almost entirely professional and leads the student into various branches of engineering.

In all this work the object is to enable the student to apply intelligently to practical problems the principles that he has studied; to give power, to avoid rule-of-thumb methods, and to train the student to have courage and self-reliance in solving the problems that the engineer has to meet.

100. Surveying and Plotting. This course consists of a thorough classroom drill in the principles of surveying given in the second term; this is followed in the third term by fieldwork, accompanied by computations and the making of scaled drawings, profiles and contour maps, and the study of their application to the solution of engineering problems. Text-book: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

100a. Surveying and Plotting. This course, given in the summer between the second and third years, covers the same ground as course 100 somewhat more briefly.

101. Surveying Instruments. This brief course illustrates the use of the common forms of surveying instruments.

102. Surveying. The methods of using the compass and chain, the transit and tape, and the level, in making plane surveys, are explained by lectures and by field exercises. In the drafting-room the computations and drawings necessary to interpret surveying field notes are made.

102a. Surveying. This course is similar to course 102. It differs mainly in the specific problems taken up.

103. Surveying. At Camp Technology, East Machias, Maine. This course is given in the summer between second and third years; it consists of 240 hours, lectures, recitations, drafting and fieldwork. The field work consists of plane, topographic and elementary railroad surveying. Plans and maps will be made in the drafting-room from notes taken in the field. Text-book: *Breed and Hosmer's Principles and Practice of Surveying, Vols. I and II.*

104. Underground Surveying. This course of 120 hours, lectures, recitations, fieldwork and drafting immediately follows course 103 and is given at some mine. The fieldwork consists of mine surveying. The drafting-room work includes computations from original field notes and the drafting of mine plans. Text-book: *Breed and Hosmer's Principles and Practice of Surveying, Vols. I and II.*

107. Plane Surveying. At Camp Technology, East Machias, Maine. This course is given in the summer between second and third years; it consists of 100 hours, lectures, fieldwork, and drafting. The fieldwork consists in making surveys with the compass and chain and with the transit and tape, the running of profiles and cross-sectioning with the level, and in the astronomical determination of a meridian. 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. Text-book: *Breed and Hosmer's Principles and Practice of Surveying, Vol. I.*

108. Geodetic and Topographic Surveying. At Camp Technolo y, East Machias, Maine. This course is given in the summer between second and third years; it consists of 100 hours, lectures, fieldwork, computations, and drafting. The fieldwork consists of the measurement of a base line, triangulation, and the determination of position astronomically; the making of topographic surveys with the transit; 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. This course also includes trigonometric and

barometric leveling. The work in the drafting-room consists of making the computations and drawings necessary to interpret the results of the field observations. Text-books: *Breed and Hosmer's Principles and Practice of Surveying, Vol. II; Hosmer's Practical Astronomy.*

109. Geodetic Surveying. At Camp Technology, East Machias, Maine. This course is given in the summer between third and fourth years; it covers three weeks, 150 hours, of fieldwork and office work. This work consists of the measurement of a base line; triangulation with repeating and with direction instrument; precise and trigonometric leveling; observations for time, latitude and longitude with astronomical transit; and magnetic observations for declination, dip and intensity. Students will also be required to calibrate instruments and to determine constants.

This course is an elective for a limited number of students in Course I who have satisfactorily completed the third year.

111. Spherical Trigonometry. This course covers the demonstration and application of the formulas required for the solution of right and of oblique spherical triangles.

112. Astronomy. This course is intended to supplement Surveying 100 and the subject is therefore treated from the standpoint of the engineer. The fieldwork for this course is given at Camp Technology and includes the determination of latitude, longitude, time and azimuth with the engineer's transit. Text-book: *Hosmer's Practical Astronomy.*

113. Geodesy. In this course 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. Text-book, *Hosmer's Geodesy.*

114. Geodesy. This course includes the theory of higher geodesy, gravity measurements, astronomical observations, and the application of least squares to geodetic measurements. The principal part of the fieldwork corresponding with this course is given in course 109 — Geodetic Surveying — offered at Camp Technology. Text-books: *Helmert's Höhere Geodäsie; Jordan's Handbuch der Vernessungskunde.*

115. Navigation. The course covers such theory and practice of navigation as is required for examination for officers' licenses, and includes (1) use of compass, log and chart, (2) piloting, (3) dead-reckoning, (4) Mercator and Great-circle sailing, (5) observations for latitude, longitude and azimuth, and (6) Sumner's Method. Practice is given in making sextant observations. Text-book: *Bowditch's Navigator.*

119. Map Reading and Topographical Drawing. This course is devoted to the study of the different conventional signs employed in making topographical maps. Each student is required to make a number of plates, and to become reasonably proficient in the preparation of such maps. Particular attention is given to the reading of contour maps, and the solution of problems relating thereto.

120. Railway Fieldwork. At Camp Technology, East Machias, Maine. This course is given in the summer between second and third years; it consists of eighty hours classroom and fieldwork. A survey is made for a railroad about two miles in length. A reconnoissance is first made, followed by a preliminary survey including the necessary topography to permit of determining the position of the location line; the location line is then staked out. There is also a systematic drill in the laying out of curves by various methods, including the A. R. E. A. spirals, and in setting slope stakes for grading. Sufficient class work of an elementary character is given at the Camp to supplement the fieldwork. Text-books: *Allen's Railroad Curves and Earthwork; Allen's Field and Office Tables.*

121. Railway and Highway Engineering. This course consists of a thorough study of curves and earthwork. The first term is devoted to the mathematics of curves with applications to the location of railways, highways, sewers, pipe lines, etc. The second term is devoted principally to the methods of staking out and computing earthwork and masonry and to spirals, Y and connecting tracks. Recitation work predominates, particularly in the first term, and many problems are assigned for solution outside and in the classroom. The applications of this course are further developed by course 123. So much of this course as relates specifically to railways (twenty hours' class work in all) is omitted by students in Courses XI, XVI. Text-books: *Allen's Railroad Curves and Earthwork; Allen's Field and Office Tables.*

123. Railway Drafting. This course supplements the class work of course 121 and the fieldwork of course 120. From notes taken in the field at Camp Technology, a map and a profile of the preliminary survey for a railway are plotted and finished. Another problem consists of a careful study in the adjustment of a line of railway location upon a contour map, involving computation of the earthwork, and the preparation of a "mass diagram" for the determination of "haul" and of "borrow and waste." The detailed design of a standard turnout is also required in course I; the location of a reservoir, including an estimate of the quantities involved, is required in course XI.

125. Railway Engineering. The subjects treated include the following: maintenance of way and structures; yards and stations; interlocking and block signals; elimination of grade crossings; rolling stock, including tractive effort of locomotives, and mechanics and operation of brakes; the economics of railway engineering, with a critical study of train resistance, tonnage rating and the influences of grade, distance, curvature and rise and fall; I. C. C. accounting and public regulation. The object is to give the student a comprehensive knowledge of railway engineering. The solution of problems on signals, tractive effort, brakes, economics and railway accounting is required. Text-books: *Willard's Maintenance of Way and Structures; Neostyled Notes on Railway Signaling and on Economics of Railway Engineering.*

126. Railway Design. A course in the drafting-room, including problems in railway location; the proportioning of culverts and water ways; the complete computation and detailed design of a division yard, including a locomotive terminal; interlocking signals and other practical railway problems involving the application of the principles taught in courses 121 and 125. Each student is given a different problem to solve, and the work is critically corrected and discussed.

127. Railway Engineering. This course is a continuation of courses 125, 126, *128.* Special attention is given to the design and operation of freight and passenger yards and terminals, locomotive terminals, coal handling; railroad electrification; electric railways. The principles of railway accounting, rates and public regulation and control are thoroughly discussed. Students in this course will make individual investigations and reports upon problems involving railway operation, economics and finances. Text-books: *Droege's Passenger Terminals and Trains; Droege's Freight Terminals and Trains; Byer's Economics of Railway Operation; Reports of the American Railway Engineering Association, and various other reports and periodicals.*

128. Railway Design. This course is a continuation of course 126 and closely correlate d with course 127. It includes the design of freight, passenger and locomotive terminals; grade crossing elimination; handling of traffic during construction, and cost estimates.

130. Roads and Pavements. This course includes an outline of the principles governing the location, construction, and maintenance of roads, and the construction and maintenance of pavements for city streets. Text-book: *Blanchard's Elements of Highway Engineering.*

131. Testing of Highway Materials. In this course physical tests of various kinds of road materials are made and their value in highway construction discussed.

140. Theory of Structures. An introductory course in the theory of structures, covering the following subjects: outer forces; reactions, moments and shears for fixed and moving loads; the use of influence lines; the design of beams and plate girders. Text-book: *Spofford's Theory of Structures.*

141. Theory of Structures. This course is similar in scope to course 140, with such minor changes as are necessary to make it better adapted to the needs of students in architectural engineering.

143. Materials. This course is designed to acquaint the student with the properties of the various materials used by the engineer, such as stone, brick, cement, concrete, wood, iron and steel. Text-book: *Johnson's Materials of Construction.*

144. Stationary Structures. This course is designed to give students in electrical and mining engineering a knowledge of the fundamentals of the theory of structures. Text-book: *Spofford's Theory of Structures.*

145. Theory of Structures. This course is specially 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, the determination of moments and shears due to moving loads, the design of plate girders, simple trusses, columns, portals, and a brief discussion of methods employed in the calculation of indeterminate structures. Text-book: *Spofford's Theory of Structures.*

146. Theory of Airplane Structures. This course consists of a study of the stresses in the various members of an airplane and the design of its details, together with a discussion of the calculations of resistance, power and performance. Each member of the class will make a stress analysis of some well-known airplane or flying boat.

148. Foundations. This course is devoted to the study of the methods of constructing foundations for bridges, buildings, and other structures. Text-book: *Jacoby and Davis' Foundations.*

149. Theory of Structures. This is an extended course, in continuation of course 140. It treats of the computation and design of structures of wood, steel and masonry, by analytical and by graphical methods. The subjects considered are: roof and bridge trusses of various forms; trestles; 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. Text-book: *Spofford's Theory of Structures.*

150. Theory of Structures. This course is identical with course 149 in the first two terms; in the third term some of the more advanced subjects covered in course 149 are omitted. Text-book: *Spofford's Theory of Structures.*

151. Theory of Structures. This course is similar to course 150, except that it is more specifically adapted to students in architectural engineering. Text-book: *Spofford's Theory of Structures.*

152. Structural Design. This course covers the designing and partial detailing of simple structures such as crane girders, travelers, mill building

units, etc. It is intended to illustrate and amplify the work of course 145 by practical design problems.

153. Bridge Design. This course aims to show the student 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, a reinforced concrete structure and a steel truss highway bridge. Emphasis is laid on the development of careful, systematic, and practical habits of computation.

154. Structural Design. This is a drafting-room course similar in character to course 153, but much shorter, and intended to give only an outline of the subject.

155. Structural Design, Advanced. The problems selected will be adapted to the individual needs of the student, and may include the design of steel and reinforced concrete bridges, buildings and miscellaneous structures.

156. Advanced Structures. This is a continuation of course 149 and requires a large amount of preparation, involving the solution of problems and investigation of references. Among the subjects which may be considered are: the computation and design of steel frames for bridges, buildings, towers, standpipes, etc.; structures of concrete and reinforced concrete, such as dams, standpipes, subways, tunnels, buildings and reservoirs; steel and reinforced concrete arches, suspension bridges, and the general study of indeterminate structures by various methods.

158. Reinforced Concrete Design. In this course instruction is given in the theoretical and practical principles involved in the design of structures of reinforced concrete. The problems considered are chiefly those arising in the construction of buildings. Text-book: *Concrete Engineers' Handbook, Hool and Johnson.*

160. Hydrographic Surveying. At Camp Technology, East Machias, Maine. This course is given in the summer between second and third years; it consists of lectures, fieldwork, computations and drafting. (a) Stream Gaging.— A course designed to instruct the students 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 given opportunity to make several complete measurements and is instructed in the use of various current meters. (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. In the drafting-room a portion of the data thus secured is plotted. Text-book (for Stream Gaging only): *Porter's Notes on Stream Gaging.*

162. Theoretical Hydraulics. This course covers the principles of hydrostatic and hydrodynamic pressure; the measurement of flowing water by orifices, nozzles and weirs; flow through pipes and open channels; losses from friction and other sources; and other related topics. Text-book: *Russell's Hydraulics.*

163. Theoretical Hydraulics. A brief course, dealing with selected portions of the work given in course 162. Text-book: *Russell's Hydraulics.*

164. Theoretical Hydraulics. A course dealing with selected portions of the work given in course 162. Text-book: *Russell's Hydraulics.*

165. Theoretical Hydraulics. This course covers the principles of hydrostatics; of the measurement of flowing water by orifices, nozzles, and weirs; of flow through pipes and open channels; and of the theory of hydraulic turbines and impulse wheels. Text-books: *Russell's Hydraulics; Daugherty's Hydraulic Turbines.*

168. Hydraulic Engineering. This course is devoted largely to a

study of the hydraulic principles underlying the proper design and operation of impulse and reaction turbines; and, in part, to problems of stream flow, storage and the general arrangement of water-power plants.

169. Hydraulic Engineering. This is essentially a course in water-power engineering, including a study of practice in regard to the construction and selection of hydraulic turbines and impulse wheels, the study of hydrology, effect of storage and pondage, estimates of available power, the important features of hydro-electric developments and their general arrangement. Text-books: *Daugherty's Hydraulic Turbines; Barrows' Notes on Water-Power Engineering.*

170. Hydraulic Engineering. This course covers the theory and practice of hydraulic turbines and impulse wheels, the study of hydrology, the determination of the available power, and the consideration of important features of water power developments. Text-books: *Daugherty's Hydraulic Turbines; Barrows' Notes on Water Power Engineering.*

171. Hydraulic Laboratory Research. The aim of this course is to offer training in hydraulic laboratory research to certain specially fitted students. The many unsolved problems relating to the flow of water through large orifices, over weirs and dams of various types, through pipes and their common fittings, the calibration and development of measuring devices, and problems arising in turbine design, furnish ample fields for interesting and important investigations. The work is carried on under the close supervision of the professor, who engages co-operatively in each problem.

173. Water-Power Engineering. This course is a continuation of courses 165, 168, 169, 175, and includes detailed studies of hydrology, storage and available power with particular reference to some water-power project, the designs for which are made in course 182 (taken simultaneously with course 173).

Studies and reports upon details of water-power development and upon the comparative economy and valuation of water power are also made. One or more visits are made each year to water-power plants in New England and reports made upon important features. Reference-book: *Mead's Water-Power Engineering.*

175. Hydraulic and Sanitary Engineering. This course is intended to acquaint the student with important features of practice in certain branches of hydraulic and sanitary engineering and to illustrate applications of hydraulics thereto. It is subdivided into: (a) Irrigation, with a general study of sources of water supply, modes of application to land, and various works required in storing, conveying and controlling the distribution of the water. (b) Sewerage, including separate and combined systems; sewage disposal by dilution, and treatment by screening, sedimentation, septic action, and various oxidizing processes. (c) Water-supply of cities, embracing study of quantity required, quality and modes of improving it by filtration and otherwise, storage computations, distribution systems, standpipes and other works. (d) Water-power, with especial attention to the hydraulic principles involved in impulse wheels and turbines; and with brief consideration of features governing the location and development of water-power plants, estimation of power capacity of a given water privilege, and commercial testing of turbines. Text-books: *Newell and Murphy's Principles of Irrigation Engineering; Folwell's Sewerage; Swan and Horton's Hydraulic Diagrams; Turneaure and Russell's Public Water Supplies; Daugherty's Hydraulic Turbines.*

177. Sanitary Engineering. This course is devoted to the general principles of sanitary engineering, with especial attention to sewerage, sewage disposal, and water supply.

Under sewerage are studied the methods of estimating the volume of flow to be provided for in separate and combined systems, the grouping, grades, velocities, sizes and materials for pipe and trunk sewers, and provisions for flushing and ventilation.

Sewage disposal includes the various modern methods of treating sewage for preventing or lessening pollution of streams and other bodies of water, and the works required therefor, such as screens, various forms of settling tanks, contact beds, sand filters, percolating filters, activated sludge tanks, and other devices.

In connection with public water supplies are considered the quantity of water required, yield from catchment areas, ground water supplies, storage computations, quality of water and methods of water purification, distributing systems, standpipes, and other works. Text-books: *Folwell's Sewerage; Swan and Horton's Hydraulic Diagrams; Kinnicutt, Winslow and Pratt's Sewage Disposal; Turneaure and Russell's Public Water Supplies.*

179. Hydraulic and Sanitary Design. In this course the time is ordinarily devoted to the general lay-out, drafting and computations for a separate sewerage system for a selected portion of a small town.

180. Hydraulic and Sanitary Design. This is a more extended course than course 179, and includes additional problems, such as a design for a cross-section of a large trunk sewer, a high masonry dam, or other structures required in connection with water supply or sewage disposal.

181. Engineering of Water and Sewage Purification. This course deals with the engineering features of existing works for the disposal and treatment of sewage and the purification of public water supplies, such as outfalls, sewage reservoirs, screens, settling tanks and filters.

182. Water Power Design. This course supplements course 173 and is devoted to the design of works connected with water-power development.

183. Sanitary Design. This supplements course 181, and is devoted to the design of works connected with the treatment of sewage and the purification of public water supplies.

190. Report Writing. The purpose of this course is to train the student to make a clear and logical report, in proper form and in good English, recording the result of an actual investigation which he has made.

DEPARTMENT OF MECHANICAL ENGINEERING

Many of the subjects taught by the Mechanical Engineering Department are fundamentals in nearly all of the different branches of engineering; consequently instruction is given not only to students in Mechanical Engineering, but also to those taking Civil, Sanitary, Electrical, Chemical and Mining Engineering, Naval Architecture and Marine Engineering, Electrochemistry and Architecture.

The course in Mechanical Engineering aims first to give the student a thorough training in the fundamentals of physics, mathematics, and applied mechanics; then by means of lectures, laboratory work and drawing room work in his different professional subjects, to familiarize him with the various problems that the mechanical engineer has to deal with. He is also given training in the mechanic arts sufficient to make him familiar with the use of shop tools, foundry practice, pattern work and forging, such knowledge being essential to the successful designer of machinery.

A considerable portion of the course is devoted to non-professional work in English, history, economics and allied subjects, extending through the entire course.

The work in mechanism, supplemented by a course in mechanical

engineering drawing, includes the study of linkages, cams, gear teeth and valve gears of steam engines; followed by a more advanced course in the third year on the mechanisms of machine tools and automatic machinery.

The instruction in applied mechanics in the second and third years covers the fundamental principles of statics, kinetics, and strength of materials; particular attention being given to the solution of problems illustrating the application of these principles in engineering practice. The work in this course is followed by a series of lectures on engineering materials intended to familiarize the student with the physical properties of materials used in engineering work and with data upon the strength of materials obtained by means of experiments. This course is supplemented by a course in testing materials laboratory in which the student is given work illustrating the methods of making tests on various materials for the purpose of determining their physical properties and also the strength of different pieces under the conditions of practice.

The course in heat engineering covers thermodynamics, steam engines, turbines, boilers, gas engines, gas producers and power station accessories. A thorough course in theoretical hydraulics is followed by a course in hydraulic engineering in which both the estimation and utilization of hydraulic power are discussed. The courses in heat engineering and hydraulics are supplemented by a course in engineering laboratory work extending through the latter half of the third year and the fourth year. The work in this course is planned to follow the classroom work and thereby assist the student in getting a better grasp of the subjects taught. The laboratories are equipped to provide for an extended series of experiments on steam and its properties, steam engines, turbines, compressed air, gas and oil engines, gas producers, refrigerating machinery, hydraulics, pumps, water wheels and turbines, devices for the mechanical transmission of power, transmission and absorption dynamometers. The main power plant of the Institute is available for complete power plant tests.

The instruction in mechanic arts aims to give a systematic training in the typical operations to be performed with the different tools and appliances used in the foundry, in the forge shop, in the machine shop and in wood working. The student is taught how to sharpen and to adjust all edge tools used, also the proper speeds, cutting angles and feeds for the various materials worked. In order to make a student familiar in as short a time as possible with the different operations and with the different methods used in any branch of the work, every problem given him is so chosen as to bring in each time one or more new operations.

The instruction is mainly by lecture, each new operation being described and discussed just before the work is to be undertaken; notes and text-books are also used. Supplementary illustrated lectures are given in connection with many of the courses descriptive of industrial appliances and methods of production used in large establishments.

The professional work of the fourth year includes courses in machine design; power plant design; refrigeration; internal combustion engines; the design and equipment of a manufacturing plant including a study of structural details and heating and ventilating equipment and problems in financing and the management of such an establishment; courses in dynamics of machinery and mechanics of engineering which involve the application of the principles of mechanics in more advanced engineering problems; and a series of professional electives in which the student has the choice of one or more of a group of somewhat specialized subjects in the field of Mechanical Engineering.

200. Mechanism. This course includes a systematic study of the

forms and motions of various mechanisms occurring in machines, independently of their strength, such as rolling cylinders and cones, belting, screws, cams, and wheel trains. Text-book: *Elements of Mechanism, Schwamb and Merrill.*

201. Mechanism. A continuation of course 200 covering linkages, the design of gear teeth and the theory and practice of designing valve gears for steam engines. Text-books: *Elements of Mechanism, Schwamb and Merrill; Mechanism of Steam Engines, James and Dole.*

202. Mechanism. A brief course covering parts of courses 200 and 201, not including valve gears. Text-book: *Elements of Mechanism, Schwamb and Merrill.*

202a. Mechanism. A course similar to course 202. Text-book: *Elements of Mechanism, Schwamb and Merrill.*

202b. Mechanism. A brief course covering a part of course 202. Text-book: *Elements of Mechanism, Schwamb and Merrill.*

203. Mechanism. A brief course covering parts of courses 200 and 201. Text-books: *Elements of Mechanism, Schwamb and Merrill; Mechanism of Steam Engines, James and Dole.*

205. Mechanism of Machines. The subject matter of this course supplements the work in pure mechanism. The discussion is intended to enable the student to become familiar 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. Text-book: *Lithographs and Blue Prints, Mechanical Engineering Department.*

206. Design of Automatic Machinery. This course includes the subject matter given in the course in Automatic Machinery extended to include more complex mechanisms and the design of an automatic machine.

210. Mechanical Engineering Drawing. A course of sixty hours of drafting-room exercises with occasional lectures, giving training in the solution of practical problems supplementary to the course in Mechanism, such as problems in belting, the design of cams and in the velocities and accelerations of moving parts. Text-book: *Working Drawings of Machinery, James and Mackenzie.*

211. Mechanical Engineering Drawing. A course of thirty hours of drafting-room exercises and lectures, devoted to work supplementary to the course in Mechanism, including the solution of problems dealing with velocities, accelerations, and forces in various linkages, the design of gear teeth and in investigating, by means of drafting board constructions, the operation of certain types of valve gears for steam engines. Text-book: *Working Drawings of Machinery, James and Mackenzie.*

212. Machine Drawing. A course of sixty hours of drafting-room exercises and lectures. Each student is furnished with blue print details of some machine, or portion of a machine, which he has never seen, and he is required to make an assembly drawing of the same. He is thus given practise in reading drawings and in building up a general drawing from details. Two, or more, lectures are given on processes for reproducing drawings, such as blue printing, zinc plate and wax plate engraving and half-tone work. Text-book: *Working Drawings of Machinery, James and Mackenzie.*

213. Machine Drawing. A course of thirty hours of drawing-room exercises devoted to more advanced work, making detail sketches and drawings of machine parts. Text-book: *Working Drawings of Machinery, James and Mackenzie.*

214. Machine Drawing. A course of sixty hours of drawing-room exercises devoted to making detail and assembly drawings. Text-book: *Working Drawings of Machinery, James and Mackenzie.*

214a. Machine Drawing. A course of forty-five hours of drafting-room exercises covering a part of course 214. Text-book: *Working Drawings of Machinery, James and Mackenzie.*

220. Applied Mechanics (Statics). This course includes a study of the resolution and composition of forces by analytical and graphical methods; the laws of equilibrium of force systems with their application in determining the reactions at the supports and the stresses in various types of frames; the analysis of distributed forces; determination of centers of gravity, moments and products of inertia and radii of gyration of plain areas and solids; principal axes and principal moments of inertia in two dimensions only. Text-book: *Applied Mechanics Vol. I, Fuller and Johnston.*

221. Applied Mechanics (Kinetics-Strength of Materials). This course comprises a study of the principles of kinetics of solid bodies with applications in cases involving motion in a plane, including the application of the principles of momentum and kinetic energy and the determination of work and power. The latter part of the course is devoted to a discussion of the physical properties of materials; the components of stress and strain in bodies subjected to tension, compression and shear and the relations between stress and strain in various cases. Text-book: *Applied Mechanics Vol. II, Fuller and Johnston.*

221a. Applied Mechanics (Strength of Materials). This course is devoted to a study of the physical properties of materials, stresses and strains in bodies subjected to tension, compression and shear; the common theory of bending, including shearing forces, bending moments, distribution of normal and shearing stresses, equation of the elastic curve, and the determination of slopes and deflections in beams; a study of stresses due to combination of bending and axial loads. Text-book: *Applied Mechanics Vol. II, Fuller and Johnston.*

222. Applied Mechanics (Strength of Materials). This course comprises a study of the common theory of bending, including shearing forces, bending moments, the distribution of normal and shearing stresses, the equation of the elastic curve and the determination of slopes and deflections in beams; a study of stresses due to a combination of bending and axial loads; the theory of columns, and the methods of determining the strength of columns under working conditions; the stresses and deformation in shafting and bars subjected to torsion and to combinations of torsion and bending, tension or compression. Text-book: *Applied Mechanics, Vol. II, Fuller and Johnston.*

222a. Applied Mechanics (Strength of Materials). This course is devoted to the study of strength of materials similar to that in course 222, especially adapted to the needs of students in course I. Text-book: *Applied Mechanics, Vol. II, Fuller and Johnston.*

222b. Applied Mechanics. This course includes a study of the theory of columns and methods of determining the strength of columns under working conditions; the stresses and deformation in shafting and bars subjected to torsion; the application of graphical methods in the solution of problems in Statics and the determination of stresses in different types of frames. Text-book: *Applied Mechanics, Vol II, Fuller and Johnston.*

223. Applied Mechanics (Strength of Materials). This course includes a study of the theorem of three moments with applications to beams and other members where continuity exists; the theory of reinforced concrete beams and columns as applied to the determination of stresses in

slabs, T beams and columns; the application of graphical methods in the solution of various problems in Statics and Strength of Materials. Text-book: *Applied Mechanics, Vol. II, Fuller and Johnston.*

223a. Applied Mechanics (Strength of Materials). This course includes a study of the theorem of three moments with applications to beams and other members where continuity exists; the application of graphical methods in the solution of problems in Statics and Strength of Materials; a brief discussion of the theories for determining the stresses in cylinders and flat plates. Text-book: *Applied Mechanics, Vol II, Fuller and Johnston.*

223b. Applied Mechanics. This course includes the study of the theorem of three moments with applications to beams and other members where continuity exists; the theory of reinforced concrete beams and columns as applied in the determination of stresses in slabs, tee beams and columns; and a brief course in the kinetics of solids. Text-book: *Applied Mechanics, Vol. II, Fuller and Johnston.*

224. Applied Mechanics (Kinetics). This course includes the study of the application of the principles of kinetics in problems involving the determination of forces, acting upon, and the stresses within the moving parts of machines, the problems chosen being such as are commonly met with in engineering practice. Both analytical and graphical methods are used. Text-book: *Applied Mechanics, Vol. I, Fuller and Johnston.*

225. Dynamics of Machines. This course is devoted to the study of the kinematics of and the forces due to inertia in the moving parts of machinery, such as crank and connecting rod mechanisms, cams, governors, flywheels, etc.; graphical and mechanical methods of differentiation and integration being studied and employed in the solution of problems. A study of different types of transmission and absorption dynamometers, their relative merits and application in the measurement of power is also included in the course. Text-books: *Dynamics of Machinery, Lanza; Notes prepared for class.*

226. Mechanics of Engineering. This course is devoted to the application of the principles of mechanics in the solution of problems of value to the mechanical engineer; including more advanced problems in statics, kinetics, work and power, and strength of materials. Particular attention is paid to various problems arising in the design and operation of heavy ordnance. Text-book: *Applied Mechanics, Fuller and Johnston.*

228. Advanced Mechanics and Theory of Elasticity. This course includes a study of some of the more advanced problems in dynamics and a detailed study of the general theory of elasticity and applications which have not been covered by the student in his undergraduate course. The work is planned to suit special needs of the student, especially in connection with his research work.

230. Materials of Engineering. This course is devoted to the study of the manufacture, physical properties and testing of engineering materials. The subject matter may be divided as follows: (a) Discussion of the relationships existing between constitution and microstructure; the effect of change of composition, hot and cold work, heat treatment and methods of manufacture upon the physical properties of iron, steel and other alloys. (b) The study of the physical properties of iron, steel, wood, cement concrete, brick, lime and plaster, bearing metals and other materials; and methods of inspection and standard specifications for different materials. (c) The study of various types of testing machines and their uses, measuring instruments, the preparation of specimens and making of reports. Text-book: *Notes prepared for class.*

232. Materials of Engineering. This course is similar to parts (b) and (c) of course 230. Text-book: *Notes prepared for class.*

234. Physical Metallurgy. A course for advanced students extending through one, two or three terms of the graduate year, consisting of conferences and laboratory work, involving investigations of the structure and physical properties of iron, steel and other metals and the changes when the materials are subjected to mechanical work, distortion, alternating stresses and heat treatment.

235. Testing Materials Laboratory. This course is devoted to the study of the behavior of engineering materials under stress, including tests of cement, sand and concrete; and laboratory experiments on the heat treatment of steel and other alloys.

236. Testing Materials Laboratory. This course is devoted to the study of methods of making physical tests for the properties of materials, and the behavior of different materials under stress.

237. Testing Materials Laboratory. This course is devoted to the study of materials under stress, more extended than course 236.

238. Testing Materials Laboratory (Concrete). This course is devoted to the 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 proper methods of placing.

240. Heat Engineering. This course begins a detailed study of the laws of thermodynamics and their application to engineering problems. It includes a discussion of the physical properties of gases, and of saturated and superheated vapors,—especially of air and steam. The student learns to use equations, vapor tables and diagrams through independent solution of drill and engineering problems. Text-books: *Thermodynamics of the Steam Engine, Peabody; The Temperature Entropy Diagram, Berry; Problems in Heat Engineering, Miller, Riley and Berry.*

241. Heat Engineering. This course includes a description of boilers, superheaters, feed water heaters, economisers, pumps, traps, fans, piping and various other accessories of steam boiler plants. Text-book: *Steam Boilers, Peabody and Miller.*

241a. Heat Engineering. This course includes about one-half of the subject matter contained in courses 241 and 243. Text-books: *Illustrations of Steam Engines, etc., Mechanical Engineering Department. Steam Boilers, Peabody and Miller.*

242. Heat Engineering. This course includes discussion of the flow of fluids, the throttling calorimeter, the steam injector and turbines, and a study of the ideal and actual cycles of hot air, internal combustion and vapor engines together with an analysis of the nature and magnitude of the various losses affecting the efficiencies of the various machines. Text-books: *Thermodynamics of the Steam Engine, Peabody; The Temperature Entropy Diagram, Berry; Problems in Heat Engineering, Miller, Riley, Berry.*

243. Heat Engineering. This course includes a description of different types of steam and internal combustion engines, large pumping engines, steam turbines, condensers, cooling towers and power station accessories. Text-book: *Illustrations of Steam Engines, etc., Mechanical Engineering Department.*

244. Heat Engineering. This course includes a thermodynamic study of condensers, cooling towers, heating and ventilation problems; an elementary discussion of the laws governing heat transmission; multiple evaporators; air compressors and motors; transmission of gases through pipe lines. Text-books: *Thermodynamics of the Steam Engine, Peabody;*

The Temperature Entropy Diagram, Berry; Problems in Heat Engineering, Miller, Riley, Berry.

245. Heat Engineering. This course begins the discussion of reversed (power-consuming) thermodynamic processes as illustrated in the Kelvin warming engine and the various refrigerative machines. Particular attention is given to both the large and domestic units operated on the compression system for various kinds of refrigerants. Warehouse construction, refrigeration and ventilation. Part of the course will be devoted to a discussion of recent developments in internal combustion engines. Text-books: *Thermodynamics of the Steam Engine, Peabody; The Temperature Entropy Diagram, Berry; Problems in Heat Engineering, Miller, Riley, Berry.*

246. Heat Engineering. This course includes a study of valve gears, and the thermodynamics of perfect gases. Text-books: *Steam Boilers, Peabody and Miller; Thermodynamics of the Steam Engine, Peabody; Problems in Heat Engineering, Miller, Riley, Berry.*

247. Heat Engineering. This course includes power station accessories and thermodynamics of saturated and superheated steam. Text-books: *Thermodynamics of the Steam Engine, Peabody; Steam Boilers, Peabody and Miller. Problems in Heat Engineering, Miller, Riley, Berry.*

248. Heat Engineering. This course includes flow of fluids, Rankine cycle, engine and turbine economies, and steam boilers. Text-books: *Thermodynamics of the Steam Engine, Peabody; Steam Boilers, Peabody and Miller; Problems in Heat Engineering, Miller, Riley, Berry.*

250. Heat Engineering. This course includes portions of courses 240 and 241. Text-books: *Thermodynamics of the Steam Engine, Peabody; Steam Boilers, Peabody and Miller; Problems in Heat Engineering, Miller, Riley, Berry.*

251. Heat Engineering. This course includes parts of courses 242 and 243. Text-books: *Thermodynamics of the Steam Engine, Peabody; Steam Boilers, Peabody and Miller; Problems in Heat Engineering, Miller, Riley, Berry.*

252. Heat Engineering. This course includes parts of courses 244 and 245. Text-books: *Thermodynamics of the Steam Engine, Peabody; Steam Boilers, Peabody and Miller; Problems in Heat Engineering, Miller, Riley, Berry.*

253. Power in Mining. The work in this course covers the elements of thermodynamics, including perfect gases, saturated and superheated vapors, and the flow of fluids, followed by the study of the principles and details of boilers, steam engines, steam turbines, internal combustion engines, air compressors, and other power plant apparatus. Text-book: *Allen and Bursley, Heat Engines.*

254. Advanced Heat Engineering. A course of reading and research will be outlined to meet the needs of each student, especial attention being given to the literature bearing on the subject matter of his research work. The distribution of time between reading and research will differ with the character of the investigation undertaken by each student. Text-book: *Notes prepared for class.*

255. Advanced Refrigeration. This course covers a thermodynamic investigation of the compression and absorption types of refrigerating systems. It includes a study of the principles underlying the mechanical production of cold, the physical properties of different refrigerants, a discussion of actual refrigeration problems such as ice making, warehouse construction, design, operative difficulties, etc. It also includes a study of the liquefaction of gases and the separation of liquid air into oxygen and nitrogen. Text-book: *Notes prepared for class.*

256. Advanced Heat Transmission. This course discusses the transmission of heat by radiation, conduction and convection as illustrated in steam condensers, feed water heaters, brine coolers, radiators, steam boilers, engine cylinders, cooling of castings, freezing of ice, etc. Text-book: *Notes prepared for class.*

257. Mechanical Equipment of Buildings, Steam, Heat and Ventilation. This course gives the student a training in the thermodynamics of gases, saturated and super-heated steam, sufficient to enable him to obtain a working acquaintance with the essential engineering principles underlying the correct practice of heating and ventilating work, which forms a part of the course. The course also includes a discussion of the various steam and mechanical appliances used in connection with the equipment of buildings. Text-book: *Notes prepared for class.*

258. Power Plant Design. The work of the course consists in making the working drawings necessary to show the location of boilers, engines, auxiliaries, piping, coal pockets, etc., for a power house and also drawings and calculations of some of the details. Text-book: *Notes on Power Plant Design, Miller.*

260. Engineering Laboratory. This course is devoted in the first term to elementary experiments necessary for a complete knowledge of methods of testing, the work being arranged to supplement the course in Heat Engineering. It includes the use of the indicator, determination of horse power, setting of different types of valves, measurement of engine clearance, calibration of pressure and vacuum gages, use of friction brakes, testing of different types of calorimeters, measurement of the flow of steam and air, power and economy tests of simple engines. Text-book: *Power Test Code of the American Society of Mechanical Engineers.*

260a. Engineering Laboratory. This course is intended for men who are allowed only one term of Engineering Laboratory and covers portions of courses 260 and 261, the elementary experiments are emphasized and enough of the more advanced work taken to exemplify the methods of testing the more common steam and hydraulic machinery. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

260b. Engineering Laboratory. This is a brief course similar to course 260a. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

260c. Engineering Laboratory. An elementary course covering a part of course 260. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

260d. Engineering Laboratory. A short course to supplement the work in course 257. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

261. Engineering Laboratory. This course is a continuation of course 260, and is designed to make the student familiar with the standard methods of testing ordinary steam and hydraulic machinery, to teach him to think systematically and accurately on such matters and to accustom him to the assumption of engineering responsibility. A few students work together under the direction of an instructor, one of them being in direct charge of the group. As far as possible the men are left to themselves in the preparation of apparatus, running of machinery, etc. Each student writes a complete report of the test, giving required results, arrangement of apparatus, method of testing and details of computation. The work in the course includes experiments in hydraulics, tests on steam engines, gas engines, producers, air compressors, hydraulic machinery and refrigeration apparatus. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

261a. Engineering Laboratory. This course covers parts of courses 261 and 262. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

261b. Engineering Laboratory. A brief course covering a part of course 261. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

262. Engineering Laboratory. This course is a continuation of course 261 and is conducted in the same manner, covering more advanced work along the same lines. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

262a. Engineering Laboratory. A brief course covering a part of course 262. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

263. Engineering Laboratory. In this course the time is devoted to a few experiments of a more advanced nature. Small groups of students are given complete experimental problems to solve or investigations of an engineering nature to make. Several exercises are allowed for one experiment. As far as possible the men are thrown on their own resources in the planning of the experiments, the operation of the machinery, the testing, calculations and deductions. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

264. Engineering and Hydraulic Laboratory. This course is designed to make the student familiar with the standard method of testing the simpler steam and hydraulic machinery, particularly as applied to Civil Engineering. Text-book: *Power Test Code of American Society of Mechanical Engineers.*

270. Machine Design. The work of this course embraces typical problems in machine design which may be solved by the application of the principles of statics. As an introduction the student is required to make complete calculations and drawings for 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. The remainder of the time is spent in the design of one of the simpler machines in which the stresses are statically determinate, such as a punch, shear, press or riveter. Graphical methods are employed for the analysis of motions and the determination of forces wherever possible. Text-book: *Design of Steam Boilers and Pressure Vessels, Haven and Swett.*

271. Machine Design. In the fourth year the course consists of an extension of the work in machine design begun in the third year. The designs consist of machines involving dynamic forces. Such a machine as a power-driven punch, press or rock crusher 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, stresses in fly-wheels, force fits, balancing, journals, and bearings and stresses in moving parts are discussed at length. A complete set of drawings and calculations for a complicated machine of the above type forms the conclusion of this course. Text-book: *Notes prepared for class.*

272. Machine Design. This course is a continuation of course 271 covering more advanced work along the same lines. Text-book: *Notes prepared for class.*

274. Advanced Machine Design. This course includes a systematic application of the principles of Applied Mechanics to the design of machines. 120 hours per term in one or more terms of the graduate year.

275a. Automatic Machinery. This course includes a discussion of a number of fully automatic machines, representative of various classes

of machinery, such as, wire-working machinery, can-making and canning machinery, printing machinery, machine tools, weighing, package and wrapping machinery, etc. In connection with the course a motion chart and the layout for some simple automatic machine are worked out in the drafting-room.

275b. Automotive Engineering. The course includes the general principles of automobile construction and operation, the theory and design of the engine, transmission and chassis, and the application of fundamental principles of current practice.

275c. Engine Design. A course of lectures and drafting-room exercises in the design of reciprocating engines, either steam or gas. 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 the way in which the thermodynamic and mechanical problems are worked out. The student makes a partial design of an engine, applying the scientific principles of heat engineering and mechanics to determine the best steam distribution and the size and strength of the essential parts.

275d. Fire Protection Engineering. The growing demand for men equipped with a knowledge of fireproofing and fire protective apparatus renders it necessary to make a special study of this branch. The erection, installation and operation of protective devices is carefully considered. A study is also made of safety appliances, both in connection with fire, as well as in relation to machines of hazardous character. A number of problems are worked out, showing how modern shops and mills may be safeguarded against fire in the most effective manner.

275e. Heat Transmission. This course embodies a discussion of the elementary principles underlying heat transmission and of the methods of adaptation employed in various technical devices.

275f. Heat Treatment. A course consisting of conferences and laboratory work, dealing with the physical properties of iron, steel and other metals and the changes which these properties undergo when the materials are subjected to heat treatment.

275g. Internal Combustion Engines. This course is in extension of course 245. Several text-books are used for reference, and reading is assigned from current articles in the technical press and transactions of engineering societies.

275h. Locomotive Engineering. This course includes the study of locomotive construction from detail drawings of modern steam locomotives, the general principles of locomotive design, the calculation of stresses in the principal parts of the engine, locomotive testing and the coal and water consumption and efficiency of different types; also, the operation of modern air brake systems.

275i. Refrigeration. This course includes a description of various refrigerative systems and a discussion of the essential engineering features, of cost, adaptability, etc., of different types of machines for various refrigerating industries; ice making, cold storage, domestic machines, etc.

275j. Textile Engineering. The subject matter of this elective consists of an extended study of the cotton process as applied to the manufacture of mechanical fabrics such as those used in airplane wings and bodies, pneumatic tires and canvas belting. The organization of a mill for the manufacture of these goods is carefully worked out and a complete set of floor plans made with the location of the necessary machines and the distribution of power. Each student is required to make a complete set of textile tests in the Textile Laboratory.

275k. Theory of Elasticity. This course includes a study of the Mathematical Theory of Elasticity with applications in determining

stresses and strains in simple and compound cylinders, and flat plates; also a study of stresses and strains in curved bars.

276. General Engineering Lectures. This course covers matters of general engineering interest, such as the development and construction of the steam or electric locomotive, the description of a modern manufacturing plant, the motive power of ships, the construction of aeroplanes, etc., the subject matter being varied from time to time.

277. Industrial Plants. This course and the following course 278 are devoted to a study of problems involved in the capitalization and organization of a modern manufacturing plant and planning, construction and equipment of the buildings required. The subjects included may be grouped as follows: (a) Financial organization, capitalization, promoting. (b) Organization of the industry including the office and engineering department, methods of superintendence, employment and cost of labor, scheduling of work, process mapping or routing, systems of compensation and efficacious conditions of labor, cost accounting and current methods of efficiency engineering. (c) Planning the layout of the plant, the distribution of power, the type and form of the building. (d) The design and planning of the foundations, and the structure of a brick and timber or brick and steel mill, including necessary calculations. (e) The design, calculations and plans for the principal parts of a steel frame for a mill and for the floor beams and columns for a reinforced concrete structure. (f) The mechanical equipment of the building including the heating and ventilating equipment. This part of the course includes a discussion of the engineering principles underlying a correct practice of heating and ventilating work, the different systems of heating and ventilating, air washing, etc., and the design and plans of the essential parts of a heating and ventilating system for a mill. Text-book: *Notes prepared for class.*

278. Industrial Plants. A continuation of course 277. Text-book: *Notes prepared for class.*

280. Forging. This course includes systematic instruction in the use of each tool as it is taken up, the study of each material worked, with an explanation of its various grades and of the proper methods of treatment for each, and the discussion of methods of making large forgings. The ground covered includes instruction in the building and care of fires, heating, drawing, forming, bending and twisting, upsetting, upsetting while bending, upsetting for square corners, punching, bolt making, welding (including careful instruction in scarfing for the various welds), chain making, and the construction of hooks and ring bolts. The work in steel includes drawing, forming, welding, refining and tempering, and spring and tool making. Training is given in the use of the power hammer, and drop forging is also included.

281. Forging. This course covers nearly the same ground as that of course 280, but in a less thorough manner.

281a. Forging. This course is similar to course 281, but with certain abbreviations.

282. Foundry. This is a course in the foundry. Instruction is first given in cutting over and tempering sand and the use of moulder's tools, making two and three-part green sand moulds and making, baking, and testing cores. Ramming, venting, facing, spruing, use of risers, the clamping and weighing of moulds, stopping off, bedding, loose-piece moulding, and use of chills are considered in proper order. Following this come exercises in multiple and duplicate production by use of snap flasks, slip jackets and machines, such as the power squeezer, hinged turn-over, and jarring stripping plate moulding machines. Here the mounting and gating of wood and metal patterns on plates, the use of follow boards, and

making of sand and plaster matches is described and illustrated by examples. Castings are first made in white metal for practice, then in brass and in cast iron, when the students are taught pouring, and the running of metal furnaces.

The laboratory work is supplemented by illustrated lectures on loam, large floor and sweep moulding, steel and aluminum casting, foundry appliances and modern methods of production. Text-book: *Notes prepared for class.*

283. Foundry. A brief course covering a part of the work given in course 282. Text-book: *Notes prepared for class.*

283a. Foundry. This course is similar to, but slightly more extended than course 283. Text-book: *Notes prepared for class.*

284. Pattern Making. The course begins with the elements of joinery and wood-turning and leads to the work in pattern making. The exercises include sawing, planing, chiseling, boring, etc.; laying out work; jig, band and circular sawing; lathe work, including center, chuck, and face plate turning. Thorough training is given in the adjustment, use, sharpening and care of wood-working tools, machines and appliances.

In the making of patterns and core boxes, the principles of moulding are carefully considered. The projects include patterns of pipe-fittings, valves, pulleys, gears, hangers, machine parts, etc. The laboratory work is supplemented by illustrated lectures on the construction and foundry application of solid, split and loose-piece patterns; large complete, 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 moulding machines. Text-book: *Notes prepared for class.*

286. Vise and Bench Work. A course in mechanical processes where the tools are guided principally by hand. The instruction is given by lectures and demonstration at the beginning of each period, supplemented by the text-book. The course is arranged to advance the students in a logical, systematic and progressive manner and in the shortest time. Each student is required to do problems which involve the application of the following principles and processes: laying out work, angles of cutting tools, grinding tools, chipping cast iron, chipping key-ways, pneumatic chipping and drilling, classification of files and methods of operating filing cast iron, filing and fitting steel and wrought iron, alignment and babbitting of bearings, scraping bronze and babbitt bearings, steam pipe fitting, oxy-acetylene welding, and measuring the hardness of common metals and hardened, tempered and heat-treated steels with the scleroscope. Text-book: *Principles of Machine Work, Smith.*

287. Vise and Bench Work. This course is similar to course 286, but much shorter. It includes laying out work, grinding tools, hand and pneumatic chipping, filing, alignment and babbitting of bearings, belt lacing, pipe fitting, and measuring the hardness of metals with the scleroscope. Text-book: *Principles of Machine Work, Smith.*

287a. Vise and Bench Work. This is a brief course covering part of the work given in course 287. Text-book: *Principles of Machine Work, Smith.*

288. Machine Tool Work. This course and the following courses 290 and 292 are devoted to instruction and practice in the use of machine tools. Instruction is given, when necessary, in the mechanism of the machine-tools used and careful attention is paid to the various adjustments for the work in hand. The different measuring tools and devices, with the advantages, methods of use, and limits of accuracy of each are considered. As each cutting tool is taken up, its cutting angles and general adjustments are discussed, together with the "feeds" and cutting speed

suitable for each material worked and for each machine. The course includes instruction in centering, squaring, straight and taper turning and fitting, outside and inside screw cutting, chucking, reaming, finishing, and polishing, drilling, tapping, mandrel making, grinding and lapping, boring, brass turning and finishing, ornamental turning, planing flat and V surfaces, fitting, the use of the milling machine, gear-cutting, tool-making, including taps, drills, reamers, milling cutters, and cylindrical gages. Text-book: *Advanced Machine Work, Smith.*

289. Machine Tool Work. Instruction is given in general machine-tool work, consisting of centering, straight and taper turning and fitting, screw cutting, chucking, finishing, accurate drilling, tapping, cylindrical grinding, shaping and planing, plain and index milling and gear cutting. Text-book: *Advanced Machine Work, Smith.*

290. Machine Tool Work. This course is a continuation of course 288. Text-book: *Principles of Machine Work, Smith.*

291. Machine Tool Work. This course and the following course 291a is a brief course in machine tool work consisting of instruction in lathe work covering centering, straight turning, screw cutting, chucking, finishing, drilling and chipping. Text-book: *Advanced Machine Work, Smith.*

291a. Machine Tool Work. This course is a continuation of course 291. Text-book: *Advanced Machine Work, Smith.*

292. Machine Tool Work. This is a continuation of course 290. Text-book: *Advanced Machine Work, Smith.*

295. Vise and Bench and Machine Tool Work. A brief course covering a small portion of courses 287a and 288. Text-book: *Advanced Machine Work, Smith.*

295a. Vise and Bench and Machine Tool Work. A brief course covering a small portion of courses 287a and 289. Text-book: *Advanced Machine Work Smith.*

295b. Vise and Bench and Machine Tool Work. A course in the use of hand tools and machine tools, covering a portion of the work given in courses 287a and 289. Text-book: *Advanced Machine Work, Smith.*

296. Foundry, Vise, Bench and Machine Tool Work. A brief course in foundry practice and the use of hand and machine tools, similar to parts of courses 282, 287 and 288. Text-book: *Advanced Machine Work, Smith.*

297. Machine Tool Work. This is a brief course in machine tool work similar to a part of the work in course 290. Text-book: *Advanced Machine Work, Smith.*

DEPARTMENT OF MINING ENGINEERING AND METALLURGY

The study of Mining and Metallurgy covers such a large field of technical endeavor that the courses given cannot follow the details of the several branches. The aim of all instruction is to ground the student in the fundamental principles of the professional studies, and to train his mind and hand that he may be a close observer, a good reasoner, and a conscientious worker.

Instruction is given by lectures and recitations, by laboratory work, and by summer schools. Work in the Department covers studies in mining, ore-dressing, metallurgy, metallography, and assaying. With these are interwoven auxiliary courses in physics, chemistry, mineralogy, geology, and in civil, mechanical, and electrical engineering. All students in the Department follow the same studies for the first and second years; differences in the options become very marked in the third and fourth years.

301. Mining Engineering. This course includes a brief preliminary

discussion of mining machinery in general and a few typical ore occurrences; a consideration of mineral lands and their tenure, with the laws relating to them; and the methods of prospecting, including prospecting drills. Text-book: *Mining Notes.*

302. Mining Engineering. This is a course on breaking ground and methods of mining, following course 301; it includes rock drills, compressors, explosives; methods of tunnel driving and shaft sinking; timbering of underground workings; the various methods of working stopes and rooms for ore and coal; and hydraulicking and dredging of placer deposits. Text-book: *Richards' Mining Notes.*

303. Mining Engineering. This course, which continues the subject of mining, is devoted mainly to machinery and apparatus for handling ore, water, men and air; it includes tramming, haulage, hoisting, drainage and pumping, ventilation, breathing apparatus, explosions, mine fires, lighting and access. Text-book: *Richards' Mining Notes.*

304. Mining Engineering. After the detailed study of mining (courses 301-303) this course is devoted to the broader aspects of the profession and touches upon the miner's health, welfare and safety; State regulations, sampling and reporting; mine accounts and cost systems; contracts; and mining from the investment viewpoint including costs, losses and smelter deductions, calculations of extractions, and final net values and profits. Text-book: *Richard's Mining Notes.*

305. Mining Engineering. This is a brief course touching upon only such operations and apparatus in courses 301-304 as are of special importance from the viewpoint of the metallurgist.

306. Mining Engineering, Advanced. This course is devoted to lectures, conferences, assigned readings, drawing, and calculations; it is designed to supplement the undergraduate work of courses 301-304 by covering details and solving problems omitted previously for lack of time. Considerable latitude is allowed the student, in time allotment and in his choice of ore mining or coal mining or of any special division of the subject. In general, a considerable portion of the time may be devoted to the design of a mine plant, starting with certain assumed conditions.

321. Ore Dressing. This course logically follows course 302 and deals with the mechanical concentration of the mine ore to save the values 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, and typical mill flow-sheets. It is aimed to correlate the lectures with the Laboratory Course 322. Text-book: *Richards' Text-book of Ore Dressing.*

322. Ore-Dressing Laboratory. This course gives the student an opportunity to become familiar with the principles and actual operation of ore-dressing apparatus. While the course may vary somewhat from year to year, the class usually makes two mill runs, one on gold ore using stamps, amalgamated plate, vanner, classifier and canvas table, and the other on a lead ore using trommel, classifier, jigs and tables. In addition, individual tests are made on crushing machines, sizing screens, hydraulic classifiers, magnets, flotation machines, etc. One very important part of this work carried out by the student is the cleaning up, weighing, sampling and analyzing of all the products, the computation of results and the preparation of written reports which are discussed at the weekly seminars.

323. Ore Dressing. The ground covered in the lectures embodies the principles of ordinary 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 course 322 with the exception that lack of time prevents the student from cleaning up his products and preparing reports. Text-book: *Richards' Text-book of Ore Dressing.*

324. Ore Dressing, Advanced. This course, somewhat variable in scope and time allotment, is devoted to lectures, conferences and assigned readings covering ground omitted in course 321. About two hundred hours out of the total time are usually devoted to the design of a mill under certain assumed conditions.

331. Fire Assaying. This course consists of one lecture, one recitation and a six hour laboratory exercise a week. In the lectures are discussed the sampling of ores and bullion, the assaying of ores for gold, silver and lead, and of bullions, solutions, mattes and miscellaneous furnace products. The fire assay of copper, tin, mercury and platinum is briefly discussed. Emphasis is laid upon the chemical and metallurgical principles involved.

The laboratory work is designed to give in a systematic and progressive manner, some experience in the manipulation and technique of fire assaying. 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. Text-book: *Bugbee, Fire Assaying.*

331a. Fire Assaying. This course consists of one lecture, one recitation, and one three-hour laboratory exercise a week. The lectures and recitations are the same as for 331. The laboratory covers only part of the ground covered by 331.

332. Fire Assaying and Metallurgical Laboratory. This is a composite course, consisting of an elementary course in fire assaying followed by a brief laboratory course in fire metallurgy.

The course in fire assaying covers only the assay of ores for silver, gold and lead. The work in fire metallurgy is similar to that of course 354.

333. Fire Assaying, Advanced. This is an advanced course in the theory and practice of fire assaying, which includes practice, with works methods for gold and silver not included in course 331; the fire assay for tin, mercury and members of the platinum group of metals; also a certain amount of research. The total time is dependent upon the hours the student is able to devote to this course.

341. Metallurgy. This course with courses 342 or 342a and 343 covers briefly the entire field of metallurgy. In the first term the subjects studied are general metallurgy, copper, gold and silver. The laboratory work in course 354 runs parallel with the classroom work in course 341. Text-books: *Hofman, General Metallurgy, Metallurgy of Copper; Thomson, Stamp Milling and Cyaniding.*

342. Metallurgy. This course covers the metallurgy of lead, zinc and aluminum, and deals with fuels and refractory materials. The laboratory work of 355 runs parallel with the lectures. Text-books: *Hofman, Metallurgy of Lead, General Metallurgy.*

342a. Metallurgy. This course finishes non-ferrous metallurgy and deals with lead, zinc and minor metals. Laboratory work 355 runs parallel with the lectures. Text-book: *Hofman, Metallurgy of Lead.*

343. Metallurgy: Iron and Steel. The course covers a study of physical and chemical properties of iron and its alloys, and the production of pig iron, steel and wrought iron. Stress is laid in the classroom mainly upon principles; the processes are given in outline and studied in detail by the student in assigned treatises and periodicals. The lectures

are supplemented by visits to plants; seminars are held to discuss the information obtained in these visits.

343a. Metallurgy: Iron and Steel. The classroom work for this course is given with course 343. The assigned readings and plant visits required in course 343 are omitted. Text-book: *Stoughton, Iron and Steel.*

344. Metallurgy: General, Zinc and Minor Metals. This course covers in a general manner the properties of metals and metallic compounds, treats in detail fuels and refractories, discusses the principles which govern pyro-hydro- and electro-metallurgical processes and considers typical metallurgical apparatus. In zinc and minor metals the work supplements that given in course 342. Text-book: *Hofman, General Metallurgy.*

345. Metallurgy of Engineering Materials. The aim of this course is to make the engineer familiar with the industrial use of fuels, with the production of metals and alloys used in construction, and the effects of impurities. The lectures are supplemented by laboratory work, confined mainly to microscopic examination of metals and alloys.

346. Metallurgical Plant Design. This course aims to make the student conversant with some construction details of metallurgical plants. It involves the fundamental calculations for a given problem, and 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.

347. General Metallurgy, Advanced. This course is a combination of lecture, conference, and reading, in which students who have had the undergraduate course of General Metallurgy can carry further their study of the subject as a whole or of several of its branches.

348. Non-Ferrous Metallurgy, Advanced. The aim of this course is to furnish facilities for a detailed study of the metallurgy of some non-ferrous metals. It consists of lectures, conferences, and reading.

354. Metallurgical Laboratory and Reports. This course consists of eight hours laboratory work accompanied by one seminar per week in which a study is made of the leading metallurgical operations, such as roasting, smelting, amalgamating, leaching and electrolysis. Ores of copper, lead, gold and silver are treated by different processes in amounts large enough to obtain results which are quantitative. Experimental tests are carried out by students either individually or assembled in sections, according to the character of the work and the size of apparatus required.

355. Metallurgical Laboratory and Reports. Copper ores are roasted and leached by different methods and metallic copper is refined by fire and electrolysis. The leaching of gold and silver ores begun in 354 is continued. The student obtains experience in plant methods for wet assay by analyzing ores and solutions from his tests.

359. Metallurgical Calculations. This course deals numerically with the physical and chemical phenomena in metallurgical operations, mainly along thermal lines. Special attention is given to thermal efficiencies and to calculations of thermal balances of a number of processes. Reference book: *J. W. Richards' Metallurgical Calculations.*

361–362. Metallography I. This course continues through two terms, with the second term given up to laboratory work. The course covers the properties of metals, the constitution of alloys and metallurgical compounds, and the influences of thermal treatment. The laboratory exercises cover the preparation and microscopical examination of samples of different grades of iron and steel, and of some of the leading industrial non-ferrous alloys; they include the study of changes in structure by mechanical stress and heat treatment, and the preparation of photo-micro-

graphs. Text-book: *Sauveur, Metallography and Heat Treatment of Iron and Steel.*

363. Metallography II. This course is similar to that of Metallography I (courses 361-362), only shorter, the aim being to familiarize non-metallurgical students with the fundamental principles of the subject.

364. Metallography and the Physics of Metals. The work of this course consists of conferences and of the study of specimens in the laboratory. It will be varied to suit individual cases, but in general there will be studied in detail the theory of grain growth in metals and alloys, the effect of mechanical deformation on the structure and properties of industrial alloys, and the theory and practice of heat treatment. Text-book: *Howe, Metallography of Cast Iron and Steel.*

DEPARTMENT OF ARCHITECTURE AND ARCHITECTURAL ENGINEERING

The courses offered by the Department naturally divide themselves into three groups: (1) those courses that are considered essential for all students in Architecture who are working for the degree; (2) those developed especially for the students in the General Option; (3) those developed for the students in Architectural Engineering.

The two options run very nearly parallel for the first two years, a small difference occurring in the second year. At the beginning of the third year the line of demarcation between the professional work of the options becomes more marked, and in the fourth year it is very sharply defined; but the general subjects, common to both options, which continue through the four years emphasize the close relation between the two and the interdependence of one upon the other in a complete architectural equipment.

The students of both options mingle in a common drawing-room so that the ideas and work of each may be influenced by those of the other. They thus learn to feel that one option is but the complement of the other, and to realize their responsibility not alone to their particular department of study but to the whole profession. Thus is accomplished in the engineering student a flexibility, and in the student of design a sincerity, that can scarcely be brought about in any other way.

In all professional work the methods of instruction are, so far as possible, individual. Even in such courses as Architectural History and European Civilization and Art, which must be presented in the lecture room, written exercises and required personal conferences keep the instructor in touch with the progress of each student. In the course in Design and Freehand Drawing individual criticism and correction form to a very large extent the basis of instruction.

As we believe that the function of the architectural school is to give training in fundamentals, our efforts are concentrated upon imparting to the student a very clear understanding of the general principles of the subject, and upon training his powers of analysis and application. It is believed undesirable, in fact dangerous, to spend much time upon the hampering limitations of ordinary practice before the student has acquired sufficient knowledge of the subject to discriminate between the general and the special case.

Daily progress and attention to work is insisted upon, and the results of class exercises during the term are considered quite as trustworthy a measure of a student's development and power as are the formal examinations.

The student is strongly advised to spend a part of the summer vaca-

tion in an office. The experience that he gets there of practical problems and conditions will be a great aid to him in a clearer understanding of the value of his school work.

411. Shades and Shadows. This course attempts to give the student an understanding of the application of the principles of descriptive geometry to methods of casting the conventional shadows used in architectual rendering. These general methods are supplemented by shorter ones often useful in actual practice. Text-book: *Notes on Shades and Shadows, H. W. Gardner.*

412. Perspective. This course consists of lectures and classroom work. The topics considered in the second term and required of all students in Course IV are the fundamental phenomena of appearance, the general theory of conical projection and its application to perspective, the method of revolved plan upon which all shorter methods are based, curves and apparent distortion.

The work in the third term is a continuation of the preceding course and considers methods of direct division, direct measurement, relations between lines and points in the vanishing point diagram; the cubic system, method of perspective plan, and shadows. Text-book: *Principles of Architectural Perspective, Lawrence.*

413. Applied Perspective. This course consists of two-hour drafting-room exercises intended to give the student facility in drawing, freehand, architectural subjects in perspective, and particularly in translating into perspective, views of objects given in plan and elevation.

414. Applied Perspective. This course, given in connection with Design I, consists of studies in composition and the rendering in perspective of some of the problems in design.

415. Applied Perspective. This course is similar in nature to course 414, and is given in connection with the problems in design.

421. Office Practice. This course consists of 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 course 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.

422. Professional Relations. This course is designed to give an understanding of the professional character of the practice of architecture. In it are discussed the personal, ethical, business, and legal relations of the architect with clients, builders, craftsmen, engineers, etc., with whom he has to work in the practice of his profession; also the relations that should exist between the architect, his professional organizations, and the community in which he lives. References are made to legal handbooks upon the laws governing architecture and building, and to the various documents that are issued by the American Institute of Architects. The students are encouraged to take part in the discussions and to express their personal opinions.

431. History of Ornament. This course explains the historical development of ornament, and the general treatment of color in decoration. The student is also made acquainted with the characteristics of different styles. Instruction is given by lectures.

441. Architectural History. This course consists of a series of lectures, illustrated by the stereopticon, devoted to Assyrian, Persian, Greek, Roman, and Byzantine architecture.

442. Architectural History. This course is a continuation of course 441, devoted to Romanesque, Gothic and Renaissance Architecture.

446. European Civilization and Art. This course treats of the rise of civilization and of its westward expansion through the Mediterranean basin. The racial, economic, religious, and political elements in this development are carefully traced, and upon the background thus gained the art of each successive epoch is studied and general æsthetic principles are discussed. The greater part of the time is devoted to Hellenic civilization and art, but as the students in Course IV have a specialized course in the History of Architecture, attention is here particularly concentrated upon sculpture. The lectures are very fully illustrated by lantern slides, supplemented by collections of photographs and by reference to the original works and casts contained in the Boston Museum of Fine Arts. Text-books: *Breasted, Ancient Times; Tarbell, Greek Art.*

447. European Civilization and Art. In this course a survey of the civilization and art of the Hellenistic and Roman world is followed by outlines of mediæval history and a brief study of Byzantine, Gothic and Early Renaissance art. Method and apparatus as in course 446, of which this course forms a continuation.

451. Philosophy of Architecture. This course consists of a series of conferences in which architecture is considered from a theoretical rather than a historical point of view. The course 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.

453. Water Color. The purpose of this course is to impress the student with the importance of combining good drawing, values, and color as applied to architectural subjects. Color-principles and color-harmony will be studied so as to give the student a practical and artistic base upon which to build. Sketching out of doors will be undertaken in three simple values from the point of view that landscape is the proper background for architecture.

Supplementing the course each student is encouraged to make at least twelve sketches from nature, as vacation work to be submitted in the fall for criticism. This is to induce the student to acquire the habit of observation until it becomes an instinct. These sketches are not in any sense intended to be pictures, but first studies with true values and simple planes well indicated.

471. Design I. This course is given by means of individual instruction in the drafting-room and by criticism of the student's work before the class. By means of simple problems in architectural composition the qualities of mind required in the profession of the architect are cultivated in the student. This course also serves to train him in the methods of studying composition and to teach him the principles of academic rendering.

472. Design II. This course is a continuation of course 471.

473. Design III. This course is a continuation of course 472. It includes the preparation of the graduating thesis.

480. Building Construction. This course consists of twenty illustrated lectures planned to give the student a general understanding of the different types of building construction, the different forms of elementary structures, and some idea of the typical proportions imposed by the use of different kinds of material.

481. Constructive Design. This is a course in the methods of analysis and computation required in elementary architectural construction. Some of the subjects treated are: the theory of construction, loads, reac-

tions, the design of beams, columns, and various details. Text-book: *Mimeograph Notes.*

482. Constructive Design. This course is a continuation of course 481, including the study and design of a wooden roof truss, a problem in slow burning construction, and simple steel framing. Text-book: *Mimeograph Notes.*

490. Structural Drawing. This course is intended to supply the preliminary knowledge of structural steel shapes and familiarity with the use of steel handbooks necessary for the study of structural design, and to give some practice in drawing. 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. Some typical shop drawings of a structural steel building frame are made, including the details of a plate girder. This course does not touch upon the manufacture of material or the computation of stresses.

491. Structural Design. This course considers fundamental principles underlying structural design. Its main object is to give the student power to analyze such problems as are found in practice, and to adapt and apply to the solution of these problems, principles already acquired in the study of mathematics and applied mechanics. Elementary forms in wood, cast iron, and steel are studied. Text-book: *Mimeograph Notes.*

492. Structural Design. This course is a continuation of course 491. Practical problems in architectural construction are given, including general framing in steel, plate and box girders, and riveted and pin trusses. The design of reinforced concrete floor systems, columns and footings is considered, with attention given to the effect of continuity of beams and rigidity of connection, also the special problems arising in the design of stairs, floor openings, roofs, walls, and partitions. Great importance is placed upon the study of the details of design; in connection with the one problem, carefully worked out and dimensioned drawings are made. Text-book: *Mimeograph Notes.*

D42. Freehand Drawing. The work consists of drawing from the cast (architectural ornament and the human figure), and in making numerous quick sketches. It is the fundamental drill for all the Freehand Drawing courses.

D43. Freehand Drawing. This course is a continuation of Freehand Drawing D42. The work includes drawing from the cast and architectural ornament in charcoal and in wash; also quick sketching direct from the human figure.

D44. Life Class. This course is a continuation of Freehand Drawing D43. The work consists of drawing from the nude, memory drawing, and direct pen and ink sketching from the figure.

D45. Life Class and Decorative Design. This advanced work is open only to students who have passed with a clear record D44. In this class the students make life-sized drawings from the nude, and study the principles of decorative figure design. This course also includes outdoor sketching from architectural subjects.

DEPARTMENT OF CHEMISTRY AND CHEMICAL ENGINEERING

Instruction in general Inorganic Chemistry is given to all students in regular courses during the first term of their first year, and to all except students of the Course in Architecture in the second and third terms of that year. The course is designed not only to impart a knowledge of the principles of the science and of the descriptive chemistry of the metallic and non-metallic elements, but to constitute an introduction to scientific methods of experimentation, observation and reasoning. Special effort is,

therefore, made to impress upon the student the importance of neatness, accuracy, and thoughtfulness in connection with his laboratory practice, and to point out the value for later professional work in all courses of intelligent observation and ability to interpret the meaning of observed phenomena.

The instruction in chemical subjects is continued in the Courses in Chemistry, Physics, Biology and Public Health and Geology, and in those of Mining, Sanitary, Electrochemical and Chemical Engineering, and includes Analytical, Theoretical, Organic and Industrial Chemistry, as well as opportunity for elective courses in such specialized lines as gas, oil, air, water, food, sugar and proximate technical analysis. In all of these subjects classroom instruction is combined with laboratory work. Students in the courses in Chemistry and Chemical Engineering devote, as a rule, more time to these subjects than students in other courses, and their work is, accordingly, somewhat more advanced.

The opportunities for research work under the direction of the instructors in the various branches enumerated above are unusually extensive, and the general and special laboratories are well equipped for advanced work of this character.

The aim throughout all the courses of chemical instruction is to teach the student self-reliance, to inculcate habits of accurate thought and work, and to afford such a training as will fit him to cope successfully with new scientific and technical problems.

501, 502, 503. Chemistry. This course deals with the fundamental principles of chemical science and with the descriptive chemistry of the more common elements and their important compounds. No previous study of chemistry is required for admission to the course but the instruction is so arranged during the first term (course 501) that students who have already spent considerable time upon chemcial work in the secondary schools are admitted to work of a somewhat advanced character in which advantage is taken of the knowledge which has already been acquired.

During the second and third terms (courses 502, 503) those students who have elected courses in which chemical subjects are contiued beyond the first year are given a laboratory course in synthetic inorganic chemistry, while students taking the other engineering courses devote their time to a study of certain special applications of chemistry to engineering problems. The lectures given to these students are also adapted to their needs and include a limited amount of organic chemistry. Text-book: *Alexander Smith, General Chemistry for Colleges.*

505. Inorganic Chemistry I. This course is designed to strengthen and broaden the student's knowledge of inorganic chemistry. The outside preparation consists in the reading of assigned portions of a standard text-book. The classroom exercises are intended to assist the student in correlating his knowledge in such a way as to increase its utility, and to assist him in logical deduction and reasoning.

506. Inorganic Chemistry II. The aim of this course, which consists in part of informal conferences, is to study in a comparative way the physical and chemical properties of the elementary substances and their more important compounds. Relationships indicated by the periodic system and the electro-motive series are emphasized, and the effect on the change in properties which accompanies change in valence is discussed. Attention is given, also, to the more important results of recent investigations in inorganic chemistry.

508. Preparation of Inorganic Compounds. The laboratory work consists of the extraction of certain of the less common elements from their ores, the study of the typical reaction of these elements, the preparation

of certain inorganic compounds which exist in several modifications and the preparation of complex substances. An attempt is made to introduce a spirit of research into the work. In the classroom the chemical principles illustrated by the work are discussed. Text-book: *Laboratory Methods of Inorganic Chemistry*, by H. and W. Biltz, translated by William T. Hall and A. A. Blanchard.

510. Qualitative Analysis. This course is intended to emphasize the principles involved in chemical analysis, to broaden the student's knowledge of inorganic chemistry, to develop deductive reasoning power and to give practice in manipulation. After a series of preliminary experiments, illustrating principles and giving practice in writing equations, the student is required to analyze unknown industrial products such as minerals, pigments, slags, and alloys. The student reports not only upon his qualitative results, but also upon the proximate amounts of each element present. Not only is the educational value of the course broad, but it serves as a necessary introduction to the study of quantitative analysis. Text-books: *Qualitative Analysis, A. A. Noyes; Analytical Chemistry, Vol. I, Treadswell-Hall.*

512a. Quantitative Analysis. This course is devoted to elementary volumetric and gravimetric analysis. The work is regarded as a preliminary training for the more advanced work and the time is spent upon simple quantitative analyses which are typical of the subdivisions of the subject. Great stress is laid upon the accuracy, care and integrity necessary for successful quantitative work; and, as in the instruction in qualitative analysis, the chief endeavor is to promote thoughtful and intelligent workmanship. Special attention is given to stoichiometry and the modern theories of solutions as applied to quantitative analysis. Text-book: *Quantitative Analysis, Talbot.*

512b Quantitative Analysis. See description of course 512a.

513. Quantitative Analysis. In this course the principles involved in the methods of analysis are discussed in detail and the applications of these principles to problems other than those being carried out by the student in the laboratory are also considered.

The laboratory work of this course includes the analysis of silicates, minerals, ores, alloys, and industrial products. The instruction is intended primarily to fit the student to judge intelligently of the adaptability and accuracy of the processes employed, rather than to furnish detailed directions for specific analyses, and to afford him some general experience with the methods employed for the accurate and rapid control of commercial products. Text-books: *Quantitative Analysis, Fay; Analytical Chemistry, Vol. II, Treadwell-Hall.*

515. Qualitative Analysis of Rare Metals. This course is given for advanced students; the work includes the testing of recently developed methods and the investigation of new procedures for the separation and detection of the rarer metals.

Students are expected to understand the chemical principles involved in the reactions used, and are required to examine chemical literature and to make reports concerning characteristic reactions of some of the metals.

517. Methods of Electrochemical Analysis. The classroom work consists of a review of the electrochemistry of aqueous solutions with particular reference to the Nerust theorem. The important technical applications are discussed and problems given for home study. In the laboratory a number of typical electrolytic determinations are made, some of which involve the careful regulation of the cathode potential. One or more electrometric titrations are made. Text-book: *Quantitative Analysis by Electrolysis, A. Classen-W. T. Hall.*

519. Chemical Literature. This course is devoted to the reading of technical chemical literature in German and French, and to practice in the use of the libraries for the purpose of compilation of journal literature on scientific topics.

520. Water Supplies and Air. This course consists of thirty hours of laboratory practice in the chemical examination of potable waters, of sewages, and of air; and of ten lectures in which the methods of analysis and the sanitary significance of the results are discussed.

521. Industrial Water Analysis. This course comprises a study of the methods of selection and treatment of water for industrial purposes. Special attention is given to the analysis and treatment of boiler waters.

522. Water Supplies and Wastes Disposal. This course deals with the chemical problems involved in modern methods of selection and treatment of potable waters and the disposal and the purification of wastes. Text-book: *Woodman and Norton, Air, Water and Food.*

525. Chemistry of Foods. A course designed to introduce the student to the methods generally employed in determining the character, purity and nutritive value of common food materials. The extent, character and legal status of food adulteration are discussed, and analyses made of typical food products. Text-book: *Woodman and Norton, Air, Water and Food.*

526. Food Analysis, Advanced. This course is designed to illustrate the manner of attacking the chemical problems arising in connection with State and municipal food control. In addition to the laboratory practice, each student is expected to present in conference a detailed written report concerning some particular food material, its forms of adulteration and the most rapid as well as systematic method of detecting them, accompanied by actual figures obtained in the laboratory. Some attention is devoted also to the system of food inspection and to a critical study of methods of food analysis. Text-book: *Woodman, Food Analysis.*

527. Biochemistry. This course consists of conferences and reports on the more important phases of biological chemistry. The chemistry of the substances occurring in the protoplasm of plants and animals, and the processes of digestion, absorption, metabolism and excretion are discussed. Respiration and oxidation are treated from the chemical standpoint. The phenomena of osmotic pressure, adorption, diffusion, and of the colloidal condition are considered from the standpoint of the biologist. Recent work on bacterial metabolism, on ptomains, toxins, and chemotherapy is outlined. The conferences are, as far as possible, illustrated with experiments. When taken as a graduate course further assigned work will be required. Text-book: *Hammarsten, Text-book of Physiological Chemistry.*

528. Selected Topics in Biochemistry. In this course biochemical methods of attack in different laboratories are considered as well as more complicated problems which could not be discussed in the more elementary course, (Biochemistry, course 527), such as the general question of neutrality in the body, enzyme action, autolysis, cell contents, gastro-intestinal reactions, internal co-ordination, growth, chemistry of immunity, of chlorophyll and of plant syntheses.

529. Optical Methods in Chemical Analysis. This course comprises standardization of saccharimeters by quartz-plate readings; determinations of specific rotary powers, double polarization, the quotient of purity; and practice in the calculations of optical analysis, with special reference to the use of the polariscope, refractometer and microscope, as applied to sugars, starches, essential oils, and the like. Text-book: *Rolfe, The Polariscope in the Laboratory.*

530. Proximate Technical Analysis. In this course the student

selects a subject, consults the literature relating to it, presents the results of his reading before the class for criticism and suggestion and then applies the method as thus worked up in the laboratory. Among the topics studied are alkaloids, asphalt, oils of all kinds, paints, paper, inks, rubber, soaps, tanning materials and the like. The course is designed to develop a critical spirit of investigation rather than merely to study the technique of analytical methods.

531. Gas Analysis I. This course considers the qualitative and quantitative analysis of the various gases, the technical analysis of commonly occurring gaseous mixtures, such as illuminating and fuel gas, gases from acid chambers and chimney gas, and the consideration of losses due to waste gases. Text-book: *Gill, Gas and Fuel Analysis for Engineers.*

532. Gas Analysis II. This course consists of ten three-hour exercises in the analysis of gases, with the use of methods and apparatus which admit of a high degree of precision.

533. Gas and Fuel Analysis. This course discusses the origin, manufacture, properties, uses, and analysis of the various fuels; also smokeless combustion, and the consideration involved in the economical application of fuel. Given in connection with Engineering Laboratory. Text-book: *Gill, Gas and Fuel Analysis for Engineers.*

534a. Applied Chemistry. This course deals with the properties, testing, and applications of paints, oils, varnishes, lubricants and wood preservatives. Alloys, bearing metals, boiler scale and corrosion of metals are also discussed.

534b. Applied Chemistry. This course is similar in character to course 534a but includes about thirty hours of laboratory practice.

536. Testing of Oils. This course covers the mechanical and chemical testing of the mineral, animal, and vegetable oils, with the purpose of detecting adulteration, and of determining their applicability, and their safety, from the point of view of the manufacturer and of the insurance underwriter. Text-book: *Gill, Handbook of Oil Analysis.*

537a. Chemistry of Road Materials. This course is intended for civil engineers and deals with the applications and tests of bitumens, tars, oils, paints and chemicals used in the preservation of roads and road structures.

537b. Chemistry of Road Materials. In this course are considered the source, preparation, application and tests of cements, bitumens, tars, binders, oils and preservative agents used in connection with road making.

540. Special Methods and Instruments. This course deals with the use of the microscope, polariscope and saccharimeter, refractometer, viscosimeter, colorimeter, turbidimeter, nitrometer, and precision centrifuge, and a study of their application to problems in technical practice.

541. Metallography I. In this course, the general methods used in the study of alloys, the construction and interpretation of equilibrium diagrams and the relations between the constitution of alloys and their physical properties will be considered. The iron-carbon diagram will be studied in detail with its application to the heat treatment and the use of steel. Text-books: *Williams, Metallography*; *Fay, Microscopic Examinations of Steel.*

542. Metallography Ia. This course is similar to course 541, but intended only for students entering from other colleges.

543. Metallography II. This is an advanced course of lectures, conferences and reports in which special problems of scientific and industrial interest are discussed in detail.

550. Organic Chemistry. (**Brief Course.**) This course is designed for students who will not pursue the study of organic chemistry further; it

includes a general discussion of the most important facts in the chemistry of the compounds of carbon. The typical methods of preparation and the chemical and physical properties of the various classes of compounds are presented, and a brief account is given of the source and technical preparation of the simpler substances of commercial importance. Text-book: *Moore; Outlines of Organic Chemistry.*

551. Organic Chemistry I. This is an extensive course in which the general principles of organic chemistry and the properties of important compounds receive thorough discussion. The lectures are fully illustrated by experiments. Text-book: *Cohen, Theoretical Organic Chemistry.*

552. Organic Chemistry II. For admission to this course students must have completed satisfactorily a year's work in organic chemistry. The important principles of the science are emphasized from a more mature point of view than is possible when the subject is approached for the first time. The usual classification of compounds into the aliphatic and aromatic series is discarded, and the properties of the compounds containing the important radicals are studied in a comparative way. Emphasis is placed on the study of unsaturation, the influence of structure and substituents on the activity of radicals, and the application of the methods of physical chemistry to the solution of problems in organic chemistry.

553. Organic Chemistry III. The object of this course is to supplement the instruction given in Organic Chemistry I and to aid the student in acquiring that broader and more intimate acquaintance with the theories, principles and applications of organic chemistry that should be possessed by the industrial organic chemist as well as by teachers and research workers in the Science. Groups of important topics, varying from year to year, are thoroughly studied by assigned reading, and the discussion of monographs and current publications in a seminar accompanied by lectures. Text-book: *Cohen, Organic Chemistry for Advanced Students (Arnold, London) is recommended.*

555. Organic Qualitative Analysis. This is a laboratory course for advanced students in the use of systematic methods for the identification of organic compounds. Text-book: *Mulliken, Identification of Pure Organic Compounds.* (Purchase of the text-book is not required.)

556a. Organic Chemical Laboratory. This course includes three kinds of laboratory practice. (a) Organic preparations. In this the student becomes familiar with the more common methods of manipulation and the more important synthetic processes, while the application of theory to the work in hand is constantly emphasized by regular conferences with individual students. (b) Identification of organic compounds. This part of the work has a similar educational value to that afforded by qualitative analysis in the inorganic field. Similar methods are pursued. (c) Ultimate analysis. This portion of the work (now given only in Course V) gives drill in combustion and the method of Carius. In these fundamental operations the student is expected so to overcome all sources of error as to acquire confidence in his results. Text-book: *Gattermann, Practical Methods of Organic Chemistry.*

556b. Organic Chemical Laboratory. This course provides laboratory practice based upon theoretical instruction given in course 550. The kind and quantity of work are widely varied, according to the professional course which the student is pursuing. Text-book: *Gatterman, Practical Methods of Organic Chemistry.*

558. Recent Developments in Organic Chemistry. This course is designed to bridge the gap between the text-books and the current journals, and so to awaken in the student the desire to read for himself. It is also

open to those members of the Instructing Staff who wish to keep in touch with what is being done in the organic field.

559. Special Topics in Organic Chemistry.

559a. Chemistry of Dyes. This is an illustrated course of lectures for graduate students on the organic chemistry of the synthetic dyestuffs and their intermediates. Synthetic methods, physical, chemical and tinctorial properties, structure, and chromaphore theory and classification are systematically discussed, and their significance in the development of the color and textile industries is indicated. Text-book: *Caine and Thorpe, The Synthetic Dyestuffs.*

559b. Chemistry of Explosives. In this course the various types of propellent powder will be considered, their history, manufacture, properties, testing, and manner of use. Initiators and commercial and military high explosives will be taken up, particular emphasis being given to their chemical reactions and to their properties with reference to current theories of explosives.

559c. Synthetic Methods in Organic Chemistry. This is a course for graduate students specializing in organic chemistry. The great methods of organic synthesis will be discussed, particular attention being given to the relation of the reagent to the structure of the product and to the varied reactivity of similar groups. The course is intended as an introduction to organic research inasmuch as it aims to describe the means whereby substances of desired structure may be deliberately synthesized.

559d. History of Organic Chemical Theory. This is a course for graduate students specializing in organic chemistry. The fundamental concepts of organic chemistry will be studied with particular reference to the experimental and other evidence which caused them to be evolved and which has caused them to be changed. The basis of such ideas as structure, tautomerisom, the arrangement of atoms in space, partial and residual valence, " negativity " of groups, etc., will be considered critically.

565. Chemical Principles I. In this course only the more important general principles of chemistry are considered, but these are treated with great thoroughness, and are illustrated by applying them to a variety of problems, which the students are required to solve. These problems are discussed in detail, the aim being to develop power to use the principles, rather than merely to impart a knowledge of the phenomena. The topics considered in the course are the pressure-volume relations of gases, the properties of solution related to molal composition, the conduction of electricity in solutions, the ionic theory, the mass-action law applied to the rate and equilibrium of chemical changes, heterogeneous equilibrium from the phase-rule standpoint, and thermo-chemistry. The laboratory course serves to emphasize the principles of the subject, rather than to teach physicochemical methods of measurement; and for this reason it is closely correlated with the classroom work. The principles are, however, illustrated by the determination of physicochemical constants; for example, of vapor-density and molecular-weight, vapor-pressure, freezing-point, transference-numbers, conductivity, and ionization, of rates of reaction, of the equilibrium-constants of gaseous, dissolved, and solid substances, and of thermo-chemical constants. Text-book: *Noyes and Sherrill, General Principles of Chemistry.*

566. Chemical Principles Ia. This course is planned solely for graduate students from other colleges who have already taken a descriptive course in physical chemistry, which is not accepted as the equivalent of Chemical Principles I. The principles of chemistry considered include all of those presented in courses 565 and 567 (Chemical Principles I and II). The principles are illustrated by problems, which the students are required to

solve. The course is conducted as a series of conferences at which the general principles and the problems which illustrate them are informally discussed in detail. Text-book: *Noyes and Sherrill, General Principles of Chemistry.*

567. Chemical Principles II. This course is a continuation of course 565, and is conducted in the same general way. The principles of electrochemistry and of thermodynamic chemistry are developed from the free-energy viewpoint. The topics considered in electrochemistry are: the electromotive force of voltaic cells and the separate electrode and liquid potentials which constitute it; electrode-potentials in relation to the equilibrium of oxidation and reduction reactions; electrolysis in relation to electromotive force; and concentration and gas polarization. In thermodynamic chemistry the free-energy decrease attending isothermal chemical changes, or the maximum work obtainable from them, is considered in relation to the equilibrium conditions of such changes; and from the effect of temperature on free energy is derived that of chemical equilibrium. Some of these topics are dealt with more briefly with Course X than with Course V students, and the time thus gained is devoted to a consideration of the chemistry of colloidal substances. Text-book: *Noyes and Sherrill, General Principles of Chemistry.*

568. Thermochemistry and Chemical Equilibrium. In this course the more important general principles of chemistry are discussed. The topics considered are the pressure-volume relations of gases, the properties of solutions, elements of thermo-chemical calculations, applications of the phase rule, the mass-action law applied to homogeneous and heterogeneous equilibria, the effect of pressure and of temperature on chemical equilibria, the elements of electrochemistry and the energy obtainable from chemical change. These principles are illustrated and emphasized by numerous problems which are solved independently by the students and afterwards discussed in the classroom. Text-book: *Walker, Introduction to Physical Chemistry.*

569. Chemistry of Colloids. This course is designed to acquaint the student with the fundamental properties of substances in the colloidal state. It will include also a consideration of surface phenomena in general, such as surface-tension, adsorption, etc. Text-book: *W. G. Taylor, Chemistry of Colloids.*

571. Physical Chemistry Seminar. The classes in this course are of an informal nature and include discussion of the assigned reading. Many of the topics are brought up to date by assignments in the current periodical literature, sometimes of definite articles for review, sometimes of a general topic which the student is expected to follow up by a search of the abstract journals. While the text serves as a general outline of the work, certain topics chosen entirely outside of the text are considered in relation to physical chemistry as a whole. These might include, for example, the extrapolation of conductivity data to zero concentration, determination of the value of the faraday, the absolute zero point, recent improvements in calorimetry, etc. The course is given only in case a sufficient number of students apply in time to arrange for it. Text-book: *Nernst, Theoretical Chemistry: Seventh English Edition.*

572. Radiochemistry and Atom Structure. This course is given as a seminar in which original articles, on atomic structure and radiochemistry, by Rutherford, Soddy, Moseley, Langmuir, etc., are read and discussed.

573. Thermodynamics of Chemical Reaction. This course deals primarily with the work obtainable from chemical changes in relation to the equilibrium conditions of such changes. The subject is presented from the free-energy viewpoint. Methods for calculating free-energy

values from equilibrium data and electromotive force, and the effect of temperature on free energy, and therefore on equilibrium, are considered in detail. The course is conducted as a seminar with definite problems to serve as a basis for discussion. The problems, which frequently necessitate reference to the chemical literature for data involved, are so selected that the student acquires an insight into a general plan for working out a complete system of free-energy values, from which could be calculated the equilibrium constants of all chemical reactions at different temperatures. Text-book: *General Principles of Chemistry, Noyes and Sherrill.*

574. Kinetic Theory of Gases, Liquids, and Solids. In this course those ideas and theories will be discussed which seek to account for the physical properties of substances from a kinetic point of view. The methods of mathematical analysis which are particularly adapted to this particular field will first be considered, after which the results obtained by their application to several molecular models will be examined. Van der Waal's ideas and his equation, and its later development by Van Faar, which attempts to account for the properties of non-perfect gases and the continuity of the three states of aggregation, will receive detailed attention. Recent attempts to use an atom model suggested by the work of Bohr and others will be considered, and a general comparison finally made showing how well the existing quantitative data can be accounted for by the most recent developments of the kinetic theory.

575. Industrial Chemistry. In this course the more important industrial chemical processes, including metallurgy, are studied from the point of view of both the chemical reactions forming the basis of the process, and the plant necessary to carry on these reactions. In this way the interrelationship of the different industries as to raw material, sources of energy, and standard types of apparatus is developed and a general survey of the field obtained. Text-book: *Thorp, Outlines of Industrial Chemistry.*

576. Chemical Engineering I. In this course are considered the principles on which the more important mechanical operations involved in the chemical manufacturing industries depend, together with a study of the types of equipment available for such operations, and the kind of work for which each is best adapted. The application of these principles is illustrated both by detailed discussion in the classroom and by the solution of typical problems. Among the subjects considered are furnaces and combustion, the flow of heat, crushing and grinding, the separation of solids, extraction, filtration, crystallization, distillation, evaporation, the flow of fluids, humidification and air drying.

576a. Chemical Engineering I. A brief course along the lines of course 576.

577. Chemical Engineering II. The purpose of this course is to study thoroughly and in detail special phases of chemical engineering. Each subdivision of the course is devoted to a single topic, and each may be taken independently of the others.

577a. Distillation and Evaporation · Design of Apparatus. Discussion of the design and operation of the standard types of stills and evaporators in more detail than is possible in Chemical Engineering I.

577b. Drying.

577c. Extraction.

577d. Combustion.

579. Chemical Engineering Laboratory. The major portion of the laboratory work in Chemical Engineering given at the Institute is obtained in the School of Chemical Engineering Practice. There are, however, certain phases of the subject which it is desirable to study in the laboratory

under conditions admitting of variation in control, which cannot be realized in the plant without interfering with production. The purpose of this course is to furnish laboratory instruction limited to such topics. The course involves experiments in the flow of gases and liquids, in filtration, evaporation, drying, combustion and electric furnace work.

580. Materials of Construction. This course treats of the mechanical properties and chemical resistance of the commercial materials of construction. Especial attention is given to the study of plastics from the point of view of the engineer.

581. Applied Thermochemistry. This course presents those phases of thermochemistry and thermodynamics which are of most importance in the field of chemical engineering.

582. Plant Design. This course is planned to familiarize the student with the more important methods of chemical engineering design, to develop original power in the solution of problems, to give experience in the selection, criticism, interpretation, and use of material available in the literature, and to emphasize the technique of the laboratory methods of obtaining needed data. Especial attention is paid to graphical methods. The subject matter of the course will vary from year to year, and will be selected from any suitable branch of applied chemistry.

583. Applied Chemical Thermodynamics. This course aims first to correlate the viewpoints of the physical chemist and the mechanical engineers in their treatment of thermodynamics, and thus give a well rounded basis for the application of thermodynamics to chemical and chemical engineering problems. The primary object of the course, however, is to give experience in the use of tools already acquired in other courses. A thorough quantitative study is made, therefore, of the equilibrium relationships at different temperatures of a few industrially important reactions, the data being derived from the ordinary sources in the literature. The bearing of the free-energy concept on various processes and operations of chemical industry is also emphasized.

584. Industrial Applications of Chemical Principles. In this course a few important industrial processes are studied from the standpoint of general chemistry. Particular attention is directed to determine the theoretical maximum efficiency in each case and methods of attaining it.

585. Selected Topics in Industrial Chemistry. Of the courses grouped under this head six are given each year, each one comprising ten lectures extending over a period of five weeks. While the whole series may be taken if desired, the individual courses are not inter-dependent and it is rather expected that the student will select only two or three.

The method of treatment pursued in this series is to take up each of the specified industries from a fundamental and more or less historical point of view. By showing the part which various economic, physico-chemical, and chemical-engineering principles have played in bringing each industry to its present state of development, it is possible to drive home the importance of these general principles and their method of application, as well as to give a more thorough appreciation of the industry as a whole than is possible in the undergraduate course where the main emphasis is placed on present practice. An effort is also made to point out the developments which are now in progress and the direction in which future improvements may be expected. In general, at least one of the ten lectures will be by a specialist who is actively engaged in the industry under consideration. At the close of the course each student will be required to present a written discussion of some assigned phase of the subject matter considered. The special topics in course 585 are as follows:

585a. Sulphuric Acid.
585b. Glass and Ceramics.
585c. Iron and Steel.
585d. Starch and Cellulose.
585e. Petroleum.
585f. Nitrogen Fixation.
585g. Fuels and Their Distillation.
585h. Rubber.
585i. Textiles and Dyeing.
585j. Paints, Oils and Varnishes.

586. Problems of the Chemical Engineer. In this descriptive course are developed the field of activity of the chemical engineer and the preparation along both chemical and engineering lines which the practice of the profession requires.

587. Experimental Problems in Industrial Chemistry. In this course no attempt is made to prepare a large number of chemical products, on the one hand, nor to ape factory methods or scale of operations on the other. The work consists rather in instruction in the evolution of a chemical process from the idea as formulated in the classroom through the successive stages of laboratory development to the design and equipment of the necessary plant.

The process is first examined in the light of available literature, and is analyzed as to the probable factors which enter into its successful operation. Commencing with the preparation of the raw material it is next carried out in a quantitative manner in the laboratory on as large a scale as is consistent with reasonable accuracy and despatch. In this way the knowledge necessary to an intelligent opinion as to the commercial practicability of the process is obtained, and the data required for the design and equipment of a plant for carrying on the process is accumulated. Each chemical operation is analytically controlled, rapid methods of the requisite accuracy being employed. The physical properties of the solutions, precipitates, and final products are critically observed and the choice of the apparatus to be recommended is based upon quantitative experimentation carried out in the laboratory. Finally, each student submits a technical report upon the process and plant, complete with blue prints of the layout and estimate of costs. In this report especial attention is devoted to the use of clear, concise English, and to the general appearance of the finished copy. Questions of labor, depreciation, interest, and insurance are discussed in the class, and so far as is possible are involved in the students' reports.

588. Economics of Chemical Industries. This course deals with the economic factors peculiar to chemical industry. A study is made of the better known and more important chemical industrial developments and of possible changes in the price of the product due to increasing outlets for by-products. Graphical studies are made of the relations between price and available market and of the factors which in a given chemical process fix the price of the several products.

Research Problems:

590. Inorganic Chemistry.
591. Organic Chemistry.
592. Physical Chemistry. These courses, 590, 591, 592, include the solution of problems of the nature of minor researches, in the respective fields indicated above, which are intended to give the student an opportunity to test his ability to do work of an original character. In

connection with this work carefully written reports are required upon the journal literature relating to the topics in hand, and a formal record of results obtained in the laboratory must be presented for acceptance. The problems in inorganic chemistry include also those of analytical chemistry.

593. History of Chemistry. This course is devoted to the historical development of the science and to the life and work of the great men who have contributed to this development. The student is required to do extensive reading and to make oral as well as written reports upon the details of classical investigations.

594. Recent Developments in Chemistry. During the second and third terms, weekly meetings of this course are held at which reports and reviews of topics of current interest are presented by members of the instructing staff or graduate students.

595. Thesis. As a part of the requirements for graduation each student is required to present a written thesis based upon an investigation carried on under the direction of a member of the instructing staff. So far as possible, each student is allowed to select the field of chemistry or chemical engineering in which to carry on his investigation.

596. Thesis Reports. A series of classroom exercises are held at which students are required to report upon the progress of the investigations upon which their theses are to be held. These reports are subject to criticism and suggestion from members of the class and of the instructing staff.

597. Thesis Reports and Memoirs. This course consists of a series of exercises, a part of which are of the same nature as course 596. In addition, each student is assigned several topics in applied chemistry upon which memoirs are prepared and presented for discussion before the class and members of the instructing staff. In these papers the student is required to present the subjects as completely and critically as is practicable, and to supplement them by experiment, drawings, or tabulated statistics.

598. Research. The research required as a part of the requirements for any of the advanced degrees may be taken in any of the following divisions of the Department: inorganic, physical, organic, or applied chemistry. In its general character the work must be of such a grade as to demonstrate the fitness of the student to carry on original investigations with a reasonable degree of independence but in consultation with the member of the staff having the research in charge.

599. Research Conferences. The researches in progress in the Research Laboratories of (a) inorganic, (b) physical, (c) organic and (d) applied chemistry are discussed by those who are at work upon them.

DEPARTMENT OF ELECTRICAL ENGINEERING

The instruction in Electrical Engineering aims to give a foundation in those general principles of electricity and magnetism upon which the development and advancement of the electrical art, in all its various phases, have been shown to rest. Co-ordinated with this instruction in the theory of electricity and magnetism and enforcing it, are courses on the larger problems of engineering, together with the work in the laboratories, embracing a detailed study of the instruments, methods, and plant used in modern electrical engineering practice, special emphasis being laid throughout on a study of sources of error, economy of time, and precision of results.

The unusually extensive equipment of the Augustus Lowell Laboratory of Electrical Engineering makes it possible to familiarize the under-

graduate student with the various types of apparatus and the engineering methods with which he will be brought into contact in his later professional work, and also affords opportunity for graduate students to carry out original investigations. The latter opportunities are enhanced by the great libraries of the Department.

Excursions to important industrial works with which the vicinity of Boston abounds keep the students in touch with present practice in electrical engineering.

In Course VI-A the instruction and experience in shop processes and shop management are added to the scientific instruction of Course VI.

600. Principles of Electrical Engineering (Electric and Magnetic Circuits). A course of recitations and problems devoted to fundamental concepts of electrical engineering and to the laws of the electric and magnetic circuits.

601. Principles of Electrical Engineering (Direct-Current Machinery). A course of recitations and supervised problem work devoted to the principles underlying the construction and performance of direct-current machinery.

602. Principles of Electrical Engineering (Variable and Alternating Currents). A course of recitations and supervised problem work devoted to variable and alternating currents.

603. Principles of Electrical Engineering (Alternating-Current Machinery). A course of recitations and supervised problem work devoted to the discussion of the various types of alternating-current machinery for the generation, transmission and distribution of power.

603a. Principles of Electrical Engineering (Alternating-Current Machinery). A course of recitations and supervised problem work, similar to course 603 and a portion of course 604, but with less attention paid to details.

604. Principles of Electrical Engineering (Alternating-Current Machinery). A continuation of course 603. A course of recitations and supervised problem work devoted to the discussion of the various types of alternating-current machinery for the generation, transmission and distribution of power and a discussion of transients in transformers and alternators.

604a. Principles of Electrical Engineering (Alternating-Current Machinery and Electric Transmission). A course of recitations and supervised problem work devoted to the continued study of alternating-current machinery and to problems involved in the electric transmission of energy.

605. Principles of Electrical Engineering (Transmission Problems). A course of recitations and supervised problem work devoted to the consideration of the electrostatic circuit, particularly with regard to its application to the dielectric stresses in insulators and cables, the phenomena of electrostatic and magnetic induction in transmission lines, corona and corona loss. A brief discussion of the electrical and mechanical calculations of transmission lines and graphical methods as applied to such problems is included.

606. Principles of Electrical Engineering (Transmission Problems). A continuation of course 605. A course of recitations and supervised problem work devoted to the consideration of power factor correction and unbalanced loads on transmission lines and economic considerations of electric power transmission.

607. Principles of Electrical Engineering. A course of recitations and supervised problem work covering the subject matter of courses 600 and 601 with some condensation. Available for college graduates entering the third year of Course VI, as a substitute for courses 600 and 601.

620. Electric Transmission Equipment. A course of lectures and recitations devoted to the design, construction and characteristics of the equipment employed in the electrical transmission of energy.

621. Industrial Applications of Electric Power. A course of lectures on electric motor drive, electric lighting and electric heating in industrial plants and for industrial purposes.

622. Central Stations. A course of lectures dealing with the design, construction and operation of electric power generating stations, accompanied by relevant problems in engineering economics.

623. Central Station Design. In this course particular attention is given to the study and projection of load curves, the economic selection of site and machinery, the arrangement of plant and a statistical analysis of the cost of electric energy.

623a. Central Stations. A course of lectures on the design, construction and operation of electric power generating stations, being a condensation of courses 622 and 623.

624. Electric Railways. A course of lectures and recitations relating to the construction, equipment and operation of different types of electric railways, together with related problems in power transmission and generation.

625. Dynamo Design. A course of exercises discussing direct-current machines and alternating-current transformers. Materials of construction, methods of construction, and the influence of the various factors in design on manufacture and operation are considered.

626. Dynamo Design. A course of exercises forming a continuation of course 625, treating of alternating-current machines.

627. Illumination. A course of lectures and laboratory exercises. The lectures are devoted to a discussion of the production, measurement and utilization of light. In the laboratory the student gains experience in the use of the ordinary apparatus designed for monochromatic and heterochromatic photometry.

628. Telegraph and Telephone Engineering. This course deals with the main systems of electrical telegraphy and telephony (using wires and wireless) in practical use with reference to the principles and modes of application. The laboratory work includes measurements of voltage and current upon several types of artificial lines, and the comparison of measured results with those deduced theoretically.

629. Storage Batteries. A course dealing with the theory, construction, care and application of storage batteries. Ten lectures, accompanied by laboratory work. To be given in one term of fourth year if applied for by six or more students.

638. Electric Wiring and Lighting of Buildings. A course of lectures on the design of electric wiring and lighting systems for buildings.

640. Elements of Electrical Engineering. A course of lectures and recitations in which are considered the fundamental principles of the generation, distribution and utilization of electric power with direct and alternating currents.

641. Elements of Electrical Engineering. A course of lectures and recitations in which are considered the fundamental principles of the generation, distribution and utilization of electric power with direct current.

642. Elements of Electrical Engineering. A course of lectures and recitations in which are considered the fundamental principles of the generation, distribution and utilization of electric power with alternating current.

644. Electric Transmission and Distribution of Energy. A course devoted to an analysis of the electric circuit and the problems of electric transmission and distribution of energy.

645. Alternating Currents and Alternating-Current Machinery. A course devoted to the principles of alternating currents and alternating-current machinery.

646. Alternating-Current Machinery and Its Applications. A continuation of course 645. A course devoted to the principles and performance of alternating machinery with special reference to mechanical and naval problems.

650. Electrical Engineering Seminar. A series of conferences of the instructing staff and all men pursuing graduate work in the branches relating to electrical engineering, for the purpose of reviewing problems of timely interest in electrical engineering. Continued through the year.

651. Alternating Currents. A graduate course concerned chiefly with the transmission of power by alternating currents and its utilization. Solutions of special problems and the performance of laboratory experiments form an important part of the work. The transmission of telephone currents along conducting lines is also discussed in its relation to the general problem of long-distance alternating-current transmission of power. In the whole course there are approximately fifteen laboratory exercises.

652. Alternating-Current Machinery. A graduate course of lectures and conferences dealing with the advanced analysis of the theory and performance of alternating-current machinery.

653. Public Service Companies. A graduate course of lectures and conferences on organization and management of such companies, accompanied by extensive assigned reading and examination of operating records.

654. Power Stations and Distribution Systems. A graduate course consisting of the examination of a project relating to the generation and distribution of the electric power and the preparation of a report dealing with the preliminary design and estimate of cost.

655. Electric Railways. A graduate course of lectures and problems on the application of electricity to the propulsion of railway trains. Special attention is paid to the predetermination of size of equipment and energy requirements, the relative advantage of steam and electricity for propulsion, the various systems of electric traction, and to the making of estimates of the cost of construction and operation.

656. Electrical Communication of Intelligence. A graduate course on the theory of telegraphy and telephony by wires and radio communications, including the problems of wave transmission of sinusoidal and non-sinusoidal impulses and trains, line loading, repeating vacuum tube effects and radio transmission. Laboratory work will be associated with the lectures.

670, 671a, b, 672a, b, 673a, b, 674b. Electrical Engineering Laboratory. A course devoted to study of technical electrical measurements and dynamo electric machinery. For purposes of administration, the work is divided into two parts. (a) Technical Electrical Measurements.— The work in technical electrical measurements consists of six exercises in the first term of the third year, five in the second term of the third year, five in the third term of the third year and three in the first term of the fourth year. Particular attention is given to tests to determine the character and behavior of the materials of electrical engineering under various circumstances and to the study of electrical measuring instruments. The laboratory exercises are supplemented by a series of conferences in which the general subject of technical electrical measurements is discussed. (b) Dynamo Electric Machinery.— The work in dynamo electric machinery consists of five exercises in the second term of the third year, five in the third term of the third year, seven in the first term of the fourth year, and ten in the

second term of the fourth year. The tests in the third year include the determination of the characteristics, efficiency, regulation, and heating of direct-current machinery. In the fourth year tests for efficiency, heating, regulation and the like are made on alternating-current machines.

The laboratory exercises are supplemented by conferences. Preliminary reports prepared in the classroom at specially assigned hours are submitted by students before performing each experiment in the laboratory.

675, 676, 677, 678. Electrical Engineering Laboratory. The subject matter is abbreviated from that of course 670-674.

680. a, b. Electrical Engineering Laboratory. This course is intended for those students who desire to do more than the regularly required amount of undergraduate work in the Electrical Engineering Laboratory. The experiments are arranged to suit the requirements of the individual student.

681, 682, 683, and 684. Electrical Engineering Laboratory. A course of laboratory exercises devoted to the study of technical electrical measurements and dynamo electric machinery. The subject matter is similar to that in courses 670-674.

685. Electrical Engineering Laboratory. A course of ten exercises designed to familiarize students with the elements of technical electric measurements and with the characteristics and operation of the ordinary types of electrical machinery.

686. Electrical Engineering Laboratory. A course of seven laboratory exercises in subject matter similar to that of course 685.

687. Electrical Engineering Laboratory. A course of ten experiments in the fourth year, designed to illustrate the operating characteristics of the common forms of alternating-current machinery and the execution of some of the more important acceptance tests.

689. Technical Electrical Measurements, Elementary. A course of five laboratory exercises devoted to the study and testing of commercial electrical measuring instruments.

690. Technical Electrical Measurements. A course of ten exercises devoted to the study of electrical measuring instruments and the materials of electrical engineering.

695. Electrical Testing (Advanced.) An advanced laboratory course intended as an introduction to more elaborate work of special investigation. Each student is assigned a particular problem and is expected to work out carefully the experimental process involved so that a just estimate of the value may be reached. To facilitate this work, a very complete collection of instruments and standards has been provided.

696. Electrical Engineering Laboratory (Advanced). The work of this course is specially arranged for each student, and deals particularly with the more advanced problems of alternating currents and alternating-current machinery.

DEPARTMENT OF BIOLOGY AND PUBLIC HEALTH

In the work of this Department some knowledge of chemistry and physics is indispensable by way of preparation, and hence no biological course is open to first-year students. In the second year, third term, courses in general biology, including botany and zoology, are given, while in the third and fourth years instruction in professional subjects is provided, chiefly for students of Biology and Public Health, Chemistry, Sanitary Engineering, Geology, and General Engineering, — as is described in detail below. The subjects fall somewhat naturally into three groups: first, the *general biological*, including the fundamental courses in biology, botany,

zoology, anatomy and physiology; second, the bacteriological group, including general bacteriology and its professional and technical applications in the laboratory; third, the *public health* group, in which broad applications to community life and public and social welfare are considered. The whole aim of the instruction in the lower years is to give a solid foundation; in later years, to develop professional attainment.

701. General Biology. This course is an introduction to the study of living things. It consists essentially of a general discussion of the fundamental facts and principles common to all the biological sciences, illustrated and made real by careful laboratory examination of selected and typical plants and animals. The first part of the course is elementary and preparatory in character and aim, and is followed by a broad survey of the fields of zoology and Botany. Text-books: *General Biology by Sedgwick and Wilson; Hertwig's Manual of Zoology by Kingsley; Text-book of Botany by Coulter, Barnes and Cowles, Volume 1.*

702. Elements of Biology. This is a briefer course of the same character as course 701, designed to furnish an introduction to the study of living things in so far as these are of especial interest to students in Chemistry, Sanitary Engineering and Geology. This course is a prerequisite for Elements of Bacteriology 731 and for Microscopy of Drinking Waters 706.

703. Theoretical Biology. This is an advanced course in General Biology of lectures and recitations 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 three major problems discussed are — heredity, morphogenesis and immunity. Special reading assigned. Text-book: *Genetics and Eugenics by Castle.*

704. Genetics. A course of lectures, assigned reading and laboratory experiments in plant and animal breeding.

706. Microscopy of Drinking Water. The aim of this course is to give first-hand knowledge of the organisms most important in the development of tastes and odors in water supplies. The treatment of water by copper sulphate, aeration, etc., is also discussed. Methods of microscopical examination are taught and practical laboratory work is required. Text-book: *The Microscopy of Drinking Water by Whipple.*

707. Parasitology. A course on invertebrate zoology with special reference to the parasitic forms and their relation to disease in man and the domestic animals. Lectures with demonstrations. Text-book: *A. C. Chandler, Animal Parasites and Human Disease. Wiley,* 1918.

710. Anatomy and Histology. A course on the 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. This course affords a sound basis for the subsequent study of human anatomy, physiology, personal hygiene and public health. Text-books: *Wilder, History of the Human Body; Kingsley, Guides to Dissection, the Dogfish; Bigelow, Directions for Dissection of the Cat; Lewis & Stobs, Text-book of Histology; Harman, Laboratory Outlines for Embryology.*

715. Anthropology. This course is a general survey of the field of anthropology in which man is studied from various standpoints, such as zoology, archaeology and ethnology.

720. General Physiology. This is a course dealing with the general principles of the physiology of protoplasms, with special emphasis upon cellular physiology.

722. Personal Hygiene I. This course deals with an extended consideration of personal health and disease, their conditions and causes, such as the regulation of the body temperature, the sources and remedies of discomfort in private rooms and public halls, due to overheating, overcrowding, and the like, together with such topics as exercise, work, play, oral hygiene, hygiene of clothing, of the feet, of the alimentary canal, mental hygiene, etc.

729. General Biology and Bacteriology. An elementary course dealing with the fundamental principles of biology, the behavior of living matter, growth, etc., and the general relation of micro-organisms to chemical changes such as fermentation, putrefaction and disease. Text-books: *Sedgwick and Wilson, General Biology; Jordan, General Bacteriology.*

730. Bacteriology. A fundamental course in the biology of the bacteria, with thorough study of selected types. The latter part of the course is devoted to the special study of the bacteriology of water, sewage, air and foods, and includes a large amount of laboratory work on the practical examination of waters, sewage and sewage effluents, special emphasis is placed on the proper interpretation of results. The third term is largely given to the bacteriological examination of air, milks, dairy products, eggs, oysters, meats and food preparations. Stress is laid on methods for the detection and estimation of intestinal, fermentative, putrefactive and pathogenic types of bacteria, and on care and accuracy in interpretation of results. Text-books: *Jordan, General Bacteriology, Saunders*, 1919; *Prescott and Winslow, Bacteriology of Water and Sewage, Wiley*, 1915. *Tanner, Bacteriology and Mycology of Foods, Wiley*, 1919.

731. Elements of Bacteriology. This course for students in sanitary engineering presents the general structure, behavior and distribution of bacteria, and their relation to disease, as well as the essentials of bacteriological technique. It is a prerequisite for bacteriology of water and sewage. Text-book: *Jordan, General Bacteriology, Saunders*, 1919.

732. Bacteriology of Water and Sewage. A course dealing with the practical methods of examination of water, sewage and sewage effluents with laboratory work. Special attention is given to standard methods in engineering practice, and to proper interpretation of results. Text-book: *Prescott and Winslow, Elements of Water; Bacteriology, Wiley*, 1915.

736. Industrial Microbiology. Conferences, lectures and detailed laboratory experimentation in the field of the most important fermentation industries, food preparations, and the industrial and economic applications of Microbiology in agriculture and the manufacture of bio-chemical preparations. Industrial alcohol, vinegar, and the leather and food industries are especially considered. A portion of the course is devoted to the study of enzymes and their technical applications. Problems of contemporary interest, to the solution of which the student must apply the data of chemistry, bacteriology and zymology are assigned, and the form and manner of presentation of reports is given special attention. Text-book: *Marshall, Microbiology, Blakiston*, 1919. Numerous other books for collateral reading.

738. Public Health Laboratory Methods. In this course the 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 complement fixation test, etc.

750. Biology of Infectious Diseases. This course deals with 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.

753. Industrial Hygiene and Sanitation. The various prejudicial effects of factory life upon health, including occupational accident, industrial poisoning and the effects of defective ventilation and of dusty trades upon the prevalence of tuberculosis and other diseases. The principles are discussed along which these dangers can be minimized under existing conditions of American factory life. Special attention is given to the problems of health administration in industry. Text-book: *The Modern Factory, Price*

754. Problems and Practice in Public Health. This course consists of lectures and discussions on the causes, history, investigation and control of epidemics caused by polluted water, milk, foods, etc. The aim of the course is to enable the student to prepare himself for the interpretation of corresponding problems arising in actual practice.

756. Sanitary Science and Public Health. This course consists of lectures (illustrated) on health and disease, parasitism, toxins and antitoxins, resistance and immunity, vaccination, epidemology, preventive sanitation and preventive hygiene.

758. Vital Statistics. This course consists of lectures, discussions and problems by which the student acquires a working knowledge of statistical methods, collection of statistics, consideration of errors, and the preparation and graphic representation and critical analysis of morbidity and mortality rates.

764. Municipal Sanitation. This course consists of lectures and problems dealing with the general principles of sanitation as applied to the community, and including housing, street cleaning, waste disposal, water supply and sewerage, sewage disposal, etc.

780. Biological Colloquium. A semi-weekly meeting of the officers and fourth year and graduate students. Each one 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.

DEPARTMENT OF PHYSICS

(Including Electrochemical Engineering and Aeronautical Engineering)

The position of Physics in science and engineering is so fundamental that it is imperative to offer a course in Physics, both theoretical and industrial, wherein the instruction shall be so organized as to carry the study of the basic sciences, mathematics, physics, and chemistry, through the Junior and into the Senior year. The student thus equipped is fitted to apply his knowledge in a broad way to existing industries or to conduct scientific investigations for the industry of the future and for science itself. A considerable part of the senior year's work is left elective so that the student may be free to follow his own bent.

Option 1. *Industrial Physics.* The demand for the industrial physicist is great and increasing. Large corporations have already come and smaller ones are rapidly coming to realize that they must have in their employ men capable of dealing with old and new problems of which the solution involves a thorough knowledge of physical instruments, of physical properties of matter, and of methods of scientific procedure. To enable the student to fit readily into the industry, a large amount of engineering work is offered in the Senior year, in part at the expense of continued work in science.

Option 2. *Theoretical Physics.* Our higher institutions of learning, great business concerns like the United States Government, and the General Electric Company, maintain large research laboratories where the pure

scientist shall carry on investigations for the future in addition to the present. To fit students for these activities the option in theoretical physics continues the work in pure physics to the end of the Senior year instead of turning aside in large part into engineering as does Option 1.

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

Electrochemical Engineering. The Course in Electrochemical Engineering aims to provide a fundamental training in the Principles of Electrical Engineering together with a broad knowledge of Chemistry, upon which as a foundation the more specialized work of theoretical and applied Electrochemistry is based. The demand for men with a training along the above lines is steadily increasing as electrochemical and electric furnace operations become more and more general. The large Industrial Research laboratories also offer excellent opportunities for Electrochemical Engineers.

The instruction in Electrochemistry extends throughout the third and fourth years. A large amount of time is devoted to laboratory work for which purpose two laboratories, established in connection with the Rogers Laboratory of Physics, have been especially equipped for carrying out all types of electrochemical and electric furnace operations. Owing to the limited capacity of these laboratories, however, the number of students who can be admitted is necessarily restricted. In the Senior Year students in Course XIV are allowed considerable option in the choice of studies in the Departments of Electrical Engineering, Chemical Engineering and Metallurgy.

800a, 801a. Physics. Statics, kinetics, sound and light.

801c. General Physics. Light, heat and electricity.

802a, 803a. Physics. Electricity, magnetism, electromagnetism and heat.

804. Precision of Measurements and Laboratory. This course is given for students from other colleges, who have inadequately covered the work in precision of measurements and laboratory as given in courses 800a, 801a, 802a, 803a.

806. Color and Acoustics. This course, consisting of one lecture per week, is given, especially for students of architecture.

807. Meteorology. This course is a general descriptive account of atmospheric conditions.

808. Descriptive Astronomy. This course is a general account of the facts and theories relative to the solar system and sideral universe.

809. Physical Instruments. This course offers training in the construction of physical apparatus.

810. Physical Literature. This course gives practice in reading physics in French or German.

811. Heat Measurements. This course consists of the theory and practice of heat measurements, particularly for industrial problems.

812. Heat Measurements. This course is an abbreviation of course 811.

813. Heat Measurements. This course consists of selected experiments given to students in Courses II, X, XIV as a part of various engineering courses.

814. Heat Measurements II. This course is given in continuation of courses 811 or 812.

816. Photography. This course offers laboratory practice in photographic manipulations. The lecture is open to all students interested.

817. Geometrical Optics. This course deals with the theory of mirrors, prisms, and lenses, the design of lenses and the study of optical apparatus. The lecture is open to all students interested.

818. Physical Optics. This course consists of general work in the wave-theory of light, diffraction, reflection and refraction, dispersion and polarization.

820. Electricity. This course takes up modern atomic views of electricity, the electron, photoelectric effect, radio-activity and discharge in gases.

823. Theoretical Physics. Mechanics, electricity, electromagnetic theory, light and heat.

824. Aeronautical Instruments. This course includes the theory, design and instruction of instruments, and practical navigation.

826. Aeronautics II. This course offers selected advance topics in continuation of course M41.

827. Electrodynamics. This course deals with the solution of problems in Jean's *Electricity and Magnetism.*

828. Electromagnetic Theory. This course is given in continuation of courses 820 and 823, a study of recent developments. (Not offered in 1920-21.)

829. Applied Electromagnetism. This course is chiefly a study of the work of Cliver Heavinside. (Not offered in 1920-21).

830. Constitution of Matter. This course consists of conferences and assigned reading.

834. Microscope Theory and Photomicrography. This course deals with the theory of the microscope with laboratory work in photomicrography and in the use of the ultra-violet miscroscope.

835. Optical Measurements. This course covers photometry, spectrophotometry, spectroscopy, etc. Short investigations with precision apparatus, in which the student is thrown on his own resources, are made.

839. Kinetic Theory and Correlation. In this course the kinetic theory of gases in the second term is followed by a term on the theory of correlation and a general discussion of statistical methods in science.

860. Airplane Design. This course consists of the theory of the methods of designing an airplane and its parts, with computations of strength. The student designs an airplane for a specified use.

861. Airship Design. This course consists of the theory of methods of designing an airship and its parts, with computations of strength. The student designs an airship of specified type.

862. Aerial Propellers. This course discusses the theory of aerial propellers with experiments.

863. Aeronautical Laboratory. This course offers training in the use of wind tunnels, especially as applied to problems of airplane and airship design. (For other aeronautical courses see courses 807, 824, 826, M41.)

Research Courses. In these courses the students work individually, and the amount of work in each term is optional jointly with the student and Professor.

870. Research in Mathematical Physics.
871. Research in Electrochemistry.
872. Research in Industrial Physics.
873. Photographic and Optical Research.
874. Research in Illumination.
875. Research in Applied Electrochemistry.
876. Research in Electricity and Magnetism.
877. Thermal Research.

878. Aeronautical Research.

879. Properties of Matter (Research).

880. Principles of Electrochemistry. In this course the fundamental principles of physics and chemistry underlying electrochemical phenomena are discussed from the standpoint of thermodynamics and kinetics. The work of the first two terms consists of lectures, recitations and problems. In the third term classroom work is accompanied by experiments illustrating such matters as the electrical conductivity of solution, transference and electrolysis.

881. Principles of Electrochemistry. This course is intended for those students who do not expect to continue the study of electrochemistry beyond one year. The work of course 880, first and second term, is completed by a discussion of those phases of electrochemistry not previously treated.

882. Electrochemistry II. In this concluding course in Electrochemistry the topics discussed are the elements of the electron theory, theories of the voltaic cell, polarization and electrolysis, the principles involved in the corrosion, electro-deposition, and refining of metals, and the energy relations underlying the mutual transformations of chemical and electrical energy.

885. Applied Electrochemistry. In this course the work of the second term is devoted to a consideration of the industrial applications of electrochemistry. The subjects discussed include the theory and construction of different types of electric furnaces, electro-metallurgical processes, accumulators and primary batteries, and the electrolytic production of chemical compounds. The work of the third term consists in working out the details of design of an electrochemical plant for some specific process.

886. Electrochemical Laboratory. This course is carried on in conjunction with course 882. The work is strictly quantitative and includes measurements of electrical conductance, single potentials, decomposition voltages, overvoltages, polarization, and practice in electro-analysis. Admission to this laboratory course will be limited to the capacity of the laboratory.

887. Applied Electrochemical Laboratory. This course affords practice in the construction and use of various types of electric furnace together with efficiency tests on their output. Arc, resistance, and induction types of furnace are provided. The production of steel, ferrosilicon, carbide, carborundum, aluminum and calcium are among the processes studied. Efficiency tests on storage cells and on technical processes involving electrolytic oxidation and reduction are also included, e. g., the production of caustic, pigments, etc.

889. Electric Furnaces. This course is 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. The course consists of descriptive lectures on electric furnace operation accompanied by a selected number of laboratory exercises described under 887.

890. Elements of Electrochemistry. This course deals with the 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. Opportunity is offered to observe the electric furnace operations in the laboratory.

893. Colloquium. In this course 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.

898. Glass Blowing. In this course students are taught how to manipulate glass and make such simple apparatus, electrodes, etc., as are likely to be needed in electrochemical research. It is given by special arrangement during any term.

DEPARTMENT OF GEOLOGY AND GEOLOGICAL ENGINEERING

The Department of Geology and Geological Engineering offers courses which lead to the degree of Bachelor of Science in Geology, and after graduate studies to the degrees of Master of Science and Doctor of Science.

The growth of economic geology is a comparatively recent development. There exists now a broad demand for men who have made a special study of the practical application of geology to metal mining, to non-metallic products like clay and building stone, to petroleum and coal, and to engineering works and hydrology. Such men must have an education in engineering subjects along with their geological training, and it is just this which is provided for in this course. Among its graduates are many of the most prominent practical geologists of the present day.

For a long time there has existed a demand for teachers in the various branches of geology and for those who desire to devote themselves to teaching, the degree of Bachelor of Science in Geology is a stepping stone to the higher degrees necessary for such work.

The subjects in Course XII, during the first and second years, do not differ greatly from those arranged for Mining Engineering (Course III), but in the third and fourth years the studies diverge. Mineralogy, petrography, geology in all its branches, including physiography, geological surveying and economic geology, are included in the curriculum. In view of the growing importance of the geology of coal and petroleum special lecture courses are established for this branch of the science. The examination, sampling and valuation of ore deposits is also emphasized.

Ample provision is made for graduate studies for the candidates desiring to obtain the higher degrees and for special students. The subjects for this advanced work include microscopic analysis, mineralogy and crystallography, chemical mineralogy, advanced petrography, advanced economic geology, geology of America and Europe, geology of igneous rocks, paleontology and organic evolution.

A beneficial co-operation in graduate studies has been established with the Department of Geology of Harvard University by which advanced students are allowed to attend Harvard courses in subjects not regularly given at the Institute and vice versa. Among such Harvard courses open to advanced students are geometrical crystallography, geology of igneous rocks, physiography and climatology offered respectively by Professors Charles Palache, Reginald A. Daly, Wallace W. Atwood and R. DeC. Ward.

The courses offered in this Department to students of other branches of engineering may be divided in four sections.

1. Students in Course III (Mining Engineering), Options 1 and 3, are instructed in mineralogy, petrology, geology (dynamic, structural and historical), geological surveying and economic geology. Students in Option 2 receive instruction in mineralogy.

2. Students in Courses I and XI (Civil and Sanitary Engineering) take dynamic and stratigraphic geology and field geology.

3. Students in chemistry and physics are offered courses in mineralogy, crystallography and microscopic analysis.

4. Students in all departments expect I, III, and XI may select, among their general studies, a course in general geology, comprising

two terms. Among the general studies is also comprised a course in organic evolution.

1201. Mineralogy and Petrology. This course consists principally of a laboratory study of the metallic minerals and their determination. Text-book: *The Study of Minerals, Rogers*; *Manual of Determinative Mineralogy, Warren.*

1202. Mineralogy and Petrology. This course is a continuation of course 1201, taking up the study and determination of the non-metallic minerals, and during the last half, the study of the common rocks. Text-book: *The Study of Minerals, Rogers; Rocks and Rock Minerals, Perison.*

1203. Mineralogy. This consists principally of a laboratory study of the important minerals and their determination, but includes the elements of crystallography. Text-book: *The Study of Minerals, Rogers.*

1214. Mineralogy and Petrography. This course is concerned chiefly with the microscopic study of minerals and rocks. Text-book: *Minerals in Rock-Section, Luquer.*

1215. Petrography. This course consists of the microscopic study of minerals and rocks with particular emphasis on the systematic description and classification of rocks. Text-books: *Petrographic Methods, Weinschenk, Clark*; *Petrology for Students, Hurker.*

1216. Petrography (Advanced). This course consists of the study of selected suites of rocks, reading of petrographic literature, and the preparation of a written report on at least one suite of rocks.

1217. Chemical Mineralogy and Petrology. This course consists of a consideration of the physico-chemical aspects of various mineralogical and petrologic problems. The work takes the form of a seminar and considerable outside reading is required. It may be given only in alternate years.

1219. Crystallography. This course consists of abrief treatment of the elements of geometrical crystallography and the salient features of physical and chemical crystallography. This is given as a part of course 1203.

1220. Physical and Chemical Crystallography. This course is conducted as a seminar supplemented by laboratory work. It may be given only in alternate years, and treats of the various physical properties of crystals and their measurement, of crystal structure, and of the growth and solution of crystals.

1221. Microscopic Analysis. This course deals principally with the application of the polarizing microscope to the determination of crystalline materials. The time devoted to laboratory may be extended if desired.

1230. Geology. (Dynamical). A consideration of the forces which have molded the earth to its present form and which are now constantly modifying it. Text-book: *Geology, Physical and Historical, Cleland.*

1230a. Geology. This course is similar to course 1230. Text-book: *Geology, Physical and Historical, Cleland.*

1230b. Geology. This course is similar to course 1230, but with greater emphasis upon the evolution of the earth and upon the origin of the forces affecting it.

1231. Geology. (Structural and Historical). A study of the structure of the earth and the history of its changing continents, and ocean basins and its evolving life forms. Text-book: *Geology, Physical and Historical, Cleland.*

1231a. Geology. This course is similar to course 1231, except that one hour each week is devoted to a laboratory study of the common rocks.

1231b. Geology. This course is similar to course 1231, but with greater emphasis upon the evolution of earth structures and life forms.

1232. Geology. A course designed to teach the principles of geological observation in the field, and the interpretation of geologic maps.

1232a. Geology. This course is similar to course 1231.

1233. Geology, Field. This course is designed to give the student practical methods of geologic mapping in the field.

1234. Geological Surveying. In this course the student makes a detailed examination of two areas, one illustrating igneous rocks and the other, folded sedimentary rocks. A written report stating the results of the field work, is required in each case.

1234a. Geological Surveying. Similar in plan to course 1234, but more extensive.

1235. Geological Surveying (Advanced). A research course in the field investigation of assigned geologic problems.

1240. Geology, Economic. A course of lectures presenting the principles, occurrence and origin of metallic and non-metallic mineral deposits. Text-book: *Mineral Deposits, Lindgren.*

1241. Geology, Economic. A laboratory course consisting of the determination and description of complex ores and altered rocks with and without the aid of the microscope.

1242. Geology, Applied Economic. A course describing methods of examination and valuation of ore deposits and placers.

1243. Geology, Economic (Advanced). Laboratory study of specimens or suites of specimens from mineral deposits; metallographic and petrographic work; discussion of special topics; graphic problems; history of science of mineral deposits.

1244. Geology of Coal and Petroleum. A course which presents in detail the geological relations of deposits of oils and fuels.

1245. Geology of Clay, Cement and Building Stones. Description of occurrence, qualities and testing of building materials.

1246. Geology of Soils and Soil Examination. An account of the origin, constitution and examination of soils, methods of soil mapping.

1247. Engineering Geology. This course considers the relations of geologic processes and structures to engineering operations.

1250. Geology, Historical. An extension of course 1231, including a study of the more common fossils. Text-book: *Historical Geology, Schuchert.*

1251. Paleontology. A course designed to give a knowledge of the past life of the earth through a comparison with living plants and animals.

1251a. Paleontology. Similar to course 1251, but more extended. Text-book: *An Introduction to the Study of Fossils, Shimer.*

1252. Paleontology (Advanced). This course consists largely of laboratory work and assigned reading upon some aspect of index fossils, stratigraphy or evolution of fossil or living forms.

1253. Index Fossils. A course in the determination of the geologic age of rock formations through a study of their included organic remains. Text-book: *North American Index Fossils, Grabau and Shimer.*

1254. Organic Evolution. A study of the evolution of life throughout the past history of the earth with a discussion of the underlying laws operating today and with especial reference to the various avenues along which man is evolving. Text-book: *Organic Evolution, Lull.*

1255. Organic Evolution (Advanced). A course of reading and discussion upon various phases of organic evolution.

1260. Physiography. A study of the characteristics and development of land forms and the methods of interpretation of topographic maps. Text-book: *College Physiography, Tarr.*

1261. Hydrology. Occurrence, composition and utilization of underground waters; methods of field examination.

1262. Geological Seminar. A course of reading and reports based upon various phases of geologic literature.

1263. Geology of North America. A course on the physiography, stratigraphy, igneous bodies and general geologic structures of North America.

1264. Geology of Europe. A course similar in plan to course 1263 but dealing with the continent of Europe.

DEPARTMENT OF NAVAL ARCHITECTURE AND MARINE ENGINEERING

The instruction in Naval Architecture and Marine Engineering is intended for those who expect to be ship-designers, shipbuilders, shipmanagers, or marine engine builders or who desire to enter allied industries. The special work of the regular course is given in the form of lectures and recitations, and drawing and computation, during the second, third and fourth years of the course.

The advantageous location of the Institute at an important seaport enables students to see ship and engine-construction (including marine steam turbines) at the Navy Yard, at several local ship and engine-works, and to visit ships of all types. This location has made it possible to arrange for power and speed trials and progressive speed trials of ships, including turbine steamers; experiments to determine the turning moments of rudders; and tests on the economy of boilers and engines.

1301. Naval Architecture. This course covers the general theory of naval architecture, including displacement and stability of ships, flooding compartments, grounding, docking, and launching. Theory of waves and rolling of ships and methods of controlling rolling. Text-book: *Naval Architecture, Peabody.*

1302. Naval Architecture. This course covers resistance and propulsion of ships by paddle wheels, propellers and sails; method of making power and speed trials. Strength of ships, structural and local. Text-book: *Naval Architecture, Peabody.*

1311. Theory of Warship Design. This course begins with an historical account and a discussion of the development of modern warships. It includes: preliminary design, comprising determination of the principal elements of design, construction of lines, stability, distribution of weights, weight calculation, and watertight subdivision; structural design of warships, comprising materials used in hull construction, strength calculations, general and local, riveted joints, and main structural features. Text-books: *Modern History of Warships, Hovgaard, Spon, London. Structural Design of Warships, Hovgaard, Spon, London; Speed and Power of Ships, D. W. Taylor, Wiley, N. Y.*

1312. Theory of Warship Design. This course includes: preliminary design and installation of boilers, engines, and propellers, as far as this work concerns the naval architect; coaling and coal storage; liquid fuel: rudders and steering gear; drainage; ventilation, and heating of warships: anchors and anchor gear; towing and warping: boats and boat handling appliances: artillery and its installation; stresses in gun turrets; ammunition and its stowage and transport on board ships; torpedo installations: protection against artillery and submarine attack; conning towers.

1314. Shipyard Practice. This course consists of lectures dealing with industrial organization, management, operation, equipment, and practice of ship and navy yards as applied to warship construction.

1315. Shipyard Organization and Management. This course deals with the division of authority and responsibility of the various officials; their duties and necessary qualifications; the efficient handling of labor and material; the sequence of work; recording of wages; materials and costs, also methods of estimating costs for tendering.

1321. Warship Design. In this course the first term and about one-half of the second term are occupied by design work of a general and introductory nature. After that the students commence to prepare a preliminary design of a waship.

1322. Warship Design. This course is a continuation of the design of a warship.

1325. Shipyard Visits. This course consists of visits to navy yards, private shipyards, and other plants, where materials and machinery used in the construction of warships are manufactured for the purpose of observing methods of work, lay-out, of plant, and operation of machinery.

1331. Ship Construction. This course covers the historical development of ship construction. Description of various types and methods of construction together with arrangement, equipment and operation of shipyards.

1332. Ship Construction. This course deals with the construction of ships in detail with special reference to the requirements of Registration Societies.

1333. Ship Construction. This course is a continuation of 1332.

1341. Ship Drawing. This course gives instruction in drawing and fairing ships lines, and in the use of instruments.

1342. Ship Drawing. This course gives instruction in drawing lines for definite displacement and longitudinal center of buoyancy, midship section with scantlings, calculations for displacement, center of buoyancy, metercenters, etc.

1343. Ship Drawing. In this course the design of a ship is carried to completion, with calculations of stability, weight, trim, strength, etc. General and special plans of details are required, also model making and lining off.

1351. Marine Engineering. This course describes marine engines and discusses methods of proportioning marine engines and determining stresses in them; and also the vibration of ships and balancing engines. Text-book, *Computations for Marine Engineers*.

1352. Marine Engine Design. This course deals with the computations and drawings for a marine engine. Text-book: *Manual of Marine Engineering; Seaton and Roundthwait.*

1353. Marine Engineering. This course is similar to course 1351 except that it deals with naval engines. Text-book: *Calculations for Marine Engines; Peabody*.

1355. Marine Engine Design. This course is similar to course 1352 except that it applies to naval engines. Text-book: *Marine Engines; Peabody.*

1360. Marine Steam Turbines. This course gives descriptions and methods of computing steam turbines, especially as applied to marine propulsion. Text-book: *Steam Turbines; Peabody.*

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 Engineering and Metallurgy, Chemistry, and

Geology. The students, accompanied by instructors, give their time to field-work 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 field-work in surveying and railroad engineering is given at Camp Technology on the shore of Gardner's Lake near the village of East Machias, Maine. This locality is well adapted for the carrying out of all the operations involved in the various problems of plane surveying; for performing the field-work 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 field-work necessary to hydrographic surveying. The Machias and East Machias Rivers are available for steam 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 principal structure consists of a central administration building, connected by covered passageways with two other buildings. The central building contains classrooms, offices, a few sleeping rooms, postoffice and store, and a general reading and assembly room. On either side of the central building are one-story wings, one of which contains a drafting-room furnishing accommodations for seventy-two students, and the other a dining-room with seating space for one hundred and sixty-eight, kitchen, lavatory and other necessary service rooms. Sleeping accommodations for members of the instructing staff and one hundred and twenty students are provided by tents with raised wooden floors, each tent furnished with cots and other necessary furniture. In addition to the tents, a wooden barracks building furnishes sleeping accommodations for sixty students and also contains one classroom. The camp is equipped with sanitary facilities of the most approved type, a wholesome water supply from driven wells and an electric light plant. A physician is in constant attendance throughout the camp session.

The camp is primarily intended for students of Courses I, III, options 1, 3, XI, XII, and XV, option 1, who are required to attend during the months of August and September following their sophomore year. A limited number of students from other courses having the requisite preparation may be admitted by petition.

No additional charge for tuition is made to Institute students. Others, not connected with the Institute, may be admitted with the approval of the Faculty upon payment of a tuition fee of $50 which will be remitted in case of later registration as Institute students and payment of full tuition for two years. The cost of camp operation and maintenance is shared equally by those in attendance.

Summer School of Surveying.— Students in Courses VI and XV, option 2, are required to take the course in Surveying 100a during the two weeks immediately following their second year. The instruction is given in Boston and vicinity. No fee is charged for regularly enrolled Institute students.

OPTIONS IN GENERAL STUDIES

All students in the regular professional courses of the Institute, except Courses IV, X and XV, are required to take four terms' work in general studies. The general study courses are non-technical in character and are intended to broaden the student's education by introducing him to some

field or fields of thought and knowledge outside of his chosen professional line of work.

Exceptions are made of the courses mentioned above for the reason that there are included in their prescribed schedule subjects sufficiently non-technical in character to fulfill wholly or in part the purpose of the general study courses. College graduates or others who have taken elsewhere a satisfactory equivalent of liberal studies may be excused from further requirements in general studies.

The particular terms in which these courses are to be taken are indicated in each course schedule.

The following list gives the general study courses for the year 1920-21. This list may be changed or extended from year to year.

First Term	Second Term	Third Term
	In Literature and History	
Contemporary Literature E51.	Contemporary Literature E52.	Shakespeare E53
Literature and Science E54	Informal Public Speaking: Committee Reports and Discussion. E55.	Lincoln and the Period of the Civil War. H51.
Foreign Literature French L72, L73. German L32–L47.	Foreign Literature French L72, L73. German L32–L47.	Foreign Literature French L72, L73. German L32–L47.
History of Science 761	History of Science 761	
	Economics and Business Subjects	
Political and Social Problems Ec. 47.	The Human Factor in Business E56. Banking and Finance Ec. 36.	Engineering Publicity E57. Business and Patent Law Ec. 62.
	Science	
Dynamic Geology 1230b	Structural and Historical Geology 1231 Descriptive Astronomy 808.	Organic Evolution 1254 Sanitary Science and Public Health 756. Anthropology 715.

DEPARTMENT OF DRAWING AND DESCRIPTIVE GEOMETRY

The work of this department includes (1) preparatory courses in mechanical drawing, and descriptive geometry, given throughout the first year, and descriptive geometry and stereotomy given in the second year; (2) courses in freehand drawing, extending through all years of the course in architecture and a course in applied decorative design given in the graduate year.

The preparatory instruction leads to the various courses in applied drawing, given in the professional departments of the Institute. The instruction therefore largely concerns the technique and principles of representation in general, or pure drawing.

The courses in mechanical drawing include the precise pencilling and finished inking of instrumental constructions and irregular curves. Most of the drawings are first laid out in pencil and then traced. Draw-

ings of machine details, made from freehand sketches or blueprints are required, and all lettering and dimensioning is done freehand. Special stress is laid upon workmanlike and time-saving methods in drafting, including the supplementary use of freehand drawing.

Special importance is attached to the study of descriptive geometry, both as embracing the principles of geometrical representation, and as a means for developing the power to visualize objects or lines in space. Training in the practical use of its principles is afforded by the solution of problems taken from engineering and architectural practice.

The courses in freehand drawing, taken by the students in architecture, begin with the drawing of simple type solids, in which are presented the first principles of perspective and the fundamental processes of freehand drawing in general. The instruction is continued in the second and third terms in the drawing of casts, both in relief and in the round and occasionally from architectural features found in the vicinity.

The later instruction in freehand drawing as given in the Department of Architecture is an extension of the methods begun in the first year to drawing from the cast and from life. Instruction in art anatomy and the principles of decorative design, together with criticism along aesthetic lines, is given in connection with the exercises in drawing. Some of these exercises are held in the galleries of the Museum of Fine Arts. The wealth of examples afforded by the collection of casts, and the art atmosphere of the Museum, are considered important influences.

The work in Decorative Design includes drawing from life, the study of principles, and the making of preliminary sketches in figure composition. The students of each graduate class co-operate in designing and executing a large mural decoration, introducing the human figure.

D11. Drawing and Descriptive Geometry. An elementary course in mechanical drawing and descriptive geometry. The instruction is given by means of blackboard explanation, together with considerable attention to the individual student.

In mechanical drawing the student is taught the correct use of the drafting instruments and other materials for both pencil and ink work.

In descriptive geometry especial emphasis is placed on the ability to "see," from different points of view, first the object, then the line or plane in space. Various simple problems on lines, planes and solids are given, including sections and developments. There is included also the construction of isometric and oblique projection views. Text-book: *Descriptive Geometry, Kenison and Bradley. Looseleaf notes on Mechanical Drawing.*

D12. Drawing and Descriptive Geometry. This course forms a continuation of the work in Descriptive Geometry and Mechanical Drawing as given in D11.

The work in Mechanical Drawing for this term consists principally of machine sketching and detailing. Text-books: *Kenison and Bradley's Descriptive Geometry, James and Mackenzie's Working Drawings of Machinery.*

D13. Drawing and Descriptive Geometry. In this course the work of the third term is a continuation of the work of the second term in mechanical drawing and descriptive geometry, and includes mechanical perspective, and practical application of the problems of descriptive geometry. Text-book: *James and Mackenzie's Working Drawings of Machinery, and Kenison and Bradley's Descriptive Geometry.*

D14. Drawing and Descriptive Geometry. This course is a continuation of the mechanical drawing and the descriptive geometry as given in D11, but differing in essential respects from course D12. Text-

book: *Kenison and Bradley's Descriptive Geometry. Looseleaf Notes on Mechanical Drawing.*

D15. Drawing and Descriptive Geometry. This course gives more extended practice in mechanical drawing and further work in descriptive geometry as necessary preparation for the second-year courses in the subject. Text-book: *Kenison and Bradley's Descriptive Geometry.*

D16. Drawing and Descriptive Geometry. This course comprises work in mechanical drawing and descriptive geometry, and is a continuation of course D11. The work is laid out with reference to the especial needs of the students in course IV. Text-book: *Kenison and Bradley's Descriptive Geometry. Notes on Mechanical Drawing* (*Looseleaf*), *Vignola* (*Esquie*).

D17. Drawing and Descriptive Geometry. This course completes the first year work in mechanical drawing and descriptive geometry for the students of Architecture and includes practical applications of descriptive geometry, and drawing and rendering of architectural details. Text-book: *Kenison and Bradley's Descriptive Geometry. Vignola* (*Esquie*).

D18. Freehand Drawing. This course consists of drawing from geometrical models and simple casts.

D19. Freehand Drawing. This course is a continuation of course D18, and includes drawing from casts, and outdoor sketching of architectural details.

D20. Freehand Drawing. This course is a continuation of D19.

D21. Descriptive Geometry. This course is based on course D15, and covers in considerable detail the consideration of tangent planes, intersection of surfaces, and practical applications. Text-book: *Kenison and Bradley's Descriptive Geometry.*

D23. Descriptive Geometry. This course is an extension of descriptive geometry D21, and includes the subject of warped surfaces. Text-books: *Kenison and Bradley's Descriptive Geometry. Adams' Descriptive Geometry, Part* 3.

D28. Stereotomy. This course consists of the application of descriptive geometry to the making of drawings for masonry structures, such as intersecting arches and walls, abutments, piers, and culverts. Text-book: *Dwight Porter. Notes on Stereotomy.*

D42. Freehand Drawing. The work consists of drawing from the the cast (architectural ornament and the human figure) and of making numerous quick sketches. It is the fundamental drill for all the freehand drawing courses.

D43. Freehand Drawing. This course is a continuation of Freehand Drawing D42. The work includes drawing from the cast and architectural ornament in charcoal and in wash; also quick sketching direct from the human figure.

D44. Life Class. The work consists of drawing from the nude, memory drawing and direct pen and ink sketching from the figure.

D45. Life Class and Decorative Design. This advanced work is only open to students who have passed with a clear record course D44. In this class the students make life-sized drawings from the nude, and study the principles of decorative figure design. This course also includes outdoor sketching from architectural subjects.

DEPARTMENT OF ECONOMICS

In this Department is grouped the instruction given in general economics to students in all courses, and also the more specialized subjects provided for the Course in Engineering Administration (XV). All courses, except

XV, take political economy (Ec. 31) in the third year, and opportunity will also be given to select a general option study in the field of Economics, as political and social problems, and banking and finance.

Students in Course XV begin political economy in the second year, but owing to the requirement of subsequent studies in business economics, devote but two terms, instead of three, to this preliminary course.

The courses in accounting, cost accounting, banking, statistics, industrial organization, securities and investments, industrial relations, business management, and business law, are designed more particularly for students in Engineering Administration, and should not be applied for except with special permission of the Department.

Ec22. Political Economy. This course is not so extensive in its scope as Political Economy Ec31. More emphasis is placed upon fundamental principles, and less time is devoted to such subjects as money, banking, trusts, labor problems, etc., which are covered by special courses in the last two years of Course XV.

Ec31. Political Economy. This course is elementary but comprehensive. It consists of an analysis and description of the existing economic structure of society, a brief study of economic theory and the application of that theory to some of the more important economic questions. Special attention is given to fundamental business processes including principles of accounting, corporate organization and finance, credit and banking, labor problems, and business management.

Ec36. Banking and Finance. This course considers the subject of banking in less technical form than Ec37. There is also a treatment of the investment and security market and the more elementary portions of corporation finance.

Ec37. Banking. In this course the following topics will be considered: national banks, state banks, trust companies, savings banks, different kinds of loans, securities for loans, the bank statement, the money market, relation of the treasury and crop movement to money market, clearing house, domestic and foreign exchange and foreign systems of banking, particularly those of Canada, England and Germany. One hour of the three will be devoted to individual investigation and the use of banking reports under the immediate supervision of the instructor.

Ec38. Securities and Investments. This course treats of (1) different kinds of securities: government, railroad, industrial, public utility, etc.; (2) the construction of bond tables, interest formulas, sinking fund calculation, serial bonds, amortization, and the mathematical theory of investment; (3) stock and produce exchanges, brokerage, and speculation.

Ec46. Industrial Relations. This course is 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 matters of public policy such as labor legislation, social insurance, immigration, and industrial education.

Ec47. Political and Social Problems. The content of this course will change from year to year. It will include such topics as immigration, national budget, tariff, civil service, railroad regulation, industrial relations, etc. The work will be conducted by means of oral discussion and written reports on assigned reading in public reports and periodicals, supplemented by lectures, some of which will be given by official or experts in the special fields covered.

Ec50. Accounting. This course is not designed to make bookkeepers, auditors, or accountants in any professional sense, but is con-

cerned primarily with the analysis of financial reports. Instruction will deal with such matters as double entry book-keeping, the significance of assets and liabilities, good-will, franchise, the construction and interpretation of the balance sheet and of the profit and loss statement. Text-book: *Patron and Stevenson, Principles of Accounting*; *Joseph Klien, Bookkeeping and Accounting*.

Ec51. Cost Accounting. In this course the following topics are considered: methods of determining costs of materials, processes of labor and machines; the distribution of direct costs and overhead expenses; cost data to secure efficiency; shipping orders; inventories; recording and payment of wages.

Ec56. Industrial Organization. This course gives anextended survey of the forms of organization under which business is carried on at the present time, treating more particularly of corporations and industrial combinations. Consideration is given to the differences in state corporation laws affecting choice of state for securing a charter, methods of promoting, underwriting, and financing a corporation, reorganization methods, and the state supervision of corporations.

Ec58. Business Management. This course deals with the activities of an individual business. The following topics are considered: organization, plant location, layout and equipment, purchasing, transportation and traffic, inspection, stores, design, scientific management, time, motion and fatigue study, production control, employment and service department operation, office organization, location, layout and equipment, credit and collections, insurance, sales management, including sales organization, analysis of product, market and trade channels, territorial divisions, selection, training, education and equipment of salesmen, budgets and costs, sales campaigns, advertising and publicity work.

Ec60. Business Law. This course deals with contracts, agency, negotiable instruments, patent law and trademarks.

Ec62. Business and Patent Law. A general course in business law with five or six of the exercises devoted to the principles of patent law.

Ec65. Statistics. In this course 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.

DEPARTMENT OF ENGLISH AND HISTORY

The work in English is designed to arouse in the student an interest in the important problems of modern life, and through the interest thus stimulated to train him in oral and written expression. The instruction is given in small sections, with frequent opportunity for class discussion and for oral presentation of topics prepared by students. Written work is corrected in personal conferences which afford opportunity for attention to the student's individual needs. Emphasis is put on the clearness and accuracy of expression which are essential in the work of a professional man.

The instruction given by the Department in literature and history is planned so that the student may acquire an understanding of the main currents of thought of the last one hundred and fifty years as they have expressed themselves in the events, the institutions, and the literature of that period. Significant works of literature which interpret phases of political, economic and social life are read and discussed concurrently with a historical study of the times. By this correlation of the work in literature

and history, — on which as has already been indicated the work in composition is based,— it is hoped that the student may gain a broad and vital comprehension of the main forces working in life and society today.

E10. English (for Foreign Students). All students bred to speak any language other than English are required, unless they pass the entrance examination, or unless special arrangement is made to the contrary, to take this course in their first year in place of Course EH11, EH12, and EH13. The work is not intended for those who are quite new to the language; but assumes that the student is able to understand exercises conducted in English, and to express himself intelligibly in written or oral English.

EH11. English and History. This course covers European History of the last hundred years. It is conducted by recitations and conferences, with oral and written reports.

EH12. English and History. This course is a continuation of EH11.

EH13. English and History. This course is a continuation of EH11 and 12, and consists of a study of the recent history of the United States.

E15. Special Composition. This course may be required at any time after the first year of any student who shows inability to write clear and correct English. It consists of theme work and consultation, and is continued in each case as long as the needs of the student require.

E20. English (for Foreign Students). This course is required, in place of Courses EH21, EH22, and EH23, in the second year, of foreign students who took E10 in the first year. Magazine articles, essays, and books on topics of contemporary history and politics are read, and made the basis of written exercises to develop the student's capacity for orderly, intelligible expression.

EH21. English and History. This course is the first term of a course given throughout the year, designed to study the main currents of thought in England during the period of the French Revolution and the Nineteenth Century. The first term deals with the French Revolution. Written and oral reports are required.

EH22. English and History. This course is a continuation of EH21. This term is devoted mainly to the conflict of political and economic principles that marked the first half of the Nineteenth Century in England. Written and oral reports are required.

EH23. English and History. This course is a continuation of EH22. This term is devoted to a study of the influence of the development of science upon English literature and thought. Written and oral reports are required.

E32. English. This course consists of oral and written discussion of problems of literature and science based on the reading of engineering addresses and of English essayists of the Nineteenth Century. Its purpose is to give students practice in oral and written discussion of the ideas suggested by the reading.

E33. Report Writing. This course makes a study of the various types of engineering reports, with practice in the investigation of subjects, the arrangement of material, and its presentation in good report form.

E51. English (Contemporary Literature). This course deals with English and American literature of the last twenty-five years, with particular reference to the fiction and the drama related to social movements.

H51. History (Lincoln and the Period of the Civil War). This course consists of a study of the life of Abraham Lincoln and his relation to his times.

E52. English (Contemporary Literature). This course is a continuation of course E51, but may be taken separately.

E53. English (Shakespeare). This course consists of the reading and discussion of three or four plays by Shakespeare, the plays being chosen to illustrate various aspects of his genius.

E54. English (Literature and Science). This course offers a study of selected works in English literature showing the influence of science (including literary essays by scientific men), together with a consideration of some of the relationships between scientific and literary thought.

E55. English (Informal Public Speaking; Committee Reports and Discussions). This course gives training in the preparation and oral presentation of committee reports. These reports serve as a basis for class discussion.

E56. English (Human Factor in Business). This course attempts to cover in outline the principal executive problems which an engineer is likely to be called upon to solve in organizing and handling men. It touches on such problems as the selection and training of subordinates and workers, problems of housing, feeding, and welfare, co-operation and morals. These topics are treated on the human side, and with only such attention to detail as would interest one looking forward to the possible executive control of the enterprises in production or construction that an Institute graduate would naturally enter.

The ground is covered in part by oral and written reports and discussions by students. Occasional talks are given by outsiders who have had experience in the fields covered.

E57. English (Engineering Publicity). The chief object of this course is to give some notion of how salesmanship and presentation are applied by engineers. It touches on the following problems: professional ethics and indirect publicity, the field of engineering journals and societies, correspondence, oral and written reports, committee discussion, the psychology of appeal.

The ground is covered in part by oral and written reports and discussions by students. Occasional talks by engineers in practice are introduced.

DEPARTMENT OF MODERN LANGUAGES

The study of Modern Languages at the Institute has two objects: that of enabling the student to make use of the languages as instruments in scientific research, and that of giving him general training and culture. It aims to give sufficient facility with modern texts to use them without the necessity of translating, and as much familiarity with the spoken language as the individual aptitude of the student and the time available permit. From the beginning as much of the classroom work as possible is carried on in the language taught. Occasional talks therein are also given, and writing from dictation is frequently practised.

A sound knowledge of grammar is attained by the careful analysis of parts of the texts read, and by oral and written illustrative exercises. To make these of value a good pronunciation is essential, and this is striven for through constant practice in the classroom. In addition to a deeper knowledge of the language and literature, the advanced courses aim to impart succinctly familiarity with the character, customs, traditions, spirit, history and development of the peoples and countries whose language is studied.

In the designation of courses the grades of Elementary and Intermediate correspond, respectively, to the definitions of the Modern Language Association of America.* All other courses are of advanced grade.

*Report of the Committee of Twelve.

L11. German. This course is intended to prepare students to fulfill the entrance requirement in German. A study of grammatical forms, syntax and vocabulary, through composition exercises and rapid reading, forms the basis of the work. This course may be taken by any student who needs it.

L21. German. This course 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.

L31. German. This course is wholly devoted to exercises in scientific German. Selections are made from current scientific journals, and the latest text-books.

L32. German. This course consists wholly of exercises in scientific German on physical, chemical, biological and geological subjects. As far as practicable the exercises are conducted in German. Open to any qualified student, or on consultation with instructor.

L33. German. This course is wholly devoted to exercises in scientific German on physical, physico-chemical and electro-chemical subjects. The work is partly based on selections from current scientific journals. As far as practicable the exercises are conducted in German. The course is open to any qualified student, or on consultation with instructor.

L41. German. This course forms a brief introduction to the German Literature of the Eighteenth and Nineteenth Centuries. It is given in brief lectures in German with readings from standard works. The course is conducted mainly in German. It is open to any qualified student, or on consultation with the instructor.

L42. German. This course consists of lectures on the German drama with a considerable amount of reading from characteristic plays, beginning with Schiller's "Don Karlos." This course is conducted mainly in German. It is open to any qualified student, or on consultation with the instructor.

L43. German. This course comprises composition, dictation, reading, lectures, and conversation. The work is partly based on current newspaper and magazine articles. This course is open to any qualified student, or on consultation with the instructor.

L44. German. This course consists wholly of exercises without preparation. It is distinctively a sight reading course for practice in rapid reading. The selections are from current periodicals. The course is open to any qualified student, or on consultation with the instructor.

L45. German. This course consists of lectures and readings on the life and work of the most important German men of science. As far as practicable the exercises are conducted in German. It is open to any qualified student, or on consultation with the instructor.

L46. German. This course consists of lectures and readings with a study of the development of the Faust legend. Opportunity is offered for theme-writing and discussion in German. The course is open to any qualified student, or on consultation with instructor.

L47. German. This is a practical course in commercial correspondence. Under normal conditions a foreign correspondent will be provided for each member of the class. The course is open to any qualified student, or on consultation with instructor.

L61. French. This course is designed to enable students to fulfill the entrance requirement in French. The program consists of training

in pronunciation, elementary grammar, and easy reading matter. The last term will include the reading of some technical French.

L62. French. This course consists of recitations partly conducted in French. It comprises a continuation of the study of grammar, translation into French of connected passages, reading and translation of some standard modern authors, reading of scientific French.

L63. French. This course is a modification of course L62 to suit the needs of Course IV. Some of the reading matter will deal with architectural subjects.

L64. French. This course consists of reading and translation of technical French.

L71. French. This course consists of the reading of French prose of a varied nature, part of which deals with description of French cities, cathedrals, chateaux, etc. Practice in pronunciation and conversational phrases useful for travel is given.

L72. French. This general course offers rapid reading of modern French prose dealing with the history of France, French life and institutions, scientific matter in French. In each term there will be a brief review of grammatical principles, with practice in useful vocabulary and sentence formation. Each term may be taken independently.

L73. French. This is a literary course: a brief survey of French literature with the reading of some prose masterpieces. Such topics as the following will be discussed: the literature of the middle ages; the Renaissance; classicism; the romantic movement; realism; naturalism; art for art's sake; impressionism and symbolism. Each term may be taken independently.

L81. Spanish. This elementary course consists of pronunciation, elementary grammar, and easy reading matter and practice in conversational phrases useful for travel.

DEPARTMENT OF MATHEMATICS

Great importance is attached to the study of mathematics, both as a means of general education and as a necessary basis for further instruction in engineering and other subjects. Students in most of the regular courses study mathematics throughout the first two years, beginning with elementary calculus, taking analytic geometry in the second term and continuing elementary calculus in the third. The second year work begins with integral calculus and continues through elementary differential equations with systematic study of applications in mechanics. From the outset, care is taken to present both underlying principles and a great variety of concrete applications, the latter connecting the mathematical instruction closely with the professional studies. The instruction is given mainly by recitations in small sections, the number of the students in a section being about twenty to twenty-five. Students having time and interest for the study of mathematics beyond the prescribed limits are offered opportunity for more advanced work, and the Institute offers exceptional opportunities for advanced and elective work in applied mathematics.

The Department possesses an excellent library, containing about twenty-five hundred carefully selected volumes and an extensive collection of models, which are of special interest and value in connection with the more advanced courses.

M11. Calculus, Introductory. This course presents in an elementary way the fundamental ideas of the calculus: — derivatives, differentials,

maxima and minima, integration, with application to simple problems of geometry and mechanics.

M12. Analytic Geometry. This course covers the following subjects: graphical representation; the polynomial of the first degree in one variable, including the analytic geometry of the straight line; the polynomial of the nth degree in one variable; the plotting of certain algebraic functions expressed by surds or fractions; change of co-ordinate axes; graphs of certain transcendental functions. Text-book: *Woods and Bailey, Analytic Geometry and Calculus.*

M13. Analytic Geometry and Calculus. This course is a continuation of the preceding and covers the following subjects: the differentiation of algebraic functions with applications to geometrical and physical problems, maxima and minima, etc.; inverse differentiation applied to problems; the analytic geometry of curves of the second degree; of elementary transcendental functions, and problems; parametric representation; polar co-ordinates; and curvature. Throughout the course special attention is given to the solution of problems, which are introduced as soon as the requisite theory has been developed. Text-book: *Woods and Bailey, Analytic Geometry and Calculus.*

M21. Calculus. This course is devoted mainly to the integral calculus of functions of one variable including methods of integration; definite integrals; geometrical applications to areas and lengths of plane curves, volumes of solids of revolution, and other volumes which can be found by a single integration; and mechanical applications to work, attraction, pressure, and centers of gravity and pressure. The division of topics between Mathematics M21 and Mathematics M22 varies from year to year. Text-book: *Woods and Bailey, Analytic Geometry and Calculus.*

M22. Calculus and Differential Equations. This course, in continuation of Mathematics M21, is mainly devoted to the study of functions of two variables and covers the following subjects: elements of solid analytic geometry; partial differentiation; multiple integration, with geometrical applications to areas and volumes, and with mechanical applications to attraction, moments of inertia, and centers of gravity; infinite series and the elements of differential equations. Text-book: *Woods and Bailey, Analytic Geometry and Calculus.*

M23. Applications of Calculus. This course aims to connect the preceding courses in mathematics with the dependent work in applied mechanics and related subjects given in the several professional departments. It includes the discussion of moments of mass and inertia, rectilinear and curvilinear motion, kinetics of a particle, central forces, motion in a resisting medium, etc. Text-book: *Smith and Longley, Theoretical Mechanics.*

M26. Theory of Probability and Methods of Least Squares. A brief course devoted to a discussion of the general principles and the more common scientific and engineering applications of the Method of Least Squares.

M35. Differential Equations of Electricity. This course 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, 38, 39. Advanced Calculus and Differential Equations. Taylor's Formula with applications to approximations in calculus and analysis, partial differentiation, complex numbers, vectors, differential equations of the first order, linear differential equations, total and partial differential equations, with numerous applications to geometry and physics.

M41. Applications of Calculus. This course is similar to M23, but especially adapted to the needs of students in Chemical Engineering.

M45. Fourier's Series; LaPlace's Coefficients. In this course the theory of Fourier's series, Bessel's functions, zonal and spherical harmonics, and their application to the solution of such problems in physics as can be expressed by certain partial differential equations, are discussed.

M50. Applications of Mathematics to Chemistry. The application of thermodynamics to chemical problems.

M54. Mathematical Laboratory. A course for practical instruction in numerical, graphical and mechanical calculation and analysis as required in the engineering or applied mathematical sciences. Either term's work may be taken without the other. The course will include: methods for checking the accuracy of arithmetic and logarithmic computations; numerical solution of algebraic, transcendental and differential equations; graphical methods in the processes of arithmetic, algebra, and the calculus; 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, such as slide-rules, arithmometers, planimeters and integraphs; and many kindred topics.

M60. Vector Analysis. This course deals with algebraic combinations of vectors, differentiation and integration of vector functions, Green's and Stokes' theorems, potential functions, applications to geometry and physics.

M61. Mechanics of Rigid Bodies. This is mainly a problem course in the application of the conditions of equilibrium and the equations of motion of a rigid body.

M62. Modern Algebra. This course includes determinants, matrices, linear transformations, invariants, quadratic forms.

M63. Modern Geometry. This course deals with co-ordinate systems, geometry of n-dimensions, differential geometry, non-Euclidean geometry.

M64. Modern Analysis. In this course particular attention is given to analytical methods used in mathematical physics. The course covers the elements of theory of functions, differential and integral equations.

M65. Analytical Mechanics. This course deals with Lagrange's and Hamilton's equation, Hamilton's principle, principle of least action, theory of elasticity, hydrodynamics.

M66. Theory of Sound. This course deals with the dynamical theory of vibrating systems and the propagation of waves in solids and fluids.

M67. Heat Conduction. This course deals with Fourier's Series, theory of the steady state and the flow of heat in one or more dimensions, with application to physics and engineering.

M68. Thermodynamics.

M69. Statistical Mechanics. This course consists of a study of average properties in a system of a large number of degrees of freedom, with application to kinetic theory and the theory of radiation.

COURSES OF STUDY TABULATED

SUBJECTS OF INSTRUCTION

The number to the left is the subject number. The numbers under the title are the numbers of the preparatory subjects. Those in italics indicate subjects to be taken simultaneously. To the right of the subjects are noted the Professional Courses which prescribe the subject and the year and term in which the subject is taught. Under the heading "Term and Hours of Exercise and Preparation" the first number shows the hours assigned to exercise in the term of ten weeks, the second the time assigned to preparation. To the extreme right is given the name of the teacher in charge of the subject.

ENTRANCE REQUIREMENTS

(For description see Circular of General Information)

M1 ALGEBRA
M2 PLANE GEOMETRY
E1 ENGLISH
H1 HISTORY
M3 SOLID GEOMETRY
L61 FRENCH (Elementary)
L62 FRENCH II
L11 GERMAN (Elementary)
L21 GERMAN II
800e PHYSICS
M4 TRIGONOMETRY

DEPARTMENT OF PHYSICAL TRAINING

No.	*Subject and Preparation*	*Taken by*	*Year*	*Term and Hours of Exercise and Preparation* 1st Term	2d Term	3d Term	*Instructor in Charge*
15.	**Physical Training**	All courses	**1**	10–0	10–0	10–0	Kanaly

DEPARTMENT OF MILITARY SCIENCE AND TACTICS

No.	*Subject and Preparation*	*Taken by*	*Year*	*Term and Hours of Exercise and Preparation* 1st Term	2d Term	3d Term	*Instructor In Charge*
21	Freshman Military Science	All courses		30–0	..	..	
22	Freshman Military Science	All courses		..	30–0	..	
23	Freshman Military Science	All courses		..	..	30–0	
24	Advanced Coast Artillery a	Optional 3					
25	Advanced Coast Artillery b	Optional 4					
26	Advanced Engineering a	Optional 3					Clark
27	Advanced Engineering b	Optional 3					
28	Advanced Ordnance a	Optional 3					
29	Advanced Ordnance b	Optional					
31	Sophomore Military Science	All courses		30–0	..	..	
32	Sophomore Military Science	All courses		..	30–0	....	
33	Sophomore Military Science	All courses		..	..	30–0	

CIVIL ENGINEERING — 100-199

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
100	Surveying and Plotting. M13, D15 or D13	I;IX-B;XI;XV$_1$	2	. . . .	20–40	30–30	Robbins
100a	Surveying and Plotting. M13, D13	VI; XV$_2$		Summer School 60–15			Hosmer
101	Surveying Instruments. D13, M13	XIII	2	. . . .	. . . .	20–0	Robbins
102	Surveying. M13, D13 or D17	II	2, 3	30–0	. . . .	. . . .	Howard
102a	Surveying. M13, D13 or D17	VIA (A)	3	. . . .	30–0	. . . .	Howard
		VIA (B)	3	30–0	. . . .	. . . .	
103	Surveying. M22, D13	III$_{1, 3}$; XII		Camp Technology 240 hours			Howard
104	Underground Surveying. 103	III$_{1, 3}$; XII		Mining Surveying Camp, 120 hours			Howard
107	Plane Surveying. 100, M22	I; XI; XV$_1$		Camp Technology 100 hours			Robbins
108	Geodetic and Topographic Surveying. *107*, 801 or 802	I; XI; XV$_1$		Camp Technology 100 hours			Robbins
109	Geodetic Surveying. 113	Elective		Camp Technology 150 hours			Hosmer
111	Spherical Trigonometry. M10, M13	I, IX-B	2	10–20	. . . .	. . . .	Hosmer
		XV$_1$	2	. . . .	10–20	. . . .	
112	Astronomy. *106*, 111	I; IX-B; XV$_1$	2	. . . .	30–30	. . . .	Hosmer
113	Geodesy. M22, 112	I	2	. . . .	. . . .	30–30	Hosmer
114	Geodesy. M23, 113	Elective	G	. . . .	. . . .	30–30	Hosmer
115	Navigation. 111	Elective	2	. . . .	. . . .	20–40	Hosmer
119	Map Reading and Topographical Drawing. D15 or D13, 100	I; IX-B; XI	2	. . . .	30–0	. . . .	Burton
120	Railway Fieldwork. 100, *107*	I; XI; XV$_1$		Camp Technology 80 hours			Babcock
121	Railway and Highway Engineering. M21, 100, 120	I	3	30–55	30–30	. . . .	Breed
		XI	3	20–40	20–25	. . . .	
		XV$_1$	3	20–40	20–30	. . . .	
123	Railway Drafting. 120, *121*	I	3	60–0	60–0	. . . .	Babcock
		XI	3	70–0	50–0	. . . .	
125	Railway Engineering. 120, 121, 222a	I$_2$	4	30–45	20–40	30–50	Breed
		XV$_1$	4	30–45	. . . .	. . . .	
126	Railway Design. 123, *125*	I$_2$	4	. . . .	40–0	40–0	Breed
127	Railway Engineering. 125, 126, *128*	Elective	G	20–40	20–40	20–40	Breed
128	Railway Design. 126, *127*	Elective	G	30–0	30–0	30–0	Breed
130	Roads and Pavements. 121	I; XI	3	. . . .	. . . .	20–20	Breed
131	Testing of Highway Materials. 130, 236	Elective	G	. . . .	30–15	. . . .	Breed
140	Structures, Theory of. 221, *222a*	I; IXB;	3	. . . .	. . . .	40–80	Sutherland
		XV$_1$	3	. . . .	. . . .	40–75	Bowman
141	Structures, Theory of. 221, *222*	IV$_2$; XI	3	. . . .	20–40	20–40	Luther
143	Materials. 221, *222* or *222a*	I; IV$_2$; XI; XV$_1$	3	. . . .	. . . .	20–40	Sutherland
144	Stationary Structures. 221, *222*	III$_2$	4	. . . .	. . . .	30–50	Sutherland
		III$_3$	3	. . . .	. . . .	30–50	
		VI(optional)	3	. . . .	. . . .	30–50	
		VI-A (A)	4	. . . .	30–50	. . . .	
		VI-A, (B)	4	30–50	. . . .	. . . .	
145	Theory of Structures. 221	XIII-A	G	20–40	30–60	. . . .	Luther

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
146	Theory of Airplane Structures. 140 or 141 or 144 and 223 or *149* or *150*	Elective	4	. . . .	30–60	. . . .	Luther
148	Foundations. 140 or 141 or 144	I; IV_2; XV_1	4	10–15	. . . .	. . . .	Spofford
149	Theory of Structures. 140 or 141; 143	I	4	40–80	30–60	50–100	Spofford
150	Theory of Structures. 140 or 141; 143	XI; XV_1	4	40–80	30–60	20–40	Spofford
151	Theory of Structures. 140 or 141, 143	IV_2	4	40–80	30–60	20–40	Spofford
152	Structural Design. *145*	XIII-A	G	. . . .	60–0	. . . .	Bowman
153	Bridge Design. *149*	I	4	50–0	60–0	70–0	Bowman
154	Structural Design. *150*	XI; XV_1	4	. . . .	40–0	20–0	Bowman
155	Advanced Structural Design 149; 153 or 492, 158, *156*	Elective	G	. . . .	60–0	60–0	Sutherland
156	Advanced Structures. 149, 153	Elective	G	30–60	30–60	30–60	Spofford
158	Reinforced Concrete Design 149 or 150 or 151	Elective	G	50–40	. . . .	. . . .	Sutherland
160	Hydrographic Surveying. *107, 108*	I; XI; XV_1		Camp Technology 75 hours			Russell
162	Theoretical Hydraulics. 220	I; XI	4	40–80	. . . .	. . . .	Russell
		XV_1	4	40–70	. . . .	. . . .	Luther
163	Theoretical Hydraulics. 220	IV_2; XIII	4	. . . .	20–40	. . . .	Russell
164	Theoretical Hydraulics. 220	II, IX-B; XV_2	3	. . . .	. . . .	30–50	Russell
		$III_{1,2}$	3	. . . .	. . . .	30–40	Luther
		III_3	4	. . . .	. . . .	30–40	Luther
165	Theoretical Hydraulics. 220	VI	4	20–40	20–40	. . . .	Barrows
		VI-A (B)	4	. .	. .	40–80	Luther
168	Hydraulic Engineering. 164	II	4	30–45	. . . .	. . . .	Russell
169	Hydraulic Engineering. 162 or 164	XV_1	4	. . . .	. . .	30–60	Barrows
		XV_2	4	30–45	. . . .	. . . .	
170	Hydraulic Engineering 165	VI Optional	4	. . . .	. . . .	30–60	Barrows
171	Hydraulic Laboratory Research. 162, 164 or 165	Elective	G	. . . .	60–0	60–0	Russell
173	Water Power Engineering. 144 or 149 or 150; 162 or 165; 168 or 169 or 175 or 177; *182*	Elective	G	30–60	30–60	30–60	Barrows
175	Hydraulic and Sanitary Engineering. *162*	I_1	4	30–45	30–50	30–60	Porter
177	Sanitary Engineering. *162*	XI	4	20–40	30–60	30–60	Porter
179	Hydraulic and Sanitary Design. 175 or 177	I_1	4	. . . .	. . . .	30–0	Porter
180	Hydraulic and Sanitary Design. 175 or 177; *150*	XI	4	. . . .	20–0	60–0	Porter
181	Engineering of Water and Sewage Purification. 149 or 150; 175 or 177	Elective	G	20–40	20–40	. . . .	Porter
182	Water Power Design. *173*	Elective	G	60–0	60–0	60–0	Barrows
183	Sanitary Design. *181*	Elective	G	60–0	60–0	60–0	Porter
190	Report Writing. E H 23	Elective in I and XI	4	. . . .	. . . .	30–30	Babcock

MECHANICAL ENGINEERING — 200-299

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
200	Mechanism. M13, D13	II;VI;XIII;XV_2	2	30–60	. . . .	. . . .	Park
201	Mechanism. 200	II;VI;XIII;XV_2	2	. . . .	30–60	. . . .	Park
202	Mechanism. M13, D13 or D15	I; XI; XV_1	2	30–45	. . . .	. . . .	Merrill
		VIII;	2	30–60	. . . .	. . . .	
		IX-B	2	30–50	. . . .	. . . .	
202a	Mechanism. M13, D13	III_2; XIV		Summer School		35–55	Merrill
202b	Mechanism. M13, D13	XV_3:	2	30–60	. . . .	. . . .	Merrill
203	Mechanism. M13; D13	X	2	. . . .	20–25	20–25	James
205	Mechanism of Machines. 201	II	3	30–40	. . . .	. . . .	Swett
206	Design of Automatic Machinery. 205, 212	II	G	Any term, 180 hours			Swett
210	Mechanical Engineering Drawing. D13, *200*	II; VI; IX-B	2	60–0	. . . .	. . . .	James
		XIII; XV_2					
211	Mechanical Engineering Drawing. 210, *201*	II	2	. . . .	30–0	. . . .	James
		II	2	. . . .	. . . .	60–0	James
212	Machine Drawing. D13	VI; IX_3; XIII; XV_2	2	. . . .	60–0	. . . .	James
213	Machine Drawing. 212	XV_2	2	. . . .	. . . .	30–0	James
214	Machine Drawing. D13	X	3	. . . .	. . . .	60–0	
		XV_2	3	60–0	. . . .	. . . .	
214a	Machine Drawing D13	III_2		Summer School		45–0	James
220	Applied Mechanics (Statics) M22, 802a	I;II;IV; VI; VIII; IX-B; X; XI XIII;XV_1; XV_2	2	. . . .	. . . .	30–60	Johnston
		III_1;III_2; III_3;XIV; XV_3	3	30–60	. . . .	. . . .	
220b	Applied Mechanics	IV_2	3	50–100	. . . .	. . . .	Johnston
221	Applied Mechanics (Kinetics, Strength of Materials) 220	I;II;VI;VI-A (B) IX-B;X; XI; XIII;XV_1; XV_2	3	30–60	. . . .	. . . .	Johnston
		III; VI-A (A)	3	. . . .	30–60	. . . .	
221a	Applied Mechanics (Strength of Materials) 220	IV_1; VIII; XIV; XV_2	3	30–60	. . . .	. . . .	Johnston
				. . . .	30–60	. . . .	
222	Applied Mechanics (Strength of Materials) 221	II; IX-B; X;XIII;XV_2	3	. . . .	30–60	. . . .	Johnston
		VI	3	. . . .	30–50	. . . .	
		III; VI-A (B)	3	. . . .	. . . .	30–60	
		VI-A; (A)	4	Summer Term		30–60	
222a	Applied Mechanics. 221 (Strength of Materials)	I; XI;XV_1	3	. . . .	20–30	20–30	Johnston
222b	Applied Mechanics. 221b	IV_2;	3	. . . .	40–80	. . . .	Johnston
222c	Applied Mechanics 221a	IV_1	3	. . . .	15–30	. . . .	Johnston
223	Applied Mechanics. (Strength of Materials) 222	II; XV_2	3	. . . .	. . . .	30–50	Fuller

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
223a	Applied Mechanics (Strength of Materials) 222	XIII	3	.. ..	.. ..	30–60	Fuller
223b	Applied Mechanics 222b	IV$_2$	3	.. ..	.. ..	30–60	Fuller
224	Applied Mechanics (Kinetics) 222	VI (optional)	3	.. ..	.. ..	30–50	Fuller
225	Dynamics of Machines 223	II	4	30–40	.. ..	.. ..	Riley
226	Mechanics of Engineering 225	II	4	.. ..	20–40	20–40	Fuller
228	Adv. Mechanics and Th. of Elasticity 226	II	G	30–60	30–60	30–60	Fuller
230	Materials of Engineering 222	II; IX-B;	3	.. ..	20–20	20–20	Hayward
		XIII	4	.. ..	20–20	20–20	
232	Materials of Engineering 222	XV$_2$	3	.. ..	.. ..	20–40	Hayward
234	Physical Metallurgy 230, 235	II	G	120	120	120	Fay
235	Testing Materials Laboratory 230	II; IX-B	4	20–10	20–10	.. ..	Hayward
236	Test. Materials Laboratory 222 or 222a	I; III; XI; XIV	3	.. ..	.. ..	20–10	
		XV$_2$	4	20–10	.. ..	.. ..	Hayward
		X; XV$_1$; XV$_2$	4	.. ..	20–10	.. ..	
237	Testing Materials Laboratory 222 or 222b	IV$_2$	4	30–10	.. ..	.. ..	Hayward
		XIII	4	30–15	.. ..	.. ..	
238	Testing Materials Laboratory (Concrete) 223b	IV$_2$	4	30–10	.. ..	.. ..	Hayward
240	Heat Engineering M23, 803a	II; IX-B; XIII; XV$_2$	3	30–60	.. ..	.. ..	Berry
		X; XV$_2$	3	.. ..	30–60	.. ..	
		III$_2$	4	30–60	.. ..	.. ..	
241	Heat Engineering 201, 211	II; IX-B; XV$_2$	3	20–20	.. ..	.. ..	Miller
		XIV	3	.. ..	.. ..	20–20	
		III$_2$	4	20–20	.. ..	.. ..	
241a	Heat Engineering 201 or 203 or 202b	XIII	3	20–20	.. ..	.. ..	Riley
		X; XV$_2$	3	.. ..	.. ..	20–20	
242	Heat Engineering 240, 241	II; IX-B; XIII; XV$_2$	3	.. ..	30–60	.. ..	Berry
		X; XV$_2$	3	.. ..	.. ..	30–60	
		III$_2$	4	.. ..	30–60	.. ..	
243	Heat Engineering 241	II; IX-B; XV$_2$; XIV	3	.. ..	20–20	.. ..	Taft
		III$_2$	4	.. ..	20–20	.. ..	
244	Heat Engineering 242, 243	II	3	.. ..	.. ..	20–40	Berry
245	Heat Engineering 244, 260	II	4	30–30	.. ..	.. ..	
246	Heat Engineering M23, 803, 202	I; XI	4	30–60	.. ..	.. ..	Miller
		XV$_1$	3	30–60	.. ..	.. ..	Miller
247	Heat Engineering 246	I; XI	4	.. ..	30–60	.. ..	Miller
		XV$_1$	3	.. ..	30–60	.. ..	Miller
248	Heat Engineering 247	I; XI	4	.. ..	.. ..	30–30	Miller
		XV$_1$	3	.. ..	.. ..	30–30	Miller
250	Heat Engineering M23, 803, 201	VI; VI-A (Group B)	3	30–60	.. ..	.. ..	Taft
		VI-A (Group A)	3	.. ..	30–60	.. ..	
251	Heat Engineering 250	VI	3	.. ..	30–60	.. ..	Taft
		VI-A (Group B)	3	.. ..	.. ..	30–60	
		VI-A (Group A)	4	Summer School		30–60	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
252	Heat Engineering..... 251	VI	3	.. ..	.. ..	30–60	Taft
		VI-A	4	.. ..	30–60	.. ..	
		VI-A (Group A)					
		VI-A (Group B)	4	30–60	.. ..	.. ..	
253	Power in Mining..... 222, 302	III_1; III_3	4	.. ..	40–40	.. ..	Jones
254	Advanced Heat Engineering 245, 263		G	30–90	30–90	30–90	Miller
255	Advanced Refrigeration 245, 263	II	G	30–90	.. ..	.. ..	Berry
256	Advanced Heat Transmis-mission..... 243, 262	II	G	.. ..	30-90	30–90	Berry
257	Mechanical Equipment of Buildings, Steam, Heat and Ventilation..... 803a	IV_2	4	.. ..	.. ..	40–40	Robinson
258	Power Plant Design..... 223, 245	II	4	.. ..	.. ..	60–0	Miller
260	Engineering Laboratory.... 242, 243, 241a	II, XV_2	3	.. ..	20–10	20–10	Eames
		XIII	3	.. ..	.. ..	40–20	
		IX-B, X	4	40–20	.. ..	.. ..	
260a	Engineering Laboratory.... 241a, 242	XV_3	4	.. ..	.. ..	60–30	Eames
260b	Engineering Laboratory	VI	4	40–30	.. ..	.. ..	
		VI-A (Group A)	5	Summer School		40–30	
		VI-A (Group B)	4	.. ..	.. ..	40–30	
260c	Engineering Laboratory.... 242, 243	III_2	4	.. ..	.. ..	20–10	Eames
260d	Engineering Laboratory.... 257	IV_2	4	.. ..	.. ..	10– 0	Eames
261	Engineering Laboratory.... 242, 243, 260, 164	II; XV_2	4	40–40	.. ..	.. ..	Eames
261a	Engineering Laboratory.... 242, 241a, 260	XIII	4	20–20	20–20	.. ..	Eames
261b	Engineering Laboratory.... 260	X	4	.. ..	20–10	.. ..	
262	Engineering Laboratory.... 261	II	4	.. ..	40–40	.. ..	Eames
262a	Engineering Laboratory.... 261	XV_2	4	.. ..	20–10	.. ..	
263	Engineering Laboratory.... 262	II	4	.. ..	.. ..	20–20	Eames
264	Engineering and Hydraulic Laboratory..... 161, 246	I; XV_1; XI	4	.. ..	30–30	.. ..	Eames
270	Machine Design..... 212, 222, 243	II	3	.. ..	30– 0	30– 0	Haven
		XV_2	4	60–10	.. ..	.. ..	
271	Machine Design..... 270	II	4	60– 0	.. ..	.. ..	Haven
		XV_2	4	.. ..	60– 0	.. ..	
272	Machine Design..... 271	II	4	.. ..	60– 0	.. ..	Haven
274	Advanced Machine Design. 272	II	G	40– 0	40– 0	40– 0	Haven
275a	Automatic Machinery..... 205, 223	II (Elective)	4	.. ..	40– 0	40– 0	Swett
275b	Automotive Machinery..... 225, 245	II (Elective)	4	.. ..	40– 0	40– 0	Park
275c	Engine Design..... 225, 245, 244	II (Elective)	4	.. ..	40– 0	40– 0	Riley
275d	Fire Protection Engineering. 223, 230	II (Elective)	4	.. ..	.. ..	40– 0	Haven
275e	Heat Transmission..... 245, 262	II (Elective)	4	.. ..	20–20	.. ..	Berry

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
275f	Heat Treatment. *230, 235*	II (Elective)	4	. . . .	40– 0	. . . .	Hayward
275g	Internal Combustion Engines 225, 245, 261	II (Elective)	4	. . . .	. . . .	40– 0	Riley
275h	Locomotive Engineering. 225, 245	II (Elective)	4	. . . .	40– 0	40– 0	Fuller
275i	Refrigeration. 245	II (Elective)	4	. . . .	. . . .	20–20	Berry
275j	Textile Engineering. 223, 230	II (Elective)	4	. . . .	40– 0	40– 0	Haven
275k	Theory of Elasticity. 223	II (Elective)	4	. . .	20–20	. . . .	Fuller
276	General Engineering Lectures 223, 244	II; XV_2	4	. . . .	10– 5	. . . .	
277	Industrial Plants. 223, 244	II	4	. . . .	60–60	. . . .	Haven
278	Industrial Plants. 277	II	4	. . . .	. . . .	60– 0	Haven
280	Forging.	II	2	30– 0	30– 0	. . . .	Lambirth
	D13	XIII	2	. . . .	60– 0	. . . .	
281	Forging. D13	III_1	4	. . . .	. . . .	40–0	Lambirth
281a	Forging. D13	III_2	3	. . . .	. . . .	30–0	Lambirth
282	Foundry.	II	2	. . . .	60–0	. . . .	O'Neill
	D13	XIII	2	60–0	. . . .	. . . .	
283	Foundry.	X	4	30–0	. . . .	. . . .	O'Neill
	D13	VI	2	30–0	. . . .	. . . .	
283a	Foundry.	III_2	4	40–0	. . . .	. . . .	O'Neill
	D13	IX-B	2	40–0	. . . .	. . . .	
284	Pattern Making. 282	II	2	. . . .	. . . .	60–0	O'Neill
286	Vise and Bench Work. D13	II; XIII	3	40– 0	. . . .	. . . .	R.H.Smith
287	Vise and Bench Work. D13	VI	2	30– 0	. . . .	. . . .	R.H.Smith
287a	Vise and Bench Work. D13	XIV	2	20– 0	. . . .	. . . .	R.H.Smith
288	Machine Tool Work. 286	II; XIII	3	. . . .	40– 0	. . . .	R.H.Smith
289	Machine Tool Work. 287	VI	2	. . . .	60– 0	. . . .	R.H.Smith
290	Machine Tool Work. 288	II; XIII	3	. . . .	. . . .	40– 0	R.H.Smith
291	Machine Tool Work. 287a	XIV	2	. . . .	20– 0	. . . .	R.H.Smith
291a	Machine Tool Work. 291	XIV	2	. . . .	. . . .	20– 0	R.H.Smith
292	Machine Tool Work. 290	II; XIII	4	30– 0	. . . .	. . . .	R.H.Smith
295	Vise and Bench and Machine Tool Work. 283	X	4	. . . .	30– 0	. . . .	R.H.Smith
295a	Vise and Bench and Machine Tool Work. D13	XV_3	4	. . . .	40– 0	. . . .	R.H.Smith
295b	Vise and Bench and Machine Tool Work.	IX-B	2	. . . .	. . .	60– 0	R.H.Smith
296	Foundry, Vise, Bench and Machine Tool Work. D13	XV_2	Summer School			75–0	R.H.Smith
297	Machine Tool Work. 295 or 296	X	4	. . . .	. . . .	30– 0	R.H.Smith
		XV_2	3	30– 0	. . . .	. . . .	

MINING ENGINEERING — 300-399

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
301	Mining Engineering. 104, S03a, 1202, 1230, D13	III1,3	3	. . . .	30-30	. . . .	Locke
302	Mining Engineering. 301	III1 / III3	3 / 3	. . . .	. . . .	40-35 / 40-40	Locke
303	Mining Engineering. 302	III1	4	20-20	. . . .	. . . .	Locke
304	Minng Engineering. 303	III1	4	. . . .	40-40	. . . .	Locke
305	Mining Engineering. 1201	III3	3	. . . .	30-30	. . . .	Locke
306	Mining Engineering (Advanced). 301, 302, 303, 304	III (Elective)	G	200 hours			Locke
321	Ore Dressing. 302	III1; III3	4	40-40	. . . .	. . . .	Locke
322	Ore Dressing, Laboratory. 331, 513, *321*	III1,3	4	80-15	. . . .	. . . .	Locke
323	Ore Dressing (Lectures and Laboratory). 305, 331	III2	4	45-10	. . . .	. . . .	Locke
324	Ore Dressing (Advanced). 321, 322	III (Elective)	G	200 hours			Locke
331	Fire Assaying. 510, 1202	III	2	. . . .	. . . .	80-20	Bugbee
331a	Fire Assaying. 510, 1202	XII	2	. . . .	. . . .	50-10	
332	Fire Assaying and Metallurgical Laboratory. 512	XIV (optional)	4	60-20	. . . .	. . . .	Bugbee
333	Fire Assaying (Advanced). 331	III (Elective)	G	200 hours			Bugbee
341	Metallurgy. 512, 331, 803a, *354*	III	3	40-40	. . . .	. . . .	Hofman
342	Metallurgy. 341	III1,3	3	. . . .	30 30	. . . .	
342a	Metallurgy. 341	III2	3	. . . .	30-30	. . . .	Hofman
343	Metallurgy of Iron and Steel 341, *344*	III2	3	. . . .	. . . .	40-80	Hayward
343a	Metallurgy of Iron and Steel 341	III1,2	3	. . . .	. . . .	20-20	Hayward
344	Metallurgy, Gen., Zinc and Minor Meals. 331, 513, 1202	III2	3	. . . .	. . . .	40-40	Hofman
345	Metallurgy of Engineering Materials. 503	III (Elective)	3 or 4	any term 40-80			Hofman
346	Metallurgical Plant Design. 342, 343, 344, 359	III (Elective)	G	200 hours			Hofman
347	General Metallurgy (Advanced). 344	III (Elective)	G	any term 40-80			Hofman
348	Non-Ferrous Metallurgy, (Advanced). 341, 342	III (Elective)	G	any term 40-80			Hofman
354	Metallurgy, Laboratory and Reports. 331, *341*	III	3	90-10	. . . .	. . . .	Hofman
355	Metallurgy, Laboratory and Reports. 331, 341, *342*	III1,2	3	. . . .	80-15	. . . .	Hayward
359	Metallurgical Calculations. 341 and 342 or 344	III1,2	4	20-20	. . . .	. . . .	Hayward
361	Metallography I. 343 or 343a	III2	4	60-20	. . . .	. . . .	Hayward

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
362	Metallography I. 343 or 343a	III_2	4	.. ..	20–0	.. ..	Hayward
363	Metallography II. 343 or 343a	III_1	4	20–10	.. ..	.. ..	Hayward
364	Metallography and the Physics of Metals. 343, 361, 362	III (Elective)	G	300 hours			Hayward

ARCHITECTURE — 400-499

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
411	Shades and Shadows. D17	IV	2	30–10	.. ..	.. ..	Gardner
412	Perspective. D16	IV_1	1	.. .	10–30	10–20	Lawrence
		IV_2	2	.. ..	10–30	.. ..	
413	Applied Perspective. 412	IV_1	2	20–0	20–0	.. ..	Gardne
414	Applied Perspective. 412	IV_1	2	.. ..	.. ..	20–0	Gardner
415	Applied Perspective. 413, *472* or *473*	IV_1	3	20–0	20–0	20–0	Gardner
421	Office Practice. D17	IV_1	2	.. .	40–0	40–0	Jenney
422	Professional Relations. 421	IV_1	4	10–0	10–0	10–0	Jenney
		IV_2	3	10–0	10–0	10–0	
431	History of Ornament. D42	IV_1	2	.. ..	.. ..	10–10	Walker
441	Architectural History	IV	2	10–20	10–20	10–20	Putnam
442	Architectural History. 441	IV	3	10–20	20–40	20–30	Cram
446	European Civilization and Art, EH 11	IV	3	30–40	30–40	30–40	Sumner
447	European Civ. and Art. 446	IV	4	30–40	30–40	30–40	Sumner
451	Philosophy of Architecture. 443-*472*	IV	4	10–0	10–0	10–0	
453	Water Color, *D42*	IV_1	2	20–0	20–0	20–0	Brown
			3	.. ..	20–0	20–0	
471	Design I. D20, D17, *411*	IV	2	100–0	100–0	140–0	Gardner
472	Design II. 413, D42, 471	IV_1	3	140–0	140–0	160–0	Stearns
473	Design III. 413, *472*, *D43*.	IV_1	4	280–0	320–0	260–0	Dodge
480	Building Construction.	V	3	20–10	.. ..	.. ..	Norton
481	Constructive Design. 221a, *222c*	IV_1	3	.. ..	25–0	60–0	Lawrence
482	Constructive Design. 481	IV_1	4	40–0	.. ..	.. ..	Lawrence
490	Structural Drawing. D17	IV_2	3	40–40	.. ..	.. ..	Norton
491	Structural Design. 490, 220b, *222b*	IV_2	3	.. ..	100–0	80–0	Lawrence
492	Structural Design. 491, *151*	IV_2	4	165–0	240–0	90–0	Lawrence
D42	Freehand Drawing.	IV	2	40–0	40–0	40–0	Brown
D43	Freehand Drawing.	IV_1	3	40–0	40–0	40–0	Brown
D44	Life Class.	V_1	4	60–0	60–0	60–0	Brown
D45	Life Class and Decorative Design.	IV_1 (Elective)	G	60–0	60–0	60–0	Brown

CHEMISTRY — 500-599

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
501	Chemistry. M1, E1, 800c	All Courses Except IV_1	1	80–50	. . . .	. . . .	Talbot
502	Chemistry. 501	All Courses Except IV_1	1	. . . .	80–50	. . . .	Talbot
503	Chemistry. 502	All Courses Except IV_1	1	. . . .	. . . .	80–50	Talbot
505	Inorganic Chemistry I. 802, 513	V	3	30–95	. . . .	. . . .	Hall
		V	2	. . . .	. . . .	30–45	Hall
		X	4	. . . .	. . . .	30–45	Norris
506	Inorganic Chemistry II. . . . 567	(Elective)	G	. . . .	20–20	20–20	Norris
508	Preparation of Inorganic Compounds.	(Elective)	G	. . . .	. . . .	70–20	Hall
510	Qualitative Analysis. 503	III	2	100–20	. . . .	. . . .	Fay
		VII	2	130–20	. . . .	. . . .	
		VIII	2	100–20	. . . .	. . . .	
		IX-A	2	110–20	. . . .	. . . .	
		XI	2	120–15	. . . .	. . . .	
		XII	2	100–20	. . . .	. . . .	
		V		Summer School		210–30	
		X		Summer School		210–30	
		XIV		Summer School		190–30	
		XV_3		Summer School		210–30	
512a	Quantitative Analysis.	III	2	. . . .	110–10	. . . .	Fay
		V	2	110–20	. . . .	. . . .	
		VII	2	. . . .	140–10	. . . .	
		VIII	2	. . . .	140–10	. . . .	
		IX-A	2	. . . .	120–10	. . . .	
		X	2	100–20	. . . .	. . . .	
		XI	2	. . . .	50–20	50 10	
		XII	2	. . . .	110–10	. . . .	
		XIV	2	90–20	. . . .	. . . .	
		XV_3	2	. . . .	80–10	. . . .	
512b	Quantitative Analysis.	III	2	. . . .	. . . .	100–10	Fay
		V	2	. . . .	120–10	. . . .	
		X	2	. . . .	75–10	. . . .	
		XII	2	. . . .	. . . .	120–20	
		XIV	2	. . . .	90–20	. . . .	
		XV_3	2	. . . .	. . . .	80–10	
513	Quantitative Analysis.	III	3	60–10	. . . .	. . . .	Fay
		V	2	. . . .	. . . .	50–10	
		X	2	. . . .	. . . .	75–10	
515	Qualitative Analysis of Rare Metals. 513	(Elective)	G	140–20	. . . .	. . . .	Hall
517	Methods of Electrochemical Analysis. 513	(Elective)	G	. . . .	70–20	. . . .	Hall
520	Water Supplies and Air. . . . 512	VII	2	. . . .	. . . .	40–0	Woodman
521	Industrial Water Analysis. . 512	XI	3	. . . .	30–0	. . . .	Woodman
522	Water Supplies and Wastes Disposal. 521	XI	4	30–20	. . . .	. . . .	Woodman
525	Chemistry of Foods. 512	VII	3	. . . .	50–10	. . . .	Woodman
		V (Elective)	4	any term		50–10	
526	Food Analysis, Advanced. . . 525	V (Elective)	4	any term		70–0	Woodman
527	Biochemistry. . . . . 730, 512, 550 or 551	VII	4	30–50	. . . .	. . . .	Mueller
		(Elective)	G	30–50	. . . .	. . . .	
528	Selected Topics in Biochemistry. 527	(Elective)	G	20–40	. . . .	. . . .	Mueller
529	Optical Methods in Chemical Analysis. 512, 802	VII_2 (Elective)	4	30–20	. . . .	. . . .	Woodman
		V	4	any term		30–20	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
530	Proximate Technical Analysis L11, 512, 550 or 551	V; X; XIV (Elective)	4	any term		90–30	Gill
531	Gas Analysis I	III	3	20–10	.. ..	.. ..	Gill
512		V	4	20–10	.. ..	.. ..	
532	Gas Analysis II	(Elective)	4 or G	any term		30–0	Gill
531							
533	Gas and Fuel Analysis	II; VI; XIII	4	9–0 (Given in connection with Engin. Lab.)			Gill
503							
534a	Applied Chemistry	XIII	4	20–20	.. ..	.. ..	Gill
534b	Applied Chemistry	II (Elective)	4	.. ..	35–5	.. ..	Gill
503			4	.. ..	.. ..	35–5	
536	Testing of Oils	(Elective)	4 or G	any term		30–0	Gill
512, 550							
537a	Chemistry of Road Materials	I (Elective)	G	.. ..	50–20	.. ..	Gill
503				.. ..	.. ..	50–20	
537b	Chemistry of Road Materials	I (Elective)	3	110–30	.. ..	.. ..	Gill
503				.. ..	110–30	.. ..	
540	Special Methods and Instruments	V (Elective)	4	.. ..	.. ..	30–20	Gill
512, 802							
541	Metallography I	V	4	.. ..	40–20	.. ..	Fay
565		VIII, XIV	4	.. ..	.. ..	40–20	Williams
542	Metallography Ia	Elective	G	20–20	.. ..	.. ..	Fay, Williams
543	Metallography II	V, VIII, X, XIV	G	.. ..	.. ..	20–20	Fay, Williams
550	Organic Chemistry (Brief Course)	VII; IX-A; XI; XIV; XV$_3$	3	30–30	.. ..	.. ..	Kneeland
503		VIII	4	30–30	.. ..	.. ..	
551	Organic Chemistry I	V	3	40–30	40–30	30–25	Moore
513, 802		X	3	40–30	40–30	30–20	
552	Organic Chemistry II	Elective	G	20–30	20–30	20–30	Norris
551,							
553	Organic Chemistry III	Elective	4, G	20–40	20–40	.. ..	Mulliken
551, 556							
555	Organic Qualitative Analysis	Option	4, G	70–0	70–0	.. ..	Mulliken
551, 556							
556a	Organic Chemical Lab.	V	3	90–0	140–0	.. ..	Moore
513, 551		X	3	90–0	60–0	.. ..	
556b	Organic Chemical Lab.	VII	3	.. ..	.. ..	100–0	Kneeland
550 or 551		XI	3	.. ..	.. ..	*60–0*	
		XIV	3	.. ..	.. ..	60–0	
		XV$_3$	3	.. ..	.. ..	110–0	
558	Recent Developments in Organic Chemistry	Elective	G	10–20	10–20	.. ..	Moore
559	Special Topics in Organic Chemistry	Elective	G				
551							
	(a) Chemistry of Dyes			.. ..	.. ..	20–20	Mulliken
	(b) Chemistry of Explosives			10–10	.. ..	.. ..	Davis
	(c) Synthetic Methods in Organic Chemistry			.. ..	30–30	.. ..	Davis
	(d) History of Organic Chemistry Theory			.. ..	.. ..	10 20	Davis
565	Chemical Principles I	V; X	3				
M21, 802, 512	Recitations			30–30	30–30	30–30	Sherrill
	Laboratory			12–18	12–18	12–18	
	Lectures			10–10	10–10	10–10	
566	Chemical Principles Ia	V; X (Coll. Class)	3	40–60	40–60	40–60	Sherrill
M21, 802, 512 and a collegiate descriptive course in Physical Chemistry							
567	Chemical Principles II	V	4	40–60	.. ..	.. ..	Sherrill
		X; XA	4	30–45	.. ..	.. ..	

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
568	Thermochemistry and Chemical Equilibrium. 503; 802	III, VII$_1$ IX-A XV$_3$	4 3 3	 30–70	. . . .	30–60 30–60	Mueller
569	Chemistry of Colloids. 551	V	4	. . . .	20–20	. . . .	
571	Physical Chemistry Seminar. 565, 567	Elective	G	20–50	20–50	20–50	Millard
572	Radiochemistry and Atom Structure. 567, 571		G	. . . .	. . . .	20–40	MacInnes
573	Thermodynamics of Chemical Reactions. 567		G	. . . .	20–50	. . . .	Sherril
574	Kinetic Theory of Gases, and Solids. 567		G	. . . .	20–40	. . . .	Keyes
575	Industrial Chemistry. 503, 550 or 551, 565	V X; XIV; XV$_3$	4 4	40–40 30–30	30–30 30–30	. . . .	Norris
576	Chemical Engineering I. 245, 565	X	4	40–55	40–60	40–60	McAdams
576a	Chemical Engineering I.	XV$_3$	4	30–30	30–30	. . . .	
577	Chemical Engineering II. 576		G				
	(a) Evaporation and Distillation			. . . .	20–20	. . . .	Robinson
	(b) Drying			. . . .	. . . .	20–30	Lewis
	(c) Extraction (Not given 1920-21)			. . . .	. . . .	20–30	Lewis
	(d) Combustion (Not given 1920-21)			. . . .	20–30	. . . .	Lewis
579	Chemical Engineering Laboratory. 576	X;XA Elective	G	. . . .	. . . .	40–30	Lewis
580	Materials of Construction. 565; 575 or 576	X; XA Elective	G	. . . .	30–30	. . . .	Lewis
581	Applied Thermochemistry. 565	Elective	G	. . . .	20–30	20–30	Lewis
582	Plant Design. 576, *566* or *581*	X, XA Elective	G	. . . .	40–40	40–40	Lewis
583	Applied Chemical Thermodynamics. 566a or 567	Elective	G	. . . .	20–30	20–30	Wilson
584	Industrial Applications of Chemical Principles.	V; X; XA Elective	G	10–10	. . . .	. . . .	Blanchard
585	Selected Topics in Industrial Chemistry.	Elective	G				
	(a) Sulphuric Acid			10–10	. . . .	. . . .	Phelan
	(b) Glass and Ceramics			10–10	. . . .	. . . .	Wilson
	(c) Iron and Steel			. . . .	10–10	. . . .	
	(d) Starch and Cellulose			. . . .	10–10	. . . .	
	(e) Petroleum			. . . .	. . . .	10–10	Robinson
	(f) Nitrogen Fixation			. . . .	. . . .	10–10	Wilson
	(g) Fuels and their Distillation			10–10	. . . .	. . . .	Phelan
	(h) Rubber			. . . .	10–10	. . . .	Lewis
	(i) Textiles and Dyeing			. . . .	. . . .	10–10	Lewis
	(j) Paints, Oils and Varnishes			. . . .	. . . .	20–20	Gill
586	Problems of the Chemical Engineer. 503	X	2	10–0	. . . .	. . . .	Lewis
587	Experimental Problems in Industrial Chemistry 513, 565, *575*	X; XA XV$_3$; V Elective	4 4	 110–20	50–10	70–30	Robinson
588	Economics of Chemical Industries. 575, 587	XV$_3$ X	4 G	. . . .	. . . .	20–30 20–30	Lewis

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
590	Research Problems in Inorganic Chemistry (optional) 513	V	3	.. ..	10–15	160–20	Fay
591	Research Problems in Organic Chemistry (optional) 551, 556	V	3	.. ..	10–15	160–20	Moore
592	Research Problems in Physical Chemistry 565, *567*	V	4	160–20	.. ..	.. ..	Noyes
593	History of Chemistry 550 or 551	V	4	.. ..	.. ..	30–30	Moore
594	Recent Developments in Chemistry 503, 565, 550 or 551	V; X Elective	4	.. ..	10–10	10–10	
595	Thesis	V	4	.. ..	100–20	200–20	
596	Thesis Reports	V	4	.. ..	10–10	10–10	Talbot
597	Thesis Reports and Memoirs	X; XA	4	.. ..	20–10	10–0	Walker
598	Research 566	V Elective	G				
599	Research Conferences	V Elective	G	10–10	10–10	10–10	Norris, Keyes Moore, Wilson

ELECTRICAL ENGINEERING — 600-699

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
600	Principles of Electrical Engineering (Electric and Magnetic Circuits)	VI	2	.. ..	.. ..	50–70	Bush
	503a, M23	XIV	2	.. ..	.. ..	50–60	
601	Principles of Electrical Engineering (Direct-Current Machinery) 600 *M31*, or *M35*	VI; VI-A; XIV	3	40–60	.. ..	.. ..	Bush
602	Principles of Electrical Engineering (Variable and Alternating Currents) 601 or 607	VI; VI-A; XIV	3	.. ..	40–60	.. ..	Lawrence
603	Principles of Electrical Engineering. (Alternating Current Machinery) 602	VI; VI-A	3	.. ..	.. ..	40–60	Lawrence
603a	Principles of Electrical Engineering. (Alternating Current Machinery) 602	XIV	3	.. ..	.. ..	40–60	Lyon
604	Principles of Electrical Engineering. (Alternating Current Machinery) 603	VI; VI-A	4	60–80	.. ..	.. ..	Lawrence
604a	Principles of Electrical Engineering. (Alternating Current Machinery and Electric Transmission) 603a	XIV	4	50–70	.. ..	.. ..	Lyon
605	Principles of Electrical Engineering. (Transmission Phenomenal) 604	VI; VI-A	4	.. ..	60–70	.. ..	Dillon
606	Principles of Electrical Engineering (Transmission Problems)	VI	4	.. ..	.. ..	60–80	Dillon
607	Principles of Electrical Engineering 803a, M23	VI	3	50–50	.. ..	.. ..	Marston
620	Electric Transmission Equipment 605	Elective	4	.. ..	.. ..	30–60	Dillon

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
621	Industrial Applications of Electric Power. 604 or 642	Elective	4	. . . .	. . . .	30–60	Dellenbaugh
622	Central Stations. 251, *605*	Elective	4	. . . .	30–60	. . . .	Nelson
623	Central Station Design. 622	Elective	4	. . . .	. . . .	30–60	Nelson
623a	Central Stations. 243, 642	XV$_2$	4	. . . .	. . . .	30–60	Nelson
624	Electric Railways. 604	Elective	4	. . . .	30–60	. . . .	Dillon
625	Dynamo Design. 603	Elective	4	30–60	. . . .	. . . .	Dellenbaugh
626	Dynamo Design. 625	Elective	4	. . . .	30–30	. . . .	Dellenbaugh
627	Illumination	Elective	4	. . . . /	30–60 /	. . . . / 30–60	Gardner
628	Telegraph and Telephone Engineering. 603	Elective	4	. . . . /	30–60 /	. . . . / 30–60	Tucker
629	Storage Batteries	Elective	4	one term		10–10	Lawrence
638	Electric Wiring and Lighting of Buildings	IV$_2$	3	10–20	. . . .	. . . .	Hudson
640	Elements of Electrical Engineering. 803a	VIII;	3	30–45	. . . .	. . . .	Hudson
		X	3	. . . .	. . . .	30–40	
		XIII	4	. . . .	. . . .	30–60	
		XV$_1$	3	30–40	. . . .	. . . .	
		XV$_3$	3	. . . .	. . . .	30–60	
641	Elements of Electrical Engineering. 803a	I; IX-B	3	30–45	. . . .	. . . .	Hudson
		II; III	4	30–45	. . . .	. . . .	
		XV$_2$	3	. . . .	. . . .	30–45	
642	Elements of Electrical Engineering. 641	I; IX-B	3	. . . .	30–45	. . . .	Hudson
		II; III	4	. . . .	30–45	. . . .	
		XV$_2$	4	30–45	. . . .	. . . .	
645	Alternating Currents and Alternating Current Machinery	XIIIA	4	30–60	. . . .	. . . .	Lawrence
646	Alternating Current Machinery and its Application. 645	XIIIA	4	. . . .	30–60	. . . .	Lawrence
650	Electrical Engineering Seminar	VI	G	50	50	50	Jackson
651	Alternating Currents	VI Elective	G	90	90	90	Bush
652	Alternating Current Machinery	VI Elective	G	60	60	60	Lyon
653	Public Service Companies	VI Elective	G	100	100	100	Jackson
654	Power Stations and Distribution Systems	VI Elective	G	90	90	90	Nelson
655	Electric Railways	VI Elective	G	90	90	90	Dillon
656	Electrical Communication of Intelligence	VI Elective	G	90	90	90	Kennelly
670	Electrical Eng. Laboratory (Tech. Elect. Meas.) 803a, 690, *601*	VI	3	25–25	. . . .	. . . .	Laws
671	Electrical Eng. Laboratory { a. Tech. Elect. Meas. / b. Dynamo Elect. Machinery } 670, *602*	VI	3	. . . .	50–40	. . . .	Laws / Ricker
672	Electrical Eng. Laboratory { a. Tech. Elect. Meas. / b. Dynamo Elect. Machinery } 671, 602, *603*	VI	3	. . . .	. . . .	50–40	Laws / Ricker
673	Electrical Eng. Laboratory { a. Tech. Elect. Meas. / b. Dynamo Elect. Machinery } 603, *604*, 672	VI	4	70–50	. . . .	. . . .	Laws / Ricker
674	Electrical Eng. Laboratory (Dynamo Elect. Machinery) 673, *605*	VI	4	. . . .	70–50	. . . .	Ricker

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
675	Electrical Eng. Laboratory	VIA (A)	3	. . . .	60	. . . .	
		(B)	3	60	. . . .	. . . .	
676	Electrical Eng. Laboratory	VIA (A)	4	Summer		90	
		(B)	3	. . . .	. . . .	90	Laws
677	Electrical Eng. Laboratory	VIA (A)	4	. . . .	50	. . . .	Ricker
		(B)	4	50	. . . .	. . . .	
678	Electrical Eng. Laboratory	VIA (A)	5	Summer		50	
		(B)	4	. . . .	. . . .	50	
680a,b	Electrical Eng. Laboratory	VI Elective		Any term. Time (individually arranged)			Laws, Ricker
681	Electrical Eng. Laboratory 803a, 600, *601*	XIV	3	30–30	. . . .	. . . .	Laws
682	Electrical Eng. Laboratory 601, *602*, 681	XIV	3	. . . .	20–10	. . . .	Laws, Ricker
683	Electrical Eng. Laboratory 602, *603a*, 682	XIV	3	. . . .	. . . .	35–25	Laws, Ricker
684	Electrical Eng. Laboratory *604a*, 683.	XIV	4	35–25	. . . .	. . . .	Ricker
685	Electrical Eng. Laboratory 640 or 641; 642	II; $III_{1,2}$; IXB; XV_2	4	. . . .	. . . .	30–40	Laws
		X; XV_2	4	30–40	. . . .	. . . .	Ricker
		VIII	3	. . . .	30–40	. . . .	
		III_3	4	. . . .	30–40	. . . .	
686	Electrical Eng. Laboratory 640 or 641, *642*	I	3	. . . .	20–30	. . . .	Laws
		XV_1	3	. . . .	. . . .	20–30	Ricker
687	Electrical Eng. Laboratory 645, 646	XIII-A	4	. . . .	. . . .	10–0	Ricker
689	Technical Electrical Measurements	III	4	. . . .	. . . .	15–15	Laws
690	Technical Electrical Measurements 803a, 640	VIII	3	30–45	. . . .	. . . .	Laws
695	Electrical Testing (Advanced)	VI (Elective)	G	5 to 10 hours per week			Laws
696	Electrical Engineering Laboratory (Advanced)	VI (Elective)	G	5 hours per week			Ricker

BIOLOGY AND PUBLIC HEALTH — 700 - 799

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
701	General Biology 501	VII	2	. . . .	. . . .	140–60	Sedgwick
702	Biology Elements	XI	3	20–10	. . . .	. . . .	Sedgwick
703	Theoretical Biology 701, 710	VII	4	20–20	20–20	20–30	Turner
704	Genetics . . . Optional 701, 710	VII	4	30–60	. . . .	. . . .	Turner
706	Microscopy of Drinking Waters 701, or 702	XI	4	. . . .	. . . .	20–20	Turner
707	Parasitology 701	VII	4	10–20	10–20	10–20	Bigelow
710	Anatomy and Histology 701	VII	3	80–40	70–30	70–30	Bigelow
		IX-A	3	70–40	. . . .	. . . .	
715	Anthropology	VII	3	. . . .	20–30	. . . .	Sedgwick
720	Physiology	VII; IX-A	3	. . . .	60–60	60–60	Sedgwick
722	Personal Hygiene	VII	4	30–30	. . . .	. . . .	Sedgwick
729	General Biology and Bacteriology 512	V_2	2	. . . .	. . . .	70–15	Prescott
		IX-A	2	. . . .	. . . .	70–60	
730	Bacteriology 701, 512	VII	3	50–30	50–30	50–20	Prescott

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
731	Elements of Bacteriology... 702, 512	XI	3	. . . .	50–10	. . . .	Prescott
732	Bacteriology of Water and Sewage..... 731	XI	4	. . . .	30–10	. . . .	Prescott
736	Industrial Microbiology.... 733, 550	VII$_2$	4	60–20	80–30	80–20	Prescott
		VII$_3$	4	60–20	. . . .	. . . .	
738	Public Health Lab. Methods 730, *750*	VII	4	. . . .	60–20	60–20	Slack
750	Biology of Infectious Diseases 701, 730	VII	4	. . . .	20–30	20–30	Slack
753	Industrial Hygiene and Sanitation..... 754	VII$_{2,3}$	4	. . . .	30–30	. . . .	Turner
754	Problems and Practice in Public Health..... 701, 730	VII$_3$	4	. . . .	30–30	30–30	Sedgwick
756	Sanitary Science and Public Health.....	I$_1$; IV$_2$; VII XI; XV$_1$	4	. . . .	. . . .	20–0	Sedgwick
758	Vital Statistics.....	VII	4	30–30	. . . .	. . . .	Sedgwick
		XI	4	20–20	. . . .	. . . .	
764	Municipal Sanitation.....	VII$_3$	4	20–30	20–30	. . . .	Sedgwick
780	Biological Colloquium.....	VII	4	10–10	10–10	10–10	Sedgwick

PHYSICS — 800-899

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
800a	Physics (Mechanics)..... 800c, M10, M11	All Courses	1	40–50	. . . .	. . . .	Wilson
801a	Physics (Mechanics) (Optics) 800a	All Courses except IV$_1$, third term	1	. . . .	40–50	40–50	Wilson
801c	Physics (Light, Heat and Electricity)..... 800a	IV$_1$	1	. . . .	. . . .	30–60	Derr
802a	Physics (Electricity)..... 800a, 801a, *M21*	All Courses except IV$_1$	2	40–50	. . . .	. . . .	Franklin
803a	Physics (Electricity) (Heat) 800a, 801a, M21	All Courses except IV$_1$	2	. . . .	40–50	40–50	Franklin
804	Precision of Measurements.	Students from other Colleges	One lecture and various time allotments in first term				Goodwin
806	Color and Acoustics.....	IV$_2$	3	10–10	. . . .	. . . .	Derr
807	Meteorology.....	(Elective)	3 or 4	30–30	. . . .	. . . .	Townshend
808	Descriptive Astronomy.....	(Elective)	3 or 4	. . . .	30–30	. . . .	Derr
809	Physical Instruments..... 200, 803a	VIII	2	. . . .	. . . .	40–20	Norton
		IX$_A$	3	. . . .	. . . .	40–20	
810	Physical Literature..... L11 or L61, 803a	VIII	2	. . . .	20–40	20–40	Derr
811	Heat Measurements..... 803a	VIII	3	. . . .	. . . .	50–40	Norton
812	Heat Measurements..... 803a	III$_{1,2}$	3	. . . .	40–15	. . . .	Norton
813	Heat Measurements.....	II; X; XIV	(Given in connection with Engineering Laboratory)				Norton
814	Heat Measurements II..... 811 or 812	(Elective)	4 or 6	40–	. . . .	. . . .	Norton
816	Photography..... 803a	VIII	3	60–30	. . . .	. . . .	Derr
817	Geometrical Optics..... 803a	VIII	3	. . . .	40–60	. . . .	Derr
818	Physical Optics..... 817	VIII	3	. . . .	. . . .	60–30	Derr
820	Electricity..... M22, 803a, *823*	VIII	3	. . . .	50–50	50–40	Page

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
823	Theoretical Physics. 803a, M22	VIII	3	30–60	30–60	30–60	Wilson
		IX-A	4	30–60	30–60	30–60	
824	Aeronautical Instruments	(Elective)	G	.. ..	.. ..	40–50	Young
826	Aeronautics II	(Elective)	G	20–70	20–70	20–70	Wilson
827	Electrodynamics. 823	(Elective)	G	20–70	20–70	20–70	Wilson
828	Electromagnetic Theory. 823 (Not offered	in 1920-21)	G	20–70	20–70	20–70	Wilson
829	Applied Electromagnetism. 823 (Not offered	in 1920-21)	G	20–70	20–70	20–70	Wilson
830	Constitution of Matter. 827, 828 or 829		G	20–70	20–70	20–70	Wilson
834	Microscope Theory and Photomicrography. 816, 817		G	60–30	.. ..	.. ..	Derr
835	Optical Measurements. 818		G	.. ..	60–30	.. ..	Goodwin
839	Kinetic Theory and Correlation. M26		G	.. ..	20–20	20–20	Franklin
860	Airplane Design. *M41*		G	90–30	70–20	.. ..	Warner
861	Airship Design		G	.. ..	90–30	50–20	Warner
862	Aerial Propellers		G	.. ..	10–40	.. ..	Warner
863	Aeronautical Laboratory		G	.. ..	.. ..	60–20	Warner
870	Research in Mathematical Physics	In these Research courses the students work individually and the amount of work in each term is optional jointly with the student and Professor.					Wilson
871	Research in Electrochemistry						Goodwin
872	Research in Industrial Physics						Norton
873	Photography and Optical Research						Derr
874	Research in Illumination						Drisko
875	Research in Applied Electrochemistry						Thompson
876	Research in Electricity and Magnetism						Page
877	Thermal Research						Wilkes
878	Aeronautical Research						Warner
879	Properties of Matter						Hersey
880	Electrochemistry, Principles of. 512, 801, M22	VIII	4	40–70	30–60	.. ..	Goodwin
		XIV	3	40–70	30–60	30–60	
881	Electrochemistry, Principles of. 880	VIII	4	.. ..	.. ..	20–40	Goodwin
882	Electrochemistry II. 880	XIV	4	30–60	.. ..	.. ..	Goodwin
		(Elective)	G				
885	Applied Electrochemistry. 882	XIV	4	.. ..	30–60	10–50	Thompson
		(Elective)	G				
886	Electrochemical Laboratory 882	XIV	4	70–0	.. ..	.. ..	Goodwin
		(Elective)	G				
887	Applied Electrochemical Laboratory. 885	XIV	4	.. ..	70–0	.. ..	Thompson
		(Elective)	G				
889	Electric Furnaces 811, 685	VIII	4	.. ..	40–20	.. ..	Thompson
		(Elective)	G	40–20	.. ..	.. ..	
890	Electrochemistry, Elements of. 801	III$_2$	3	.. ..	30–30	.. ..	Thompson
893	Colloquium. 882	XIV	4	.. ..	10–10	10–10	Goodwin
		(Elective)	G				
898	Glass Blowing	(Elective)	4, G	8 0	.. ..	.. ..	Thompson

GEOLOGY — 1200-1299

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
1201	Mineralogy and Petrology 503, 801a	III, XII, IX-A.	2 3	80–10 60–10	. . . .	. . . .	Warren
1202	Mineralogy and Petrology 1201	III, XII$_3$, IX-A	2 3	. . . .	80–10 40–20	. . . .	Warren
1203	Mineralogy 503, 801a	V	2	. . . .	. . . .	70–15	Warren
1214	Mineral and Petrography 1201, 1202	III$_3$	3	. . . .	60–30	30–20	Warren
1215	Petrography 1201, 1202 and *1231, 1232*	XII	3	40–20	40–20	60–40	Warren
1216	Petrography (Advanced) 1215	XII	G	60–60	60–60	60–60	Warren
1217	Chemical Mineralogy and Petrology 503, 802, 1230, 1231, 1232	XII	G	. . . .	30–60	30–60	Warren
1219	Crystallography 503, 801a	(Elective)		. . . .	. . . .	20–20	Warren
1220	Physical and Chemical Crystallography 503, 802, 1219	XII	G	. . . .	. . . .	60–60	Warren
1221	Microscopic Analysis 817, 818	VIII$_1$ and (Elective)	4	20–20	20–20	. . . .	Warren
1230	Geology 1202	III$_{1,3}$; XII IX-A.	3	30–30	. . . .	. . . .	Shimer
1230a	Geology, Dynamical	I; XI	3	30–20	. . . .	. . . .	Shimer
1230b	Geology General study except in I, III, XI, XII		3–4	30–30	. . . .	. . . .	Shimer
1231	Geology 1202, 1230	III$_{1,3}$; IX-A; XII	3	. . . .	30–30	. . . .	Shimer
1231a	Geology 1230a	I; XI	3	. . . .	40–25	. . . .	Shimer
1231b	Geology 1230 or 1230a or 1230b General study except in I, III, XI, XII		3	. . . .	30–30	. . . .	Shimer
1232	Geology 1202, 1231	III$_{1,3}$; XII IX-A.	3	. . . .	. . . .	30–30	Barry
1232a	Geology 1231a	I; XI	3	. . . .	. . . .	30–30	
1233	Geology, Field 104, 1202, 1232	III$_{1,3}$; XII	4	40–20	. . . .	. . . .	Barry
1234	Geological Surveying 1233	III$_{1,3}$	4	. . . .	. . . .	40–30	Barry
1234a	Geological Surveying 1215, 1233	XII	4	. . . .	. . . .	80–30	Lindgren
1235	Geological Surveying (Advanced) 1215, 1234	XII	G	60–60	. . . .	60–60	Lindgren
1240	Geology, Economic 1202, 1232	III$_1$; III$_3$; XII	4	. . . .	50–50 50–40	. . . .	Lindgren
1241	Geology, Economic 1240	III$_3$; XII	4	. . . .	. . . .	40–10 60–30	Lindgren
1242	Geology, Applied Economic 1240	III$_3$ XII	4	. . . .	. . . .	20–20	Lindgren
1243	Geology, Economic (Advanced) 1241	XII	G	60–30	60–30	60–30	Lindgren
1244	Geology of Coal and Petroleum 1230, 1231, 1232, 1233	XII and Elective	4	. . . .	30–30	. . . .	Jones
1245	Geology of Clay, Cement and Building Stone 1230, 1231, 1232	XII and Elective	4	. . . .	. . . .	20–20	Barry
1246	Geology of Soils and Soil Examination 1230, 1231, 1232	XII and Elective	4	. . . .	. . . .	20–20	Lindgren

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
1247	Engineering Geology..... 1230, 1231, 1232	XII and Elective	4	20–20	.. ..	.. ..	Barry
1250	Geology, Historical..... 1230, 1231, 1232	IIIs; XII	4	.. ..	40–30	.. ..	Shimer
1251	Paleontology..... 1230, 1231	XII	3	30–40	30–40	.. ..	Shimer
1251a	Paleontology.....	VII	4	20–20	40–20	40–20	Shimer
1252	Paleontology (Advanced).. 1251	XII	G	.. ..	10–30	.. .. / 10–30	Shimer
1253	Index Fossils..... 1230, 1231	XII	4	60–30	.. ..	.. ..	Shimer
1254	Organic Evolution.....	Gen. Study	3 or 4	.. ..	.. ..	30–30	Shimer
1255	Organic Evolution Adv.... 1254	XII and Elective	G	.. ..	.. ..	20–40	Shimer
1260	Physiography..... 1230, 1231, 1232	XII	4	30–30	.. ..	.. ..	Shimer
1261	Hydrology..... 1230, 1231, 1232	XII	4	.. ..	20–20	.. ..	Lindgren
1262	Geological Seminar.....	XII	4	30–60	30–60	.. ..	Dept. Staff
1263	Geology of North America. 1230, 1231, 1232, 1215, 1250	XII	4	.. ..	30–60	.. ..	Dept. Staff
1264	Geology of Europe..... 1230, 1231, 1232, 1215, 1253.	XII	4	.. ..	.. ..	30–60	Dept. Staff

NAVAL ARCHITECTURE AND NAVAL ENGINEERING 1300-1399

NAVAL ARCHITECTURE 1300-1399

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
1301	Naval Architecture..... M22, 220, *1342*	XIII	3	20–30	20–40	20–40	Jack
1302	Naval Architecture..... 1301, *1343*	XIII / XIIIA	4 / 4	20–40 / 20–40	30–60 / 20–40	.. .. /	Jack
1311	Theory of Warship Design *1301*	XIIIA	4	40–40	40–40	40–40	Hovgaard
1312	Theory of Warship Design 1311, *1302*	XIIIA	G	40–40	40–40	40–40	Hovgaard
1314	Shipyard Practice 1301, 1311	XIIIA	4	.. ..	30–40	.. ..	Jack
1315	Shipyard Organization and Management.....	XIII	4	.. ..	.. ..	20–20	Jack
1321	Warship Design..... 1301, *1311*	XIIIA	4	80–0	80–0	80–0	Hovgaard
1322	Warship Design..... 1311, *1312*	XIIIA	G	60–0	60–0	60–0	Hovgaard
1325	Shipyard Visits.....	XIIIA	4	40–0	.. ..	.. ..	Jack
1331	Ship Construction..... D13, 212	XIII	2	.. ..	.. ..	20–20	Owen
1332	Ship Construction..... 1331, 1342	XIII	3	.. ..	10–10	20–20	Owen Jack
1333	Ship Construction.....	XIII	4	20–20	20–20	20–20	
1341	Ship Drawing..... D 13, 206	XIII	2	.. ..	.. ..	60– 0	Owen
1342	Ship Drawing..... 1331, 1301	XIII	3	50–0	60–0	70–0	Owen
1343	Ship Drawing..... 1301, 1342	XIII	4	75–0	90–0	60–0	Owen
1351	Marine Engineering..... 223a, 241a, 242	XIII	4	.. ..	20–40	20–30	
1352	Marine Engineering Design *1351*	XIII	4	.. ..	60–0	50–0	
1353	Marine Engineering.....	XIIIA	G	30–30	.. ..	.. ..	
1355	Marine Engine Design....	XIIIA	G	60–30	30–15	.. ..	
1360	Marine Steam Turbines... 241a, 242	XIII	4	30–60	.. ..	.. ..	

DRAWING AND DESCRIPTIVE GEOMETRY

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
D11	Drawing and Desc. Geom. M_2, M_3	All Courses	1	60–0	. . . .	. . . .	Kenson
D12	Drawing and Desc. Geom. DII	All courses except I, IV, XI, XV_1	1	. . . .	60–0	. . . .	Kenison
D13	Drawing and Desc. Geom. D11, D12	All courses except I; IV; XI; XV_1	1	. . . .	. . . .	60–0	Kenison
D14	Drawing and Desc. Geom. D11	I; XI; XV_1	1	. . . .	60–0	. . . .	Kenison
D15	Drawing and Desc. Geom. D11, D14	I; XI; XV_1,	1	. . . .	. . . .	60–0	Kenison
D16	Drawing and Desc. Geom. D11	IV	1	. . . .	60–0	. . . .	Kenison
D17	Drawing and Desc. Geom. D11, D16	IV	1	. . . .	60–0	. . . .	Kenison
D18	Freehand Drawing	IV	1	70–0	. . . .	. . . .	Brigham
D19	Freehand Drawing. D18	IV	1	. . . .	30–0	. . . .	Brigham
D20	Freehand Drawing	IV	1	. . . .	. . . .	40–0	Brigham
D21	Desc. Geom. D15	XI	2	. . . .	50–0	. . . .	Kenison
		XV_1;	2	45–0	. . . .	. . . .	Kenison
D23	Desc. Geom. D15	I	2	60–45	. . . .	. . . .	Kenison
D28	Stereotomy. D23	I	2	. . . .	50–10	. . . .	Bradley
D42	FreehandDrawing. D19	IV	2	40–0	40–0	40–0	Brown
D43	Freehand Drawing. D42	IV_1	3	40–0	40–0	40–0	Brown
D44	Life Class. D43	IV_1	4	60–0	60–0	60–0	Brown
D45	Life Class and Decorative Design. D44	Elective IV_1	G	60–0	60–0	60–0	Brown

ECONOMICS

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
Ec22	Political Economy. Ec 50	XV_1; XV_3	2	. . . .	30–30	30–30	Doten
		XV_2	2	30–30	30–30	. . . .	
Ec31	Political Economy. EH21, 22, 23	All courses except XV	3	30–30	30–30	30–30	Dewey
Ec36	Banking and Finance	Elective	3–4	. . . .	30–30	. . . .	Dewey
Ec37	Banking. Ec50, Ec22	XV	3	30–50	. . . .	. . . .	Dewey
Ec38	Securities and Investments Ec65, Ec56	XV	3	. . . .	. . . .	30–40	Dewey
Ec46	Industrial Relations	XV_1	3	. . . .	. . . .	30–45	Doten
	Ec22 or Ec31	XV_3; XV_3	3	. . . .	. . . .	30–50	
Ec47	Political and Social Problems	Elective	3	30–30	. . . .	. . . .	Doten
Ec50	Accounting. EH11, 12, 13	XV_1; XV_3	2	40–50	. . . .	. . . .	Shugrue
		XV_2	2	. . . .	. . . .	40–50	
Ec51	Cost Accounting. Ec50, *Ec58*	XV	4	. . . .	40–70	. . . .	Shugrue
Ec56	Industrial Organization. Ec22, Ec50	XV	3	30–60	30–60	. . . .	Armstrong
Ec58	Business Management. Ec56, Ec46	XV	4	30–60	30–60	40–80	Schell
Ec60	Business Law. Ec56, Ec37, Ec38	XV	4	20–40	20–40	20–40	Schaub

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
Ec62	Business and Patent Law	Elective IV	3 4	. . . .	. . . .	30–30 30–30	Albers
Ec65	Statistics Ec56	XV	3	. . . .	40–10	. . . .	Dewey

ENGLISH AND HISTORY

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
E10	English	Foreign Students	1	30–50	30–50	30–50	Seaver
EH11	English and History	All courses	1	30–50	. . . .	. . . .	Robinson
EH12	English and History EH11	All courses		. . . .	30–50	. . . .	Robinson
EH13	English and History EH12	All courses	1	. . . .	. . . .	30–50	Robinson
EH15	Special Composition	As required	1	. . . .	. . . .	. . . .	Rogers
E20	English E10	Foreign Students	2	20–20	20–20	20–20	Seaver
EH21	English and History EH13	All courses	2	30–50	. . . .	. . . .	Aydelotte
EH22	English and History EH21	All courses	2	. . . .	30–50	. . . .	Aydelotte
EH23	English and History EH22b	All courses	2	. . . .	. . . .	30–50	Aydelotte
E31	English	VIA	3	20–40	Summer Term		
E32	English E31?23	XV	3	. . . .	30–60	. . . .	Aydelotte
E33	Report Writing EH23	XV$_1$ XV$_2$, XV$_3$	3 3	30–30	 30–30	. . . .	Prescott
E51	English (Contemporary Literature)	Elective		30–30	. . . .	. . . .	Rogers
E52	English (Contemporary Literature)	Elective		. . . .	30–30	. . . .	Rogers
E53	English (Shakespeare)	Elective		. . . .	. . . .	30–30	Aydelotte
E54	English (Literature and Science)	Elective		30–30	. . . .	. . . .	Aydelotte
E55	English (Informal Public Speaking; Committee Reports and Discussions)	Elective		. . . .	30–30	. . . .	Pearson
H51	History (Lincoln)	Elective		. . . .	. . . .	30–30	Pearson
E56	English (Human Factor in Business)	Elective		. . . .	30–30	. . . .	Robinson
E57	English (Engineering Publicity)	Elective		. . . .	. . . .	30–30	Robinson

MODERN LANGUAGES

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
L11	German (Elementary)	(Elective)	1	30–60	30–60	30–60	Vogel
L21	German (Intermediate) L11	V; IX-A; X; XIV VII; XV$_3$ XII	2 2 3	30–50 30–30 30–50	30–50 30–30 30–50	30–50 30–30 30–50	Vogel
L31	German (Advanced) L21	X	3	30 30	. . . .	. . . .	
L32	German (Advanced) Option in General Studies L21	(Elective)	3, 4	30–30	. . . .	. . . .	Vogel

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
L33	German (Advanced)..... Option in General Studies	(Elective)	3, 4	.. ..	30–30	.. ..	Vogel
L41	German (Advanced) Literature..... Option in General Studies L21	(Elective)	3, 4	.. ..	30–30	.. ..	Vogel
L42	German (Advanced) Drama Option in General Studies L21	(Elective)	3, 4	.. ..	....	30–30	Vogel
L43	German (Advanced) Composition and Conversation Option in General Studies L21	(Elective)	3, 4	.. ..	.. ..	30–30	Vogel
L44	German (Advanced) Sight Reading..... Option in General Studies L21	(Elective)	3, 4	.. ..	30–0	30–0	Vogel
L45	German (Advanced) Life of German Scientific men Option in General Studies L21	(Elective)	3, 4	.. ..	30–30	30–30	Vogel
L46	German (Advanced) Faust.. Option in General Studies L21	(Elective)	3, 4	.. ..	.. ..	30–30	Vogel
L47	German (Advanced) Commercial Correspondence.. Option in General Studies L21	(Elective)	3, 4	.. ..	30–30	30–30	Vogel
L61	French (Elementary).....	(Elective)	1	30–60	30–60	30–60	Langley
L62	French (Intermediate).....	(Elective)	1	30–60	30–60	30–60	Langley
L63	French (Intermediate)..... L61	IV$_1$	1	.. ..	20–40	20–40	Langley
L64	French Technical (Elective) L61	V; X	2	30–50	.. ..	.. ..	Langley
L71	French (Advanced)..... Architectural Reading L62	IV$_1$	2	20–30	20–30	.. ..	Langley
L72	French (Advanced) French History..... Option in General Studies L62	(Elective) VII optional	3, 4 2	30–30 30–30	30–30 30–30	30–30 30–30	Langley
L73	French (Advanced) French Literature..... Option in General Studies L62	(Elective) VII	3, 4 2	30–30 30–30	30–30 30–30	30–30 30–30	Langley
LS1	Spanish (Elementary).....	(Elective) III$_1$	3, 4 4	30–60	20–30 20–30	40–50 40–50	Langley

MATHEMATICS

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation 1st Term	2d Term	3d Term	Instructor in Charge
M11	Mathematics..... (Calculus, Introductory) M1, M2, M3	All courses	1	30–60	.. ..	.. ..	Tyler
M12	Mathematics..... (Analytic Geometry) M1, M2, M3	All courses	1	.. ..	30–60	.. ..	Bailey
M13	Mathematics (Analytic) Geometry and Calculus) M11, M12	All courses	1	.. ..	.. ..	30–60	George
M15	Slide Rule.....	Elect.....		Four Exercises	.. ..	.. ..	Lipka

No.	Subject and Preparation	Taken by	Year	Term and Hours of Exercise and Preparation: 1st Term	2d Term	3d Term	Instructor in Charge
M21	Mathematics (Integral Calculus) M13	All courses	2	30–60	.. ..	.. ..	Woods
M22	Mathematics (Calculus and Differential Equations) M21	All courses	2	.. ..	30–60	.. ..	Bartlett
M23	Applied Mathematics M22	All courses except IV1, V, VII, X'	2	.. ..	.. ..	30–60	Moore
M26	Theory of Probability and Method of Least Squares M22	VIII2	4	20–20	20–20	.. ..	Bartlett
M35	Mathematics M23	VI	3	30–60	.. ..	.. ..	Moore
		VIA (A)		.. ..	30–60	.. ..	
		(B)		30–60	.. ..	.. ..	
M36	Mathematics (Advanced Calculus & Diff. Equations) M22	VIII	3	30–60	.. ..	.. ..	Woods
M38	Mathematics (Advanced Calculus & Diff. Equations) M36	VIII	3	.. ..	30–60	.. ..	Woods
M39	Mathematics (Advanced Calculus & Diff. Equations)	VIII	3	.. ..	.. ..	30–60	Woods
M41	Applied Mathematics	X	4	30–60	.. ..	.. ..	Moore
M45	Fourier's Series M35 or 36	(Elective)		20–40	20–40	20–40	Bailey
M50	Applications of Mathematics to Chemistry M23	(Elective)		.. ..	30–60	.. ..	Hitchcock
M54	Mathematical Laboratory M22	IX-B	4	.. ..	20–40	20–40	Lipka
		(Elective)	3, 4, G	.. ..	20–40	20–40	
M60	Vector Analysis	(Elective)		30–60	.. ..	.. ..	Different Members of department from year to year.
M61	Mechanics of Rigid Bodies	(Elective)		.. ..	30–60	.. ..	
M62	Modern Algebra	(Elective)		.. ..	.. ..	30–60	
M63	Modern Geometry	(Elective)		30–60	30–60	30–60	
M64	Modern Analysis	(Elective)		30–60	30–60	30–60	
M65	Analytical Mechanics	(Elective)		30–60	30–60	30–60	
M66	Theory of Sound	(Elective)		30–60	.. ..	.. ..	
M67	Heat Conduction	(Elective)		.. ..	30–60	.. ..	
M68	Thermodynamics	(Elective)		30–60	.. ..	.. ..	
M69	Statistical Mechanics	(Elective)		.. ..	.. ..	30–60	

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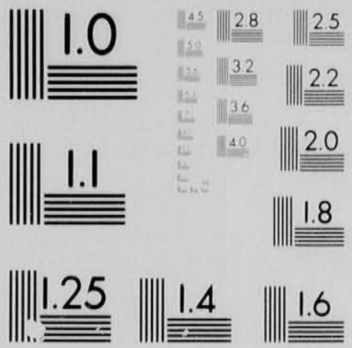
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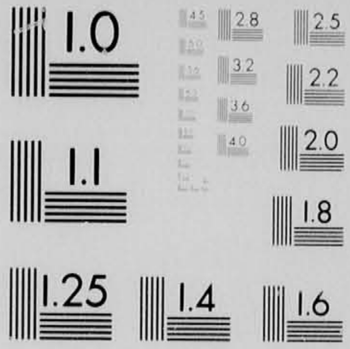
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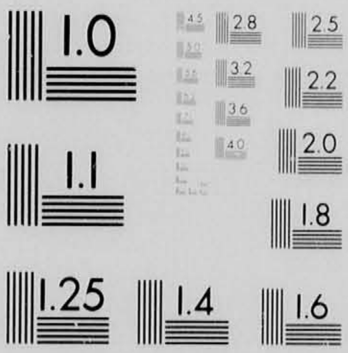
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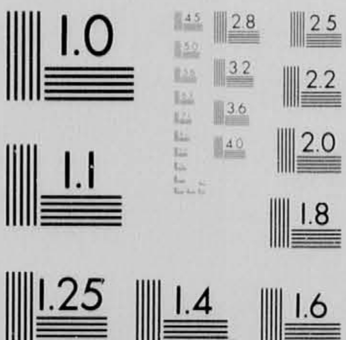
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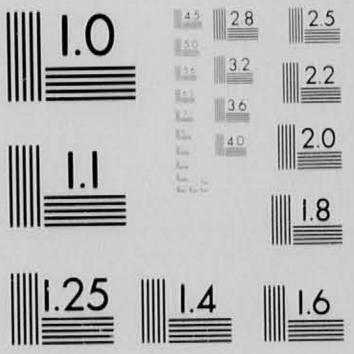
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